VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

I SEMESTER B.E./B.TECH.

PHYSICS GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory / Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT11	Engineering Maths I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15PHY12	Engineering Physics	BS	Physics	Basic Sc.	4 (T)	80	20	100	4
3	15CIV13	Elements of Civil Engg. & Mechanics	ES	Civil Engg.	Civil Engg.	4 (T)	80	20	100	4
4	15EME14	Elements of Mechanical Engg.	ES	Mech. Engg.	Mech. Engg.	4 (T)	80	20	100	4
5	15ELE15	Basic Electrical Engg.	ES	E & E	E & E	4 (T)	80	20	100	4
6	15WSL16	Workshop Practice	ES	Mech., Auto, IP, IEM, Mfg. Engg.	Mech. Engg.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
7	15PHYL17	Engg. Physics Lab	BS	Physics	Basic Sc.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
8	15CPH18	Constitution of India, Professional Ethics and Human Rights (CPH)	MNC	Humanities		2 (Tutorial)	40	10	50	--
9		Language (Kan.)	Mandatory Learning	Humanities		1 (T)	-	-	-	--
						29	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

II SEMESTER B.E./B.TECH.

PHYSICS GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory / Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT21	Engineering Maths II	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15PHY22	Engineering Physics	BS	Physics	Basic Sc.	4 (T)	80	20	100	4
3	15CIV23	Elements of Civil Engg. & Mechanics	ES	Civil Engg.	Civil Engg.	4 (T)	80	20	100	4
4	15EME24	Elements of Mechanical Engg.	ES	Mech. Engg.	Mech. Engg.	4 (T)	80	20	100	4
5	15ELE25	Basic Electrical Engg.	ES	E & E	E & E	4 (T)	80	20	100	4
6	15WSL26	Workshop Practice	ES	Mech., Auto, IP, IEM, Mfg. Engg.	Mech. Engg.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
7	15PHYL27	Engg. Physics Lab	BS	Physics	Basic Sc.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
8	15CPH28	Constitution of India, Professional Ethics and Human Rights	MNC	Humanities		2 (Tutorial)	40	10	50	--
9		Language (Kan.)	Mandatory Learning	Humanities		1 (T)	-	-	-	--
						29	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

I SEMESTER B.E./B.TECH.

CHEMISTRY GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT11	Engineering Maths-I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15CHE12	Engineering Chemistry	BS	Chemistry	Basic Sc.	4 (T)	80	20	100	4
3	15PCD13	Programming in C & Data Structures	ES	Any Engineering Department	CSE	4 (T)	80	20	100	4
4	15CED14	Computer Aided Engineering Drawing	ES	Mech./IP/Auto/ Mfg.Engg./ IEM	Mech. Engg.	6 (2I+ 4P)	80	20	100	4
5	15ELN15	Basic Electronics	ES	E & C / E & E / TC / IT	E & C	4 (T)	80	20	100	4
6	15CPL16	Computer Programming Lab	ES	Any Engineering Department	CSE	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
7	15CHEL17	Engg. Chemistry Lab	BS	Chemistry	Basic Sci.	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
8	15CIV18	Environmental Studies	MNC	Civil / Environmental	Civil	2 (Tutorial)	40	10	50	–
9		Language (Eng.)	Mandatory Learning	Humanities		1 (T)	-	-	-	–
					Total	31	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

II SEMESTER B.E./B.TECH.

CHEMISTRY GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT21	Engineering Maths-II	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15CHE22	Engineering Chemistry	BS	Chemistry	Basic Sc.	4 (T)	80	20	100	4
3	15PCD23	Programming in C & Data Structures	ES	Any Engineering Department	CSE	4 (T)	80	20	100	4
4	15CED24	Computer Aided Engineering Drawing	ES	Mech./IP/Auto/ Mfg.Engg./ IEM	Mech. Engg.	6 (2I+ 4P)	80	20	100	4
5	15ELN25	Basic Electronics	ES	E & C / E & E / TC / IT	E & C	4 (T)	80	20	100	4
6	15CPL26	Computer Programming Lab	ES	Any Engineering Department	CSE	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
7	15CHEL27	Engg. Chemistry Lab	BS	Chemistry	Basic Sc.	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
8	15CIV28	Environmental Studies	MNC	Civil / Environmental	Civil	2 (Tutorial)	40	10	50	–
9		Language (Eng.)	Mandatory Learning	Humanities		1 (T)	-	-	-	–
					Total	31	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

(Common to _____________)

III SEMESTER

Sl. No	Subject Code	Title	Teaching Hours / Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics – III	04		03	80	20	100	4
2	15CV32	Strength of Materials	04		03	80	20	100	4
3	15CV33	Fluid Mechanics	04		03	80	20	100	4
4	15CV34	Basic Surveying	04		03	80	20	100	4
5	15CV35	Engineering Geology	04		03	80	20	100	4
6	15CV36	Building Materials and Construction	04		03	80	20	100	4
7	15CVL37	Building Materials Testing Laboratory		1I+2P	03	80	20	100	2
8	15CVL38	Basic Surveying Practice		1I+2P	03	80	20	100	2
TOTAL			**24**	**6**	**24**	**640**	**160**	**800**	**28**

Note:

Core Subjects:	*15CV31, 15CV32, 15CV33, 15CV34, 15CV35, 15CV36*
Laboratory & Practice:	*15CVL37, 15CVL38*

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

(Common to ______________)

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours / Week		Examination				Credits
			Theory	Practical / Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics – IV	04		03	80	20	100	4
2	15CV42	Analysis of Determinate Structures	04		03	80	20	100	4
3	15CV43	Applied Hydraulics	04		03	80	20	100	4
4	15CV 44	Concrete Technology	04		03	80	20	100	4
5	15CV45	Basic Geotechnical Engineering	04		03	80	20	100	4
6	15CV46	Advanced Surveying	04		03	80	20	100	4
7	15CVL47	Fluid Mechanics Laboratory		1I+2P	03	80	20	100	2
8	15CVL48	Engineering Geology Laboratory		1I+2P	03	80	20	100	2
		TOTAL	**24**	**06**	**24**	**640**	**160**	**800**	**28**

Note:

Core Subjects:	*15CV 41, 15CV42, 15CV43, 15CV 44, 15CV45, 15CV46*
Laboratory & Practice:	*15CVL47, 15CVL48*

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

V SEMESTER

Sl. No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15CV51	Design of RC Structural Elements	04		03	80	20	100	4
2	15CV52	Analysis of Indeterminate Structures	04		03	80	20	100	4
3	15CV53	Applied Geotechnical Engineering	04		03	80	20	100	4
4	15CV54	Computer Aided Building Planning and Drawing	01	3D	03	80	20	100	4
5	15CV55X	Professional Elective-1	03		03	80	20	100	3
6	15CV56X	Open Elective-1	03		03	80	20	100	3
7	15CVL57	Geotechnical Engineering Laboratory		1I+2P	03	80	20	100	2
8	15CVL58	Concrete and Highway Materials Laboratory		1I+2P	03	80	20	100	2
		TOTAL	**19**	**09**	**24**	**640**	**160**	**800**	**26**

Professional Elective 1		Open Elective 1	
15CV551	Air pollution and Control	15CV561	Traffic Engineering
15CV552	Railways, Harbours, tunneling and Airports	15CV562	Sustainability Concepts in Engineering
15CV553	Masonry Structures	15CV563	Remote Sensing and GIS
15CV554	Theory of Elasticity	15CV564	Occupational Health and Safety
		15NC565	NCC

1. **Professional Elective:** Elective relevant to chosen specialization/ branch
2. **Open Elective:** Electives from other technical and/or emerging subject areas

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

VI SEMESTER

Sl. No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15CV61	Construction Management and Entrepreneurship	04		03	80	20	100	4
2	15CV62	Design of Steel Structural Elements	04		03	80	20	100	4
3	15CV63	Highway Engineering	04		03	80	20	100	4
4	15CV64	Water Supply and Treatment Engineering	04		03	80	20	100	4
5	15CV65X	Professional Elective 2	03		03	80	20	100	3
6	15CV66X	Open Elective 2	03		03	80	20	100	3
7	15CVL67	Software Application Lab		1I+2P	03	80	20	100	2
8	15CVP68	Extensive Survey Project /Camp		1I+2P	03	80	20	100	2
TOTAL			22	6	24	640	160	800	26

Professional Elective-2		Open Elective-2	
15CV651	Solid Waste Management	15CV661	Water Resource Management
15CV652	Matrix Method of Structural Analysis	15CV662	Environmental Protection and Management
15CV653	Alternative Building Materials	15CV663	Numerical Methods and applications
15CV654	Ground Improvement Techniques	15CV664	Finite Element Analysis

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

VII SEMESTER

Sl. No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CV71	Municipal and Industrial Waste Water Engineering	04		03	20	80	100	4
2	15CV72	Design of RCC and Steel Structures	04		03	20	80	100	4
3	15CV73	Hydrology and Irrigation Engineering	04		03	20	80	100	4
4	15CV74X	Professional Elective 3	03		03	20	80	100	3
5	15CV75X	Professional Elective 4	03		03	20	80	100	3
6	15CVL76	Environmental Engineering Laboratory		1I+2P	03	20	80	100	2
7	15CVL77	Computer Aided Detailing of Structures		1I+2D	03	20	80	100	2
8	15CVP78	Project Phase I +Project Seminar		3		100		100	2
TOTAL			**18**	**9**	**21**	**240**	**560**	**800**	**24**

Professional Elective 3		Professional Elective 4	
15CV741	Design of Bridges	15CV751	Urban Transportation and Planning
15CV742	Ground Water & Hydraulics	15CV752	Prefabricated Structures
15CV743	Design Concept of Building Services	15CV753	Rehabilitation and Retrofitting of Structures
15CV744	Structural Dynamics	15CV754	Reinforced Earth Structures

1. Project Phase-I + Seminar: Literature Survey, Problem Identification, objectives and Methodology, Submission of synopsis and seminar

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016
B.E. CIVIL ENGINEERING

VIII SEMESTER

SL No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CV81	Quantity Surveying and Contracts Management	4	-	3	20	80	100	4
2	15CV82	Design of Pre Stressed Concrete Elements	4	-	3	20	80	100	4
3	15CV83X	Professional Elective 5	3	-	3	20	80	100	3
4	15CV84	Internship/Professional Practice	Industry Oriented		3	50	50	100	2
5	15CVP85	Project Work	-	6	3	100	100	200	6
6	15CVS86	Seminar on current trends in Engineering and Technology	-	4	-	100	-	100	1
		TOTAL	11	10	15	310	390	700	20

Professional Elective 5	
15CV831	Earthquake Engineering
15CV832	Hydraulic Structures
15CV833	Pavement Design
15CV834	Advanced Foundation Design

1.2.1

1.2.1
CSE

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering/ B.E. Information Science & Engineering

III SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics - III	04	--	03	80	20	100	4
2	15CS32	Analog and Digital Electronics	04	--	03	80	20	100	4
3	15CS33	Data Structures and Applications	04	--	03	80	20	100	4
4	15CS34	Computer Organization	04	--	03	80	20	100	4
5	15CS35	Unix and Shell Programming	04	--	03	80	20	100	4
6	15CS36	Discrete Mathematical Structures	04	--	03	80	20	100	4
7	15CSL37	Analog and Digital Electronics Laboratory	--	1I+2P	03	80	20	100	2
8	15CSL38	Data Structures Laboratory	--	1I+2P	03	80	20	100	2
		TOTAL	24	6	24	640	160	800	28

Note: 'I' Stands for Instruction Hours and 'P' for practical Hours

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering/ B.E. Information Science & Engineering

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT41	Engineering Mathematics - IV	04	--	03	80	20	100	4
2	15CS 42	Software Engineering	04	--	03	80	20	100	4
3	15CS43	Design and Analysis of Algorithms	04	--	03	80	20	100	4
4	15CS 44	Microprocessors and Microcontrollers	04	--	03	80	20	100	4
5	15CS45	Object Oriented Concepts	04	--	03	80	20	100	4
6	15CS46	Data Communication	04	--	03	80	20	100	4
7	15CSL47	Design and Analysis of Algorithm Laboratory	--	1I+2P	03	80	20	100	2
8	15CSL48	Microprocessors Laboratory	--	1I+2P	03	80	20	100	2
TOTAL			24	06	24	640	160	800	28

Note: 'I' Stands for Instruction Hours and 'P' for practical Hours

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering

V SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	**15CS51**	Management and Entrepreneurship for IT Industry	04	--	03	80	20	100	4
2	**15CS52**	Computer Networks	04	--	03	80	20	100	4
3	**15CS53**	Database Management System	04	--	03	80	20	100	4
4	**15CS54**	Automata theory and Computability	04	--	03	80	20	100	4
5	**15CS55x**	Professional Elective 1	03	--	03	80	20	100	3
6	**15CS56x**	Open Elective 1	03	--	03	80	20	100	3
7	**15CSL57**	Computer Network Laboratory	--	1I+2P	03	80	20	100	2
8	**15CSL58**	DBMS Laboratory with mini project	--	1I+2P	03	80	20	100	2
TOTAL			**22**	**6**	**24**	**640**	**160**	**800**	**26**

Professional Elective 1	
15CS551	Object Oriented Modeling and Design
15CS552	Introduction to Software Testing
15CS553	Advanced JAVA and J2EE
15CS554	Advanced Algorithms

1. **Professional Elective: Electives relevant to chosen specialization / branch**
2. **Open Elective: Electives from other technical and/or emerging subject areas (Announced separately)**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016
B.E. Computer Science & Engineering

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	**15CS61**	Cryptography, Network Security and Cyber Law	04	--	03	80	20	100	4
2	**15CS62**	Computer Graphics and Visualization	04	--	03	80	20	100	4
3	**15CS63**	System Software and Compiler Design	04	--	03	80	20	100	4
4	**15CS64**	Operating Systems	04	--	03	80	20	100	4
5	**15CS65x**	Professional Elective 2	03	--	03	80	20	100	3
6	**15CS66x**	Open Elective 2	03	--	03	80	20	100	3
7	**15CSL67**	System Software and Operating System Laboratory	--	1I+2P	03	80	20	100	2
8	**15CSL68**	Computer Graphics Laboratory with mini project	--	1I+2P	03	80	20	100	2
		TOTAL	**22**	**6**	**24**	**640**	**160**	**800**	**26**

Professional Elective 2	
15CS651	Data Mining and Data Warehousing
15CS652	Software Architecture and Design Patterns
15CS653	Operations research
15CS654	Distributed Computing system

1. **Professional Elective: Electives relevant to choosen specialization / branch**
2. **Open Elective: Electives from other technical and/or emerging subject areas (Announced separately)**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CS71	Web Technology and its applications	04	--	03	20	80	100	4
2	15CS72	Advanced Computer Architectures	04	--	03	20	80	100	4
3	15CS73	Machine Learning	04	--	03	20	80	100	4
4	15CS74x	Professional Elective 3	03	--	03	20	80	100	3
5	15CS75x	Professional Elective 4	03	--	03	20	80	100	3
6	15CSL76	Machine Learning Laboratory	--	1I+2P	03	20	80	100	2
7	15CSL77	Web Technology Laboratory with mini project	--	1I+2P	03	20	80	100	2
8	15CSP78	Project Phase 1 + Seminar	--	--	--	100	--	100	2
		TOTAL	18	6	21	240	560	800	24

Professional Elective 3		Professional Elective 4	
15CS741	Natural Language Processing	15CS751	Soft and Evolutionary Computing
15CS742	Cloud Computing and its Applications	15CS752	Computer Vision and Robotics
15CS743	Information and Network Security	15CS753	Digital Image Processing
15CS744	Unix System Programming	15CS754	Storage Area Networks

1. Professional Elective: Electives relevant to choosen specialization / branch
2. Project Phase 1 + Seminar : Literature Survey, Problem Identification, Objectives and Methodology, Submission of Synopsis and Seminar

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering
VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CS81	Internet of Things and Applications	4	--	3	20	80	100	4
2	15CS82	Big Data Analytics	4	--	3	20	80	100	4
3	15CS83x	Professional Elective 5	3	--	3	20	80	100	3
4	15CS84	Internship / Professional Practice	Industry Oriented		3	50	50	100	2
5	15CSP85	Project work phase II	--	6	3	100	100	200	5
6	15CSS86	Seminar	--	4	--	100	--	100	2
TOTAL			11	10	15	310	390	700	20

Professional Elective 5	
15CS831	High Performance Computing
15CS832	User Interface Design
15CS833	Network management
15CS834	System Modeling and Simulation

1. Professional Elective: Electives relevant to chosen specialization / branch
2. Internship / Professional Practice: To be carried out between 6th and 7th semester vacation or 7th and 8th semester vacation period

1.2.1
(ECE)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E Electronics & Communication Engineering / Telecommunication Engineering

(Common to Electronics & Communication and Telecommunication Engineering)

III SEMESTER

SL No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics -III	04		03	80	20	100	4
2	15EC32	Analog Electronics	04		03	80	20	100	4
3	15EC33	Digital Electronics	04		03	80	20	100	4
4	15EC34	Network Analysis	04		03	80	20	100	4
5	15EC35	Electronic Instrumentation	04		03	80	20	100	4
6	15EC36	Engineering Electromagnetics	04		03	80	20	100	4
7	15ECL37	Analog Electronics Lab		1I+2P	03	80	20	100	2
8	15ECL38	Digital Electronics Lab		1I+2P	03	80	20	100	2
TOTAL			24	6	24	640	160	800	28

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E Electronics & Communication Engineering / Telecommunication Engineering

(Common to Electronics & Communication and Telecommunication Engineering)

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical / Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT 41	Engineering Mathematics – IV	04		03	80	20	100	4
2	15EC 42	Microprocessor	04		03	80	20	100	4
3	15EC43	Control Systems	04		03	80	20	100	4
4	15EC44	Signals and Systems	04		03	80	20	100	4
5	15EC45	Principles of Communication Systems	04		03	80	20	100	4
6	15EC46	Linear Integrated Circuits	04		03	80	20	100	4
7	15ECL47	Microprocessor Lab		1I+2P	03	80	20	100	2
8	15ECL48	Linear ICs and Communication Lab		1I+2P	03	80	20	100	2
TOTAL			24	06	24	640	160	800	28

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E.: Electronics & Communication Engineering

REVISED SCHEME OF SYLLABUS UPDATED ON 14.08.2017

V SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ES51	Management and Entrepreneurship Development	04		03	80	20	100	4
2	15EC52	Digital Signal Processing	04		03	80	20	100	4
3	15EC53	Verilog HDL	04		03	80	20	100	4
4	15EC54	Information Theory & Coding	04		03	80	20	100	4
5	15EC55X	Professional Elective-1	03		03	80	20	100	3
6	15EC56X	Open Elective-1	03		03	80	20	100	3
7	15ECL57	DSP Lab		1I+2P	03	80	20	100	2
8	15ECL58	HDL Lab		1I+2P	03	80	20	100	2
TOTAL			22	06	24	640	160	800	26

Professional Elective-1			Open Elective – 1* (List offered by EC/TC Board only)	
15EC551	Nanoelectronics		15EC561	Automotive Electronics
15EC552	Switching & Finite Automata Theory		15EC562	Object Oriented Programming Using C++
15EC553	Operating System		15EC563	8051 Microcontroller
15EC554	Electrical Engineering Materials			
15EC555	MSP430 Microcontroller			

1. **Professional Elective:** Elective relevant to chosen specialization/ branch.
2. * **Open Elective List**: For other Open Electives offered by other Boards, refer the Scheme of other Boards or Consolidated list in VTU Website

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016
B.E.: Electronics & Communication Engineering

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/Drawing	Duration	Theory/Practical Marks	I.A. Marks	Total Marks	
1	15EC61	Digital Communication	04		03	80	20	100	4
2	15EC62	ARM Microcontroller & Embedded Systems	04		03	80	20	100	4
3	15EC63	VLSI Design	04		03	80	20	100	4
4	15EC64	Computer Communication Networks	04		03	80	20	100	4
5	15EC65X	Professional Elective-2	03		03	80	20	100	3
6	15EC66X	Open Elective-2	03		03	80	20	100	3
7	15ECL67	Embedded Controller Lab		1I+2P	03	80	20	100	2
8	15ECL68	Computer Networks Lab		1I+2P	03	80	20	100	2
TOTAL			22	6	24	640	160	800	26

Professional Elective-2			Open Elective - 2* (List offered by EC/TC Board only)	
15EC651	Cellular Mobile Communication		15EC661	Data Structures Using C++
15EC652	Adaptive Signal Processing		15EC662	Power Electronics
15EC653	Artificial Neural Networks		15EC663	Digital System Design using Verilog
15EC654	Digital Switching Systems			
15EC655	Microelectronics			

1. **Professional Elective:** Elective relevant to chosen specialization/branch.
2. *** Open Elective List**: For other Open Electives offered by other Boards, refer the Scheme of other Boards or Consolidated list in VTU Website.

SCHEME OF TEACHING AND EXAMINATION
B.E.: Electronics & Communication Engineering

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				15EC
			Theory	Practical/Drawing	Duration	I.A Marks	Theory/ Practical Marks	Total Marks	
1	15EC71	Microwave and Antennas	04		03	20	80	100	4
2	15EC72	Digital Image Processing	04		03	20	80	100	4
3	15EC73	Power Electronics	04		03	20	80	100	4
4	15XX74X	Professional Elective-3	03		03	20	80	100	3
5	15EC75X	Professional Elective-4	03		03	20	80	100	[illegible]
6	15ECL76	Advanced Communication Lab		1I+2P	03	20	[illegible]	[illegible]	2
7	15ECL77	VLSI Lab		1I+2P	03	20	80	100	2
8	15ECP78	Project Work Phase-I + Project work Seminar		03		100	[illegible]	100	1
		TOTAL	18	09	21	240	560	800	24

Professional Elective-3	
15EC741	Multirate [illegible]
15EC742	Biomedical Signal Processing
15EC743	Real Time Systems
15EC744	Cryptography
15EC745	CAD for VLSI

Professional Elective-4	
15EC751	DSP Algorithms and Architecture
15EC752	IoT and Wireless Sensor Networks
15EC753	Pattern Recognition
15EC754	Advanced Computer Architecture
15EC755	Satellite Communication

1. Project Phase-I + Project Work Seminar: Literature Survey, Problem Identification, [illegible] and Seminar.

SCHEME OF TEACHING AND EXAMINATION
B.E.: Electronics & Communication Engineering

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EC81	Wireless Cellular and LTE 4G Broadband	4	-	3	20	80	100	4
2	15EC82	Fiber Optics & Networks	4	-	3	20	80	100	4
3	15EC83X	Professional Elective-5	3	-	3	20	80	100	3
4	15EC84	Internship/Professional Practice	Industry Oriented		3	50	50	100	2
5	15ECP85	Project Work	-	6	3	100	100	200	6
6	15ECS86	Seminar	-	4	-	100	-	100	1
		TOTAL	11	10	15	310	390	700	20

Professional Elective -5	
15EC831	Micro Electro Mechanical Systems
15EC832	Speech Processing
15EC833	Radar Engineering
15EC834	Machine learning
15EC835	Network and Cyber Security

1. Internship / Professional Practice: To be carried between the (6th and 7th Semester) or (7th and 8th) Semester Vacation period

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

III SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT31	Core Subject	Engineering Mathematics-III	Mathe matics	04	--	03	20	80	100	4
2	15EE32	Core Subject	Electric Circuit Analysis	EEE	04	--	03	20	80	100	4
3	15EE33	Core Subject	Transformers and Generators	EEE	04	--	03	20	80	100	4
4	15EE34	Core Subject	Analog Electronic Circuits	EEE	04	--	03	20	80	100	4
5	15EE35	Core Subject	Digital System Design	EEE	04	--	03	20	80	100	4
6	15EE36	Foundation Course	Electrical and Electronic Measurements	EEE	04	--	03	20	80	100	4
7	15EEL37	Laboratory	Electrical Machines Laboratory -1	EEE	01- Hour Instruction 02- Hour Practical		03	20	80	100	2
8	15EEL38	Laboratory	Electronics Laboratory	EEE	01- Hour Instruction 02- Hour Practical		03	20	80	100	2
				TOTAL	**Theory:24 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**28**

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. FoundationCourse: The courses based upon the content that leads to Knowledge enhancement.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
SCHEME OF TEACHING AND EXAMINATION - 2015-16
B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

IVSEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT41	Core Subject	Engineering Mathematics-IV	Math - matics	04	--	03	20	80	100	4
2	15EE42	Core Subject	Power Generation and Economics	EEE	04	--	03	20	80	100	4
3	15EE 43	Core Subject	Transmission and Distribution	EEE	04	--	03	20	80	100	4
4	15EE 44	Core Subject	Electric Motors	EEE	04	--	03	20	80	100	4
5	15EE 45	Core Subject	Electromagnetic Field Theory	EEE	04	--	03	20	80	100	4
6	15EE 46	Foundation Course	Operational Amplifiers and Linear ICs	EEE	04	--	03	20	80	100	4
7	15EE L47	Laboratory	Electrical Machines Laboratory -2	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEL48	Laboratory	Op- amp and Linear ICs Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
				TOTAL	**Theory:24 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**28**

Number of credits completed at the end of IV semester: 24 + 24 + 28 +28 = 104

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study
2. Foundation Course: The courses based upon the content that leads to Knowledge enhancement.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

V SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EE51	Core Subject	Management and Entrepreneurship	EEE	04	--	03	80	20	100	4
2	15EE52	Core Subject	Microcontroller	EEE	04	--	03	80	20	100	4
3	15EE53	Core Subject	Power Electronics	EEE	04	--	03	80	20	100	4
4	15EE54	Core Subject	Signals and Systems	EEE	04	--	03	80	20	100	4
5	15EE55X	Professional Elective	Professional Elective – I	EEE	04	--	03	80	20	100	3
6	15EE56Y	Open Elective	Open Elective - I	EEE	04	--	03	80	20	100	3
7	15EEL57	Laboratory	Microcontroller Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
8	15EEL58	Laboratory	Power Electronics Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
				TOTAL	**Theory:24 hours** **Practical: 06 hours**		24	160	640	800	26

Elective

Professional Elective		Open Elective
Courses under Code 15EE55X	**Title**	
15EE551	Solar & Wind Energy	**The list of Open electives, which is common to all programs, will be shortly announced by the University.**
15EE552	Electrical Engineering Materials	
15EE553	Sensors and Transducers	
15EE554	Special Electrical Machines	

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. **Professional Elective:** Electives relevant to chosen specialization/ branch.

3. **Open Elective:** Electives from other technical and/ or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VI SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EE61	Core Subject	Control Systems	EEE	04	--	03	80	20	100	4
2	15EE62	Core Subject	Power System Analysis – 1	EEE	04	--	03	80	20	100	4
3	15EE63	Core Subject	Digital Signal Processing	EEE	04	--	03	80	20	100	4
4	15EE64	Core Subject	Electrical Machine Design	EEE	04	--	03	80	20	100	4
5	15EE65X	Professional Elective	Professional Elective – II	EEE	03	--	03	80	20	100	3
6	15EE66Y	Open Elective	Open Elective - II	EEE	03	--	03	80	20	100	3
7	15EEL67	Laboratory	Control System Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
8	15EEL68	Laboratory	Digital Signal Processing Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
				TOTAL	**Theory:22 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**26**

Elective

Professional Elective		**Open Elective*** Offered by the Department of Electrical and Electronics Engineering**	
Courses under Code 15EE65X	**Title**	**Courses under Code 15EE66Y**	**Title**
15EE651	Computer Aided Electrical Drawing	15EE661	Artificial Neural Networks and Fuzzy logic
15EE652	Advanced Power Electronics	15EE662	Sensors and Transducers
15EE653	Energy Audit and Demand side Management	15EE663	Batteries and Fuel Cells for Commercial, Military and Space Applications
15EE654	Solar and Wind Energy	15EE664	Industrial Servo Control Systems

*** Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided;

- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Electives relevant to chosen specialization/ branch.

3. Open Elective: Electives from other technical and/ or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VII SEMESTER

Sl. No	Course Code	Subject (Course)	Title	Teaching Department	Teaching Hours/Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EE71	Core Subject	Power System Analysis - 2	EEE	04	--	03	20	80	100	4
2	15EE72	Core Subject	Power System Protection	EEE	04	--	03	20	80	100	4
3	15EE73	Core Subject	High Voltage Engineering	EEE	04	--	03	20	80	100	4
4	15EE74X	Professional Elective	Professional Elective – III	EEE	04	--	03	20	80	100	3
5	15EE75Y	Professional Elective	Professional Elective – IV	EEE	04	--	03	20	80	100	3
6	15EEL76	Laboratory	Power system Simulation Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
7	15EEL77	Laboratory	Rely and High Voltage Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEP78	Project Phase – I + Seminar		EEE	--		--	100	--	100	2
				TOTAL	Theory:24 hours Practical: 06 hours		21	240	560	800	24

Elective

Professional Elective – III		Professional Elective – IV	
Courses under Code 15EE74X	**Title**	**Courses under Code 15EE75Y**	**Title**
15EE741	Advanced Control Systems	15EE751	FACTs and HVDC Transmission
15EE742	Utilization of Electrical Power	15EE752	Testing and Commissioning of Power System Apparatus
15EE743	Carbon Capture and Storage	15EE753	Spacecraft Power Technologies
15EE744	Power System Planning	15EE754	Industrial Heating

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch.

3. Project Phase –I + Seminar: Literature Survey, Problem Identification, objectives and Methodology. Submission of synopsis and seminar.

4. Internship / Professional Practice: To be carried between the VI and VIIsemester vacation or VII and VIII semester vacation period.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VIII SEMESTER

Sl. No	Course Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EE81	Core Subject	Power System Operation and Control	EEE	04	--	03	20	80	100	4
2	15EE82	Core Subject	Industrial Drives and Applications	EEE	04	–	03	20	80	100	4
3	15EE83X	Professional Elective	Professional Elective – V	EEE	03	–	03	20	80	100	3
4	15EE84	Core Subject	Internship / Professional Practice	EEE	Industry Oriented		03	50	50	100	2
5	15EEP85	Core Subject	Project Work Phase -II	EEE	–	06	03	100	100	200	6
6	15EES86	Core Subject	Seminar	EEE	–	04	--	100	–	100	1
				TOTAL	Theory:11 hours Practical: 10 hours		15	310	390	700	20

Professional Elective – V

Courses under Code 15EE83X	Title
15EE831	Smart Grid
15EE832	Operation and Maintenance of Solar Electric Systems
15EE833	Integration of Distributed Generation
15EE834	Power System in Emergencies

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch.
3. **Internship / Professional Practice:** To be carried between the VI and VIIsemester vacation or VII and VIII semester vacation period.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Mechanical Engineering

III SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics -- III	04			03	80	20	100	4
2	15ME32	Materials Science	04			03	80	20	100	4
3	15ME33	Basic Thermodynamics	03	02		03	80	20	100	4
4	15ME34	Mechanics of Materials	03	02		03	80	20	100	4
5	15ME35A/ 15ME35B	Metal Casting and Welding / Machine Tools and Operations	04			03	80	20	100	4
6	15ME36 A/ 15ME36B	Computer Aided Machine Drawing	02		4	03	80	20	100	3
		Mechanical Measurements and Metrology	04							
7	15MEL37A/ 15MEL37B	Materials Testing Lab/ Mechanical Measurements and Metrology Lab	1		2	03	80	20	100	2
8	15MEL38A/ 15MEL38B	Foundry and Forging Lab / Machine Shop/	1		2	03	80	20	100	2
		TOTAL	**22/24**	**04**	**08/04**		**640**	**160**	**800**	**27**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Mechanical Engineering

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT41	Engineering Mathematics – ~~III~~ IV	04			03	80	20	100	04
2	15ME42	Kinematics of Machinery	03	02		03	80	20	100	04
3	15ME43	Applied Thermodynamics	03	02		03	80	20	100	04
4	15ME44	Fluid mechanics	03	02		03	80	20	100	04
5	15ME45A/ 15ME45B	Metal Casting and Welding Machine Tools and Operations	04			03	80	20	100	04
6	15ME46 A/ 15ME46B	Computer Aided Machine Drawing	02		4	03	80	20	100	03
		Mechanical Measurements and Metrology	04							
7	15MEL47A/ 15MEL47B	Materials Testing Lab/ Mechanical Measurements and Metrology Lab	1		2	03	80	20	100	02
8	15MEL48A/ 15MEL48B	Foundry and Forging Lab Machine Shop/	1		2	03	80	20	100	02
		TOTAL	19/21	06	08/04		640	160	800	27

B.E. Mechanical Engineering

V SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME51	Management and Engineering Economics	3	2	0	03	80	20	100	4
2	15ME52	Dynamics of Machinery	3	2	0	03	80	20	100	4
3	15ME53	Turbo Machines	3	2	0	03	80	20	100	4
4	15ME54	Design of Machine Elements - I	3	2	0	03	80	20	100	4
5	15ME55X	Professional Elective-I	3	0	0	03	80	20	100	3
6	15ME56X	Open Elective-I	3	0	0	03	80	20	100	3
7	15MEL57	Fluid Mechanics & Machinery Lab	1	0	2	03	80	20	100	2
8	15MEL58	Energy Lab	1	0	2	03	80	20	100	2
TOTAL			21	06	04		640	160	800	26

Professional Elective-I		Open Elective-I	
15ME551	Refrigeration and Air-conditioning	15ME561	Optimization Techniques
15ME552	Theory of Elasticity	15ME562	Energy and Environment
15ME553	Human Resource Management	15ME563	Automation and Robotics
15ME554	Non Traditional Machining	15ME564	Project Managemet

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **Open Elective:** Electives from other technical and/or emerging subject areas.

B.E. Mechanical Engineering

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME61	Finite Element Analysis	3	2	0	03	80	20	100	4
2	15ME62	Computer integrated Manufacturing	4	0	0	03	80	20	100	4
3	15ME63	Heat Transfer	3	2	0	03	80	20	100	4
4	15ME64	Design of Machine Elements -II	3	2	0	03	80	20	100	4
5	15ME65X	Professional Elective-II	3	0	0	03	80	20	100	3
6	15ME66X	Open Elective-II	3	0	0	03	80	20	100	3
7	15MEL67	Heat Transfer Lab	1	0	2	03	80	20	100	2
8	15MEL68	Modeling and Analysis Lab(FEA)	1	0	2	03	80	20	100	2
		TOTAL	**21**	**6**	**04**		**640**	**160**	**800**	**26**

Professional Elective-II		Open Elective-II	
15ME651	Computational Fluid Dynamics	15ME661	Energy Auditing
15ME652	Mechanics of Composite Materials	15ME662	Industrial Safety
15ME653	Metal Forming	15ME663	Maintenance Engineering
15ME654	Tool Design	15ME664	Total Quality Management
15ME655	Automobile Engineering		

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **OpenElective**: Electives from other technical and/or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

VII SEMESTER **B.E. Mechanical Engineering**

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME71	Energy Engineering	3	2	0	03	80	20	100	4
2	15ME72	Fluid Power Systems	4	0	0	03	80	20	100	4
3	15ME73	Control Engineering	3	2	0	03	80	20	100	4
4	15ME74X	Professional Elective - III	3	0	0	03	80	20	100	3
5	15ME75X	Professional Elective-IV	3	0	0	03	80	20	100	3
6	15MEL76	Design Lab	1	0	2	03	80	20	100	2
7	15MEL77	CIM Lab	1	0	2	03	80	20	100	2
8	15MEP78	Project Phase – I	-	-	-	-	-	100	100	2
		TOTAL	18	4	04		560	240	800	24

Professional Elective-III		Professional Elective-IV	
15ME741	Design of Thermal Equipments	15ME751	Automotive Electronics
15ME742	Tribology	15ME752	Fracture Mechanics
15ME743	Financial Management	15ME753	Human Resource Management
15ME744	Design for Manufacturing	15ME754	Mechatronics
15ME745	Smart Materials & MEMS	15ME755	Advanced Vibrations

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Mechanical Engineering

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME81	Operations Research	3	2	0	03	80	20	100	4
2	15ME82	Additive Manufacturing	4	0	0	03	80	20	100	4
3	15ME83X	Professional Elective - V	3	0	0	03	80	20	100	3
4	15ME84	Internship / Professional Practice	Industry Oriented			03	50	50	100	2
5	15ME85	Project Phase – II	-	6	-	03	100	100	200	6
6	15MES86	Seminar	-	4	-	-	-	100	100	1
TOTAL			10	12	-		390	310	700	20

Professional Elective-V	
15ME831	Cryogenics
15ME832	Experimental Stress Analysis
15ME833	Theory of Plasticity
15ME834	Green Manufacturing
15ME835	Product life cycle management

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **Internship / Professional Practice:** To be carried out between 6th & 7th semester vacation or 7th & 8th semester vacation.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

M. Tech (Computer Network Engineering)

II Semester **CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment/ Tutorials		I.A.	Exam		
16SCN21	Multimedia Communications	4	--	3	20	80	100	4
16SCN22	Cloud Computing	4	--	3	20	80	100	4
16SCN23	Network Management	4	--	3	20	80	100	4
16SCN24	Managing Big Data	4	--	3	20	80	100	4
16SCN25x	Course Electives – II	4	--	3	20	80	100	3
16SCN26	Mini-project	--	**3 hrs lab**	3	20	80	100	2
16SCN27	Seminar	--	--	--	100	--	100	1
	Total	**20**	**3**	**18**	**220**	**480**	**700**	**22**

Course Elective II	
16SCN251	Switching & Statistical Multiplexing In Telecommunications
16SCN252	Wireless Sensor Networks
16SCN253	Optical networks
16SCN254	Mobile application development

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

M. Tech. (Computer Science & Engineering)

III SEMESTER: Internship **CREDIT BASED**

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16SCN31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	-	-	-	25	-	25	20
2	16SCN32	Report on Internship	-	-	-	25	-	25	
3	16SCN33	Evaluation and Viva-Voce of Internship	-	-	-	-	50	50	
4	16SCN34	Evaluation of Project phase -1	-	-	-	50	-	50	1
TOTAL			**-**	**-**	**-**	**100**	**50**	**150**	**21**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

M. Tech (Computer Network Engineering)

IV SEMESTER **CREDIT BASED**

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16SCN41	Client Server Programming	4	-	3	20	80	100	4
2	16SCN42x	Course Electives-III	3	-	3	20	80	100	3
3	16SCN43	Evaluation of Project phase -2	-	-	-	50	-	50	3
4	16SCN44	Evaluation of Project and Viva-Voce	-	-	-	-	100+100	200	10
TOTAL			**7**	**-**	**6**	**90**	**360**	**450**	**20**

Elective	
16SCN421	Service Oriented Architecture
16SCN422	Analysis of Computer Networks
16SCN423	Network Routing Algorithm
16SCN424	Web Mining

Note:

1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee constituted comprising of HoD as Chairman, Guide and Senior faculty of the department.

3. **Project Evaluation**: Evaluation shall be taken up at the end of 4th semester. Project work evaluation and Viva-Voce examination shall conducted

4**. Project evaluation:**

a. Internal Examiner shall carry out the evaluation for 100 marks.

b. External Examiner shall carry out the evaluation for 100 marks.

c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.

d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME OF TEACHING AND EXAMINATION 2016-2017

M. Tech in Design Engineering(MDE)

III SEMESTER: Internship **CREDIT BASED**

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Lecture Hours	Practical/ Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16MDE31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	-	-	-	25	-	25	20
2	16MDE32	Report on Internship	-	-	-	25	-	25	
3	16MDE33	Evaluation and Viva-Voce of Internship	-	-	-	-	50	50	
4	16MDE34	Evaluation of Project phase -1	-	-	-	50	-	50	1
TOTAL			**-**	**-**	**-**	**100**	**50**	**150**	**21**

Common to Design Engineering (MDE), Engineering Analysis & Design (MEA),Machine Design (MMD),Computer Aided Engineering(CAE)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION FOR
M.TECH. Machine Design

I SEMESTER **CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment/ Tutorials		I.A.	Exam		
16 MDE11	Applied Mathematics	4	2	3	**20**	**80**	100	4
16 MDE12	Finite Element Method	4	2	3	**20**	**80**	100	4
16CAE13	Continuum Mechanics	4	2	3	**20**	**80**	100	4
16CAE16	Experimental Mechanics	4	2	3	**20**	**80**	100	4
	Elective – I	4	2	3	**20**	**80**	100	4
16MDE16	Design Engineering Lab I	--	3	3	**20**	**80**	100	2
16MMD17	SEMINAR	--	-	--	**100**	**--**	100	1
	Total	**20**	**13**	18	**220**	**480**	**700**	**23**

ELECTIVE-I

16MDE 151	Computer Graphics	16 MDE 153	Mechatronics System Design
16MDE 152	Computer Applications in Design	16MDE 154	Design for Manufacture
16MEA155	Advanced Fluid Dynamics		

APPLIED MATHEMATICS

(Common to MDE,MMD,MEA,CAE,MCM,MAR,IAE,MTP,MTH,MTE,MST,MTR)

Sub Code : 16MDE11	IA Marks :20
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :80

Course Objectives:

The main objectives of the course are to enhance the knowledge of various methods in finding the roots of an algebraic, transcendental or simultaneous system of equations and also to evaluate integrals numerically and differentiation of complex functions with a greater accuracy. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects.

Course Content:

1. Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws ofEngineering.**06 Hours**

2. Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration.
   Roots of polynomial-Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe's Roots Squaring Method.**12 Hours**

3. Numerical Differentiation and Numerical Integration: Newton –Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae**06 Hours**

4. System of Linear Algebraic Equations And Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods.

Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method .**16 Hours**

5. Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering

   Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram-schmidt process, Least Square problems, Inner product spaces**. 12 Hours**

Text Books:

1. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4^{th} Ed, 2002.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books:

1. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
2. David. C. Lay, Linear Algebra and its applications, 3^{rd} edition, Pearson Education, 2002.

Course Outcomes:

The Student will be able to

1. Model some simple mathematical models of physical Applications.
2. Find the roots of polynomials in Science and Engineering problems.
3. Differentiate and integrate a function for a given set of tabulated data, forEngineering Applications

FINITE ELEMENT METHOD
(Common to MDE,MEA,MMD,CAE,MTR)

Sub Code : 16MDE12	IA Marks :20
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :80

Course Objectives

1. To present the Finite element method (FEM) as a numerical method for engineering analysis of continua and structures
2. To present Finite element formulation using variational and weighted residual approaches
3. To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems.

Course Content:

1. **Introduction to Finite Element Method:** Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) problems: Functional approach and Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non Conforming elements, C_o C_1 and C_n Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions.

10 Hours.

2. **Solid Mechanics : One-Dimensional Finite Element Formulations and Analysis** – Bars- uniform, varying and stepped cross section-Basic(Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems. Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems. Trusses, Plane Frames and Space Frame Basic(Linear) Elements Formulations for different boundary condition -Axial, Bending, Torsional, and Temperature Loads with problems.

10 Hours.

3. **Two Dimensional Finite Element Formulations for Solid Mechanics Problems:** Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems. Triangular and Quadrilateral Axi-symmetric basic and higher order Elements formulation for axi-symmetric loading only with sample problems
   Three Dimensional Finite Element Formulations for Solid Mechanics Problems: Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions. Serendipity and Lagrange family Elements

10 Hours.

4. **Finite Element Formulations for Structural Mechanics Problems:** Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat, curved, cylindrical and conical Shell elements
5. **Dynamic Analysis:** Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two dimensional dynamic analysis: triangular membrane and axisymmetric element, quadrilatateral membrane and axisymmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.

10 Hours.

Text Books:

1. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.
2. Lakshminarayana H. V., Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

Reference Books:

1. Rao S. S. , Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006
2. P.Seshu, Textbook of Finite Element Analysis, PHI, 2004.
3. J.N.Reddy, Introduction to Finite Element Method, McGraw -Hill, 2006.
4. Bathe K. J., Finite Element Procedures, Prentice-Hall, 2006..
5. Cook R. D., Finite Element Modeling for Stress Analysis, Wiley,1995.

Course Outcome:

On completion of the course the student will be

1. Knowledgeable about the FEM as a numerical method for the solution of solid mechanics, structural mechanics and thermal problems
2. Developing skills required to use a commercial FEA software

CONTINUUM MECHANICS
(Common to MDE, MEA, MMD, CAE)

Sub Code: 14CAE13 **IA Marks: 20**
Hrs/ Week: 04 **E x a m H o u r s: 0 3**
Total Hrs: 50 **Exam Marks: 80**

Course Objective:

The course Continuum Mechanics aims at a comprehensive study of Mechanics of Solids and Mechanics of Fluids. The topics covered are: Analysis of Stress, Deformation and Strain, Generalized Hooke's law, Formulation of Two Dimensional Electrostatic problems, Basic equations of Viscoelasticity.

Course Content:

1. Analysis of Stress: Definition and Notation for forces and stresses. body force, surface force Components of stresses, equations of Equilibrium, Specification of stress at a point. Principal stresses, maximum and minimum shear stress, Mohr's diagram in three dimensions. Boundary conditions .Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress, deviator and spherical stress tensors, Stress transformation. 10 Hours

2. Deformation and Strain: Deformation, Strain Displacement relations, Strain components, The state of strain at a point, , Principal strain, strain invariants, Strain transformation, Compatibility equations, Cubical dilatation, spherical and deviator strains, plane strain, Mohr's circle, and compatibility equation

Relations and the General Equations of Elasticity: Generalized Hooke's; law in terms of engineering constants. Formulation of elasticity Problems. 12 Hours

3. Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation of simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems.
Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal theorem. 9 Hours.

4. Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis, Strain components in polar co-ordinates, Rotating disk and cylinder, Concentrated force on semi-infinite plane, Stress concentration around a circular hole in an infinite plate.

Thermal Stresses: Introduction, Thermo-elastic stress -strain relations, thin circular disc, long circular cylinder. 9 Hours

5 Torsion of Prismatic Bars: Introduction, Torsion of Circular cross section bars, Torsion of elliptical cross section bars, Soap film analogy, Membrane analogy, Torsion of thin walled open tubes.

Elastic Stability: Axial compression of prismatic bars, Elastic stability, buckling load for column with constant cross section. **Viscoelasticity**: Linear viscoelastic behavior. Simple viscoelastic models-generalized models, linear differential operator equation. Creep and Relaxation- creep function, relaxation function, hereditary integrals. Complex moduli and compliances. (Note: No numerical) 10 Hours

Text Books:

1 Timoshenko and Goodier, "**Theory of Elasticity"-**'Tata McGraw Hill, New Delhi,3rd edition , 1970

2. L S Srinath "Advanced Mechanics of Solids"- Tata McGraw Hill, New Delhi, 3rd edition, 2010

3 G. Thomas Mase, Ronald E. Smelser, George. E. Mase, Continuum Mechanics for Engineers, 3rd Edition, CRC Press,Boca Raton, 2010

References:

1. Batra, R. C., Elements of Continuum Mechanics, Reston, 2006.
2. George E. Mase, Schaum's Outline of Continuum Mechanics, McGraw-Hill, 1970
3. Dill, Ellis Harold, Continuum Mechanics: Elasticity, Plasticity, Viscoelasticity, CRC Press , 2006.
4. Sadhu Singh," Theory of Elasticity"- Khanna publisher, 4th edition, 2013

Course Outcome:

Continuum Mechanics background essential to mathematically model physical problems in Solid Mechanics

EXPERIMENTAL MECHANICS

(Common to MDE,MEA,MMD,CAE)

Sub Code : 16CAE16 IA Marks :20

Hrs/ Week : 04 Exam Hours : 03

Total Hrs: 50 Exam Marks :80

Course Objective:

This course aims at a comprehensive study of mechanics of solids. The topics covered are

The objective of this course is to familiarize the student with state of the art experimental techniques namely strain gauges, photo elasticity, moiré interoferometry, brittle coating, moiré fringes and holography.

Course Content:

1. **Introduction**: Definition of terms, calibration, standards, dimension and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

   Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis.

   10 Hours

2. **Data Acquisition and Processing:** General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.

   Force, Torque and Strain Measurement: Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.

   10 **Hours**

3. **Stress Analysis:** Two Dimensional Photo elasticity **-** Nature of light, - wave theory of light,- optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, IsoclinicsIso chromatics fringe order determination - Fringe multiplication

techniques - Calibration Photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling.

10 Hours

4. **Three Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses.

10 Hours

5. **Coating Methods:** a) Photoelastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photoelastic strain gauges. b) Brittle Coatings Method:Brittle coating technique Principles data analysis - coating materials, Coating techniques. c) Moire Technique - Geometrical approach, Displacement approach- sensitivity of Moire data data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production.

   Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holograpicinterferomerty, Realtime. and double exposure methods, Displacement measurement, Isopachics.

10 Hours

Text Books:

1. **Holman,**"Experimental Methods for Engineers" 7th Edition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. **R. S. Sirohi, H. C. Radha Krishna,** "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004
3. **Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. **Instrumentation, Measurement And Analysis -**Nakra&Chaudhry, B C Nakra K KChaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

Reference Books:

1. **Measurement Systems Application and Design** - Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989
2. **Design and Analysis of Experiments -** Montgomery D.C., John Wiley & Sons, 1997.
3. **Experimental Stress Analysis** - Dally and Riley, McGraw Hill, 1991.
4. **Experimental Stress Analysis -** Sadhu Singh, Khanna publisher, 1990.
5. **PhotoelasticityVol I and Vol II -** M.M.Frocht,. John Wiley and sons, 1969.
6. **Strain Gauge Primer -** Perry and Lissner, McGraw Hill, 1962.

Course Outcome: It helps the students to

1. Undertake experimental investigations to verify predictions by other methods.
2. To acquire skills for experimental investigations an accompanying laboratory course is desirable.

Elective-I

COMPUTER GRAPHICS

(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE151 IA Marks :20

Hrs/ Week : 04 Exam Hours : 03

Total Hrs: 50 Exam Marks :80

Course Objective:

This course will help the student to be knowledgeable of concepts, principles, processes and techniques essential to all areas of computer graphics

Course Content:

1. Transformations : Representation of points, Transformations: Rotation, Reflection, Scaling, Shearing, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity, Rotation about an arbitrary point, Reflection through an arbitrary line, Rotation about an axis parallel to coordinate axis, Rotation about an arbitrary axis in space, Reflection through an arbitrary plane.

10 Hours

2. Types and Mathematical Representation of Curves: Curve representation, Explicit, Implicit and parametric representation. Nonparametric and parametric representation of Lines, Circles, Ellipse, Parabola, Hyperbola, Conics. Parametric representation of synthetic curve, Hermite cubic splines, , Bezier curves: Blending function, Properties, generation, B-spline curves- Cox-deBoor recursive formula, Properties, Open uniform basis functions, Non-uniform basis functions, Periodic B-spline curve.

Types and Mathematical Representation of Surfaces Surface entities and parametric representation- Plane, Ruled, surface of revolution, Offset surface, Coons patch, Bezier surface, B-spline surface

10Hours

3. Types and Mathematical Representation of Solids

Solid entities: Block, Cylinder, Cone, Sphere, Wedge, Torus, Solid representation, Fundamentals of solid modeling, Set theory, Regularized set operations, Set membership classification, Half spaces, Basic elements, Building operations, Boundary representation and Constructive solid geometry, Basic elements, Building operations.

Scan Conversion and Clipping: Representation of points, lines, Drawing Algorithms: DDA algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, Polygon filling algorithms: Scan conversion, Seed filling, Scan line algorithm. Viewing transformation, Clipping - Points, lines, Text, Polygon, Cohen-Sutherland line clipping, Sutherland-Hodgmen algorithm.

10Hours

4. Visual Realism: Introduction, Hidden line removal, Visibility of object views, Visibility techniques: Minimax test, Containment test, Surface test, Silhouttes, Homogeneity test, Sorting, Coherence, Hidden surface removal- Z-buffer algorithm, Warnock's algorithm, Hidden solid removal - ray tracing algorithm, Shading, Shading models, Diffuse reflection, Specular reflection, Ambient light, Shading of surfaces: Constant shading, Gourand shading, Phong shading, Shading enhancements, Shading Solids, Ray tracing for CSG, Z-buffer algorithm for B-rep and CSG

10 Hours

5.Applications: Colouring- RGB, CMY, HSV, HSL colour models, Data Exchange: Evolution of Data exchange, IGES, PDES, Animation: Conventional animation-key frame, Inbetweening, Line testing, Painting, Filming, Computer animation, Entertainment and Engineering Animation, Animation system hardware, Software architecture, Animation types, Frame buffer, Colour table, Zoom-pan-scroll, Cross bar, Real time play back, Animation techniques- key frame, Skelton. Path of motion and p-curves.

10 Hours

TextBooks:

1. IbrahamZeid, CAD/CAM-Theory and Practice-McGraw Hill, 2006.
2. David Rogers & Alan Adams, Mathematical Elements for Computer Graphics-Tata McGraw Hill, 2002.

ReferenceBooks:

1. Xiang Z, Plastock, R. A, Computer Graphics- Schaum's Outline, McGraw Hill, 2007.
2. Foley, van Dam, Feiner and Hughes, Computer Graphics- Principles and Practice-Addison Wesley, 1996.
3. Sinha A N., Udai A D., Computer Graphics- Tata McGraw Hill, 2008.

Course Outcome:

This course will enable students to:

1. Recognize how a visual image can be an effective means of communication
2. Acquire and develop the skills needed to creatively solve visual communication problems.
3. Understand, develop and employ visual hierarchy using images and text

COMPUTER APPLICATIONS IN DESIGN

(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE152	IA Marks :20
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :80

Course Objective

It helps the students to learn the principles of CAD/CAM/CAE Systems, Graphics Programming, Geometric Modeling Systems, CAD, CAM and CAE Integration, Standards for Communicating between Systems

Course Content:

1. **Introduction To CAD/CAM/CAE Systems**

   Overview, Definitions of CAD. CAM and CAE, Integrating the Design and Manufacturing Processes through a Common Database-A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example.

   Components of CAD/CAM/CAE Systems: Hardware Components ,Vector-Refresh(Stroke-Refresh) Graphics Devices, Raster Graphics Devices, Hardware Configuration, Software Components, Windows-Based CAD Systems.**10 Hours**

2. **Basic Concepts of Graphics Programming**:

   Graphics Libraries, Coordinate Systems, Window and Viewport, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden-Line and Hidden-Surface Removal, Back-Face Removal Algorithm, Depth-Sorting, or Painters, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System.

   Standards

   Standards for Communicating Between Systems: Exchange Methods of Product Definition Data, Initial Graphics Exchange Specification, Drawing Interchange Format, Standard for the Exchange of Product Data. Tutorials, Computational exercises involving Geometric Modeling of components and their assemblies

   10 Hours

3. **Geometric Modeling Systems**

   : Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, Euler Operators, Boolean Operations, Calculation of Volumetric Properties, Non manifold Modeling Systems, Assembly Modeling Capabilities, Basic Functions of Assembly Modeling, Browsing an Assembly, Features of Concurrent Design, Use of Assembly models, Simplification of Assemblies, Web-Based Modeling.

   Representation and Manipulation of Curves: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermite Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve

10 Hours

4. B-Spline Curve, Evaluation of a B-Spline Curve, Composition of B-Spline Curves, Differentiation of a B-Spline Curve, Non uniform Rational B-Spline (NURBS) Curve, Evaluation of a NURBS Curve, Differentiation of a NURBS Curve, Interpolation Curves, Interpolation Using a Hermite Curve, Interpolation Using a B-Spline Curve, Intersection of Curves.
   Representation and Manipulation of Surfaces: Types of Surface Equations, Bilinear Surface, Coon's Patch, Bicubic Patch, Bezier Surface, Evaluation of a Bezier Surface, Differentiation of a Bezier Surface, B-Spline Surface, Evaluation of a-B-Spline Surface, Differentiation of a B-Spline Surface, NURBS Surface, Interpolation Surface, Intersection of Surfaces.

10 Hours

5. **CAD and CAM Integration**
   Overview of the Discrete Part Production Cycle, Process Planning, Manual Approach, Variant Approach, Generative Approach, Computer-Aided Process Planning Systems, CAM-I CAPP, MIPLAN and Multi CAPP, Met CAPP,ICEM-PART, Group Technology, Classification and Coding, Existing Coding Systems, Product Data Management (PDM) Systems.

10 Hours

Text Books:

1. Kunwoo Lee, “Principles of CAD/CAM/CAE systems”-Addison Wesley, 1999
2. RadhakrishnanP.,etal.,“CAD/CAM/CIM”-New Age International, 2008

Reference Books:

1. Ibrahim Zeid, “CAD/CAM – Theory & Practice”, McGraw Hill, 1998
2. Bedworth, Mark Henderson & Philip Wolfe, “Computer Integrated Design and Manufacturing” -McGraw hill inc., 1991.
3. Pro-Engineer, Part modeling Users Guide, 1998

Course Outcome:

Students develop expertise in generation of various curves, surfaces and volumes used in geometric modeling systems.

MECHATRONICS SYSTEM DESIGN
(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE153	IA Marks :20
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :80

Course Objective

1. To educate the student regarding integration of mechanical, electronics, electrical and computer systems in the design of CNC machine tools, Robots etc.
2. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics.

Course Content:

1. Introduction: Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers. Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics. **10 Hours**

2. Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors. System Models: Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems. **11 Hours**

3. Signal Conditioning: Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals , Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation.
   MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging. **13 Hours**

4. Data Presentation Systems: Basic System Models, System Models, Dynamic Responses of System. **8 Hours**

5. Advanced Applications in Mechatronics: Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design. **8 Hours**

Text Books:

1. W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999
2. HSU “MEMS and Microsystems design and manufacture”- Tata McGraw-Hill Education, 2002

Reference Books:

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics”- IEEE Press, 1 edition ,1996
2. Shetty and Kolk “Mechatronics System Design”- Cengage Learning, 2010
3. Mahalik “Mechatronics”- Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics”- Tata McGraw-Hill Education, 1998
5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”–. Mc Grew Hill, 2002
6. “Fine Mechanics and Precision Instruments”- Pergamon Press, 1971.

Course Outcome:

This course makes the student to appreciate multi disciplinary nature of modern engineering systems. Specifically mechanical engineering students to collaborate with Electrical, Electronics, Instrumentation and Computer Engineering disciplines.

DESIGN FOR MANUFACTURE
(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE154 IA Marks :20
Hrs/ Week : 04 Exam Hours : 03
Total Hrs: 50 Exam Marks :80

Course Objective:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability

Course Content:

1. Effect of Materials And Manufacturing Process On Design: Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, Weighted properties and limits on properties methods.

   Tolerence Analysis: Process capability, mean, varience, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law. **12 Hours**

2. Selective Assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1 : Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, Laminated shims, examples.

   Datum Features : Functional datum, Datum for manufacturing, Changing the datum. Examples.**12 Hours**

3. Design Considerations: Design of components with casting consideration. Pattern,Mould, and Parting line. Cored holes and Machined holes. Identifying the possibleand probable parting line. Casting requiring special sand cores. Designing to obviatesand cores.

   Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish- machining operations. **13 Hours**

4. True positional theory : Comparison between co-ordinate and convention method offeature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging. **7 Hours**

5. Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **6 Hours**

Text Books:

1. Harry Peck , “Designing for Manufacturing”, Pitman Publications, 1983.
2. Dieter , “Machine Design” - McGraw-Hill Higher Education, -2008
3. R.K. Jain, "Engineering Metrology", Khanna Publishers, 1986
4. Product design for manufacture and assembly - Geoffrey Boothroyd, Peter dewhurst, Winston Knight, Merceldekker. Inc. CRC Press, Third Edition
5. Material selection and Design, Vol. 20 - ASM Hand book.

Course Outcome:

Students will have added capability to include manufacturability in mechanical engineering design of parts and their assemblies.

ADVANCED FLUID DYNAMICS
(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MEA155	IA Marks :20
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :80

Course Objective:
The student will gain knowledge of dynamics of fluid flow under different conditions.

1. **Review of undergraduate Fluid Mechanics** : Differential Flow analysis- Continuity equation (3D Cartesian, Cylindrical and spherical coordinates) Navier Stokes equations (3D- Cartesian, coordinates) Elementary inviscid flows; superposition (2D). **8 Hours**
2. **Integral Flow Analysis**: Reynolds transport theorem, Continuity, momentum, moment of momentum, energy equations with applications such as turbo machines, jet propulsion &propellors;
   Exact solution of viscous flow equations: Steady flow: Hagen Poiseuille problem, plane Poiseuille problem, Unsteady flow: Impulsively started plate
   12 Hours
3. **Low Reynolds number flows**:Lubrication theory (Reynolds equation), flow past rigid sphere, flow past cylinder
   Boundary Layer Theory:Definitions, Blasius solution, Von-Karman integral, Separation, **10 Hours**
4. Thermal Boundary layer and heat transfer, (Laminar & turbulent flows);
   Experiments in fluids: Wind tunnel, Pressure Probes, Anemometers and flow meters
   10 Hours
5. **Special Topics**:Stability theory; Natural and forced convection; Rayleigh Benardproblem;Transition to turbulence; Introduction to turbulent flows
   10 Hours

Text Books:
1. **“Foundations of fluid mechanics”** - S. W. Yuan,SI Unit edition, 1988.
2. **“Advanced Engineering Fluid Mechanics**”- K. Muralidhar& G. Biswas, Narosa Publishers, 1999.

Reference Books:
1. **“Physical Fluid Dynamics”** 2nd edition – D.J. Tritton, Oxford Science Publications, 1988.
2. **“Boundary Layer Theory”**8th edition, H. Schlichting, McGraw Hill, New York., 1999.

Course Outcome:

The student will be able to apply concepts of fluid dynamics in solving real time problems.

Design Engineering Laboratory – Lab 1
(Common to MDE,MEA,MMD,CAE,MCS)

Sub Code : 16MDE16 IA Marks :20
Hrs/ Week : 3 Exam Hours : 03
Total Hrs:42 Exam Marks : 80

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1
Numerically Calculation and MATLAB Simulation
Part A:Invariants, Principal stresses and strains with directions
Part A: Maximum shear stresses and strains and planes,Von-Mises stress
Part C: Calculate and Plot Stresses in Thick-Walled Cylinder

Experiment #2
Stress analysis in Curved beam in 2D
Part A : Experimental studies using Strain Gauge Instrumentation.
Part B : 2D Photo elastic Investigation.
Part C :Modelling and Numerical Analysis using FEM.

Experiment #3
Stress analysis of rectangular plate with circular hole under i. Uniform Tension and ii. shear
Part A: Matlab simulation for Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate
Part B: Modelling of plate geometry under chosen load conditions and study the effect of plate geometry.
Part C: Numerical Analysis using FEA package.

Experiment #4

Single edge notched beam in four point bending.

Part A: Modeling of single edge notched beam in four point bending.

Part B: Numerical Studies using FEA.

Part C: Correlation Studies.

Experimental #5

Torsion of Prismatic bar with Rectangular cross-section.

Part A: Elastic solutions, MATLAB Simulation

Part B: Finite Element Analysis of any chosen geometry.

Part C: Correlation studies.

Experiment #6

Contact Stress Analysis of Circular Disc under diametrical compression

Part A: 3-D Modeling of Circular Discs with valid literature background, supported with experimental results on contact stress.

Part B: Numerical Analysis using any FEA package.

Part C: 2D Photo Elastic Investigation.

Experiment #7

Vibration Characteristics of a Spring Mass Damper System.

Part A: Analytical Solutions.

Part B: MATLAB Simulation.

Part C: Correlation Studies.

Experiment #8

Modelling and Simulation of Control Systems using MATLAB.

SCHEME OF TEACHING AND EXAMINATION
M.Tech in DIGITAL ELECTRONICS / ELECTRONICS

(Common to M.Tech in Digital Electronics and M.Tech in Electronics)

I SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16ELD11	Advanced Engineering Mathematics	4	-	3	20	80	100	4
2	16EVE12	Digital VLSI Design	4	-	3	20	80	100	4
3	16EVE13	Advanced Embedded System	4	-	3	20	80	100	4
4	16ELD14	Digital Circuit and Logic Design	4	-	3	20	80	100	4
5	16EXX15X	Elective-1	3	-	3	20	80	100	3
6	16ELDL16	Digital Electronics Lab -1		3	3	20	80	100	2
7	16ELD17	Seminar on advanced topics from refereed journals	-	3	-	100	-	100	1
TOTAL			**19**	**6**	**18**	**220**	**480**	**700**	**22**

Elective-1	
16EVE151	Digital System Design using Verilog
16EVE152	Nanoelectronics
16EVE153	ASIC Design
16ELD154	Advanced Computer Architecture

M.Tech in DIGITAL ELECTRONICS / ELECTRONICS

(Common to M.Tech in Digital Electronics and M.Tech in Electronics)

II SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16ECS21	Advanced DSP	4	-	3	20	80	100	4
2	16ECS22	Error Control Coding	4	-	3	20	80	100	4
3	16EVE23	Advances in VLSI Design	4	-	3	20	80	100	4
4	16EVE24	Real Time Operating System	4	-	3	20	80	100	4
5	16EXX25X	Elective –2	3	-	3	20	80	100	3
6	16ELDL26	Digital Electronics Lab - 2		3	3	20	80	100	2
7	16ELD27	Seminar on Advanced topics from refereed journals	-	3	-	100	-	100	1
TOTAL			**19**	**6**	**18**	**220**	**480**	**700**	**22**

Elective-2	
16ELD251	Automotive Electronics
16ECS252	Multimedia Over Communication Links
16ELD253	Micro Electro Mechanical Systems
16ECS254	Cryptography and Network Security

M.Tech in DIGITAL ELECTRONICS / ELECTRONICS

(Common to M.Tech in Digital Electronics and M.Tech in Electronics)

III SEMESTER: Internship

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16ELD31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	-	-	-	25	-	25	20
2	16ELD32	Report on Internship	-	-	-	25	-	50	
3	16ELD33	Evaluation and Viva-Voce of Internship	-	-	-	-	50	50	
4	16ELD34	Evaluation of Project phase -1	-	-	-	50	-	25	1
TOTAL			**-**	**-**	**-**	**100**	**50**	**150**	**21**

M.Tech in DIGITAL ELECTRONICS / ELECTRONICS

(Common to M.Tech in Digital Electronics and M.Tech in Electronics)

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16ELD41	Synthesis and optimization of Digital Circuits	4	-	3	20	80	100	4
2	16EXX42X	Elective-3	3	-	3	20	80	100	3
3	16ELD43	Evaluation of Project phase -2	-	-	-	50	-	50	3
4	16ELD44	Evaluation of Project and Viva-Voce	-	-	-	-	100+100	200	10
TOTAL			**-**	**-**	**6**	**90**	**360**	**450**	**20**

Elective-3	
16EVE421	CMOS RF Circuit Design
16ECS422	Advances in Image Processing
16ECS423	Communication System Design using DSP Algorithms
16ELD424	Reconfigurable Computing

Note:

1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee constituted comprising of HoD as Chairman, Guide and Senior faculty of the department.

3. **Project Evaluation**: Evaluation shall be taken up at the end of 4th semester. Project work evaluation and Viva-Voce examination shall be conducted .

a. Internal Examiner shall carry out the evaluation for 100 marks.

b. External Examiner shall carry out the evaluation for 100 marks.

c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.

d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks.

M.Tech – DE & E - FIRST SEMESTER SYLLABUS

ADVANCED ENGINEERING MATHEMATICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16ELD11	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Acquaint with principles of linear algebra, calculus of variations, probability theory and random process.
- Apply the knowledge of linear algebra, calculus of variations, probability theory and random process in the applications of electronics and communication engineering sciences.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
Module -1	
Linear Algebra-I Introduction to vector spaces and sub-spaces, definitions, illustrative examples and simple problems. Linearly independent and dependent vectors-definition and problems. Basis vectors, dimension of a vector space. Linear transformations- definition, properties and problems. Rank-Nullity theorem(without proof). Matrix form of linear transformations-Illustrative examples.**(Text 1 & Ref. 1)**	**L1,L2**
Module -2	
Linear Algebra-II Computation of Eigen values and Eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process. QR decomposition, singular value decomposition, least square approximations.**(Text 1 & Ref. 1)**	**L1,L2**
Module -3	
Calculus of Variations Concept of functional-Eulers equation. functional dependent on first and higher order derivatives, functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries.**(Text 2 & Ref. 2)**	**L1,L2**
Module -4	

Probability Theory Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Binomial, Poisson, Exponential, Gaussian and Rayleigh distributions-examples.**(Text 3 & Ref. 3)**	**L1,L2**
Module -5	
Joint probability distributions Definition and properties of CDF, PDF, PMF, conditional distributions. Expectation, covariance and correlation. Independent random variables. Statement of central limit theorem-Illustrative examples. Random process- Classification, stationary and ergodic random process. Auto correlation function-properties, Gaussian random process.**(Text 3 & Ref. 3)**	**L1,L2**

Course Outcomes: After studying this course, students will be able to:

- Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
- Apply the techniques of QR and singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.
- Utilize the concepts of functionals and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.
- Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.
- Apply the idea of joint probability distributions and the role of parameter-dependent random variables in random process.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. David C.Lay, Steven R.Lay and J.J.McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.
2. E. Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley, 2015.
3. Scott L.Miller, Donald G. Childers: “Probability and Random Process with application to Signal Processing”, Elsevier Academic Press, 2nd Edition,2013.

Reference books:

1. Richard Bronson: “Schaum’s Outlines of Theory and Problems of Matrix Operations”, McGraw-Hill, 1988.
2. Elsgolts, L.:”Differential Equations and Calculus of Variations”, MIR Publications, 3rd Edition, 1977.
3. T.Veerarajan: “Probability, Statistics and Random Process“,3rd Edition, Tata McGraw Hill Co.,2008.

Web links:

1. http://nptel.ac.in/courses.php?disciplineId=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://ocw.mit.edu/courses/mathematics/
4. www.wolfram.com

<table>
<tr><td colspan="4"><u>DIGITAL VLSI DESIGN</u>
[As per Choice Based Credit System (CBCS) scheme]</td></tr>
<tr><td>Subject Code</td><td>16EVE12</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number</td><td>04</td><td>Exam Marks</td><td>80</td></tr>
<tr><td>Total Number of</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
Explain VLSI Design Methodologies
Learn Static and Dynamic operation principles, analysis and design of inverter circuit.
Infer state of the art Semiconductors Memory circuits.
Outline the comprehensive coverage of Methodologies and Design practice that are used to reduce the Power Dissipation of large scale digital circuits.
Illustrate VLSI and ASIC design.</td></tr>
</table>

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects. **MOS Inverters-Static Characteristics**: Introduction, Resistive-Load Inverter, Inverters with n_Type MOSFET Load.	**L1, L2**
Module -2	
MOS Inverters-Static Characteristics: CMOS Inverter. **MOS Inverters**: Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definition, Calculation of Delay Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.	**L2, L3**
Module -3	

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Nonvolatile Memory, Flash Memory, Ferroelectric Random Access Memory (FRAM).	**L1, L2, L3**
Module -4	
Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits. **BiCMOS Logic Circuits**: Introduction, Bipolar Junction Transistor (BJT): Structure and Operation, Dynamic Behavior of BJTs, Basic BiCMOS Circuits: Static Behavior, Switching Delay in BiCMOS Logic Circuits, BiCMOS Applications.	**L1,L2, L3**
Module -5	
Chip Input and Output (I/O) Circuits: Introduction, ESD Protection, Input Circuits, Output Circuits and L(di/dt) Noise, On-Chip Clock Generation and Distribution, Latch-Up and Its Prevention. **Design for Manufacturability**: Introduction, Process Variations, Basic Concepts and Definitions, Design of Experiments and Performance Modeling.	**L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Analyse issues of On-chip interconnect Modelling and Interconnect delay calculation.
2. Analyse the Switching Characteristics in Digital Integrated Circuits.
3. Use the Dynamic Logic circuits in state-of-the-art VLSI chips.
4. Study critical issues such as ESD protection, Clock distribution, Clock buffering, and Latch phenomenon
5. Use Bipolar and Bi-CMOS circuits in very high speed design.

Question Paper Pattern

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Sung Mo Kang & Yosuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, Tata McGraw-Hill, Third Edition.

Reference Books:

1. Neil Weste and K. Eshragian, “Principles of CMOS VLSI Design: A System Perspective”, Second Edition, Pearson Education (Asia) Pvt. Ltd. 2000.
2. Wayne, Wolf, “Modern VLSI Design: System on Silicon” Prentice Hall PTR/Pearson Education, Second Edition, 1998.
3. Douglas A Pucknell & Kamran Eshragian , “Basic VLSI Design” PHI 3rd Edition (original Edition – 1994).

ADVANCED EMBEDDED SYSTEM [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16EVE13	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Describe the hardware software co-design and firmware design approaches
- Explain the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Program ARM CORTEX M3 using the various instructions, for different applications.

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems (Text 1: Selected Topics from Ch -1, 2, 3).	**L1, L2, L3**
Module -2	
Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Text 1: Selected Topics From Ch-7, 9, 12, 13).	**L1, L2, L3**
Module -3	
ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 2: Ch 1, 2, 3)	**L1, L2, L3**

Module -4	
Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Text 2: Ch-4, 5, 6)	**L1, L2, L3**
Module -5	
Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Text 2: Ch-7, 8, 10)	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Explain the hardware software co-design and firmware design approaches.
- Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.
2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2ndedn, Newnes, (Elsevier), 2010.

Reference Book:

James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008.

DIGITAL CIRCUITS AND LOGIC DESIGN [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16ELD14	IA Marks	20
Number of Lecture	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the concepts of sequential machines
- Design Sequential Machines/Circuits
- Analyze the faults in the design of circuits
- Apply fault detection experiments to sequential circuits

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Threshold Logic: Introductory Concepts, Synthesis of Threshold Networks, Capabilities, Minimization, and Transformation of Sequential Machines: The Finite- State Model, Further Definitions, Capabilities.	**L1, L2,L3**
Module -2	
Fault Detection by Path Sensitizing, Detection of Multiple Faults, Failure-Tolerant Design, Quadded Logic, Reliable Design and Fault Diagnosis Hazards: Fault Detection in Combinational Circuits.	**L1, L2, L3,L4**
Module -3	
Fault-Location Experiments, Boolean Differences, Limitations of Finite – State Machines, State Equivalence and Machine Minimization, Simplification of Incompletely Specified Machines.	**L1, L2, L3,L4**
Module -4	
Structure of Sequential Machines: Introductory Example, State Assignments Using Partitions, The Lattice of closed Partitions, Reductions of the Output Dependency, Input Independence and Autonomous Clocks, Covers and Generation of closed Partitions by state splitting, Information Flow in Sequential Machines, ELD ecompositions, Synthesis of Multiple Machines.	**L1, L2, L3,L4**
Module -5	

State Identifications and Fault-Detection Experiments: Homing Experiments, Distinguishing Experiments, Machine Identification, Fault Detection Experiments, Design of Diagnosable Machines, Second Algorithm for the Design of Fault Detection Experiments, Fault-Detection.	**L1, L2, L3,L4**

Course outcomes: At the end of the course, the students will be able to:

- Understand the concepts of sequential machines
- Design Sequential Machines/Circuits
- Analyze the faults in the design of circuits
- Apply fault detection experiments to sequential circuits

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Zvi Kohavi, "Switching and Finite Automata Theory", 2nd Edition, TMH.

Reference Books:

1. Charles Roth Jr., "Digital Circuits and logic Design", 7thedn, Cengage Learning, 2014.
2. Parag K Lala, "Fault Tolerant And Fault Testable Hardware Design", Prentice Hall Inc. 1985.
3. E. V. Krishnamurthy, "Introductory Theory of Computer", Macmillan Press Ltd, 1983
4. Mishra & Chandrasekaran, "Theory of computer science – Automata, Languages and Computation", 2nd Edition, PHI, 2004.

DIGITAL SYSTEM DESIGN USING VERILOG [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	16EVE151	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Understand the concepts of Verilog Language
- Design the digital systems as an activity in a larger systems design context.
- Study the design and operation of semiconductor memories frequently used in application specific digital system.
- Inspect how effectively IC's are embedded in package and assembled in PCB's for different application
- Design and diagnosis of processors and I/O controllers they can be used in embedded systems

Modules	**Revised Bloom's Taxonomy (RBT)**
Module -1	
Introduction and Methodology: Digital Systems and Embedded Systems, Binary representation and Circuit Elements, Real-World Circuits, Models, Design Methodology.	**L1, L2**
Module -2	
Number Basics: Unsigned and Signed Integers, Fixed and Floating-point Numbers. **Sequential Basics**: Storage elements, Counters, Sequential Data paths and Control, Clocked Synchronous Timing Methodology.	**L1, L2**
Module -3	
Memories: Concepts, Memory Types, Error Detection and Correction. **Implementation Fabrics**: ICs, PLDs, Packaging and Circuit Boards, Interconnection and Signal Integrity.	**L1, L2**
Module -4	
Processor Basics: Embedded Computer Organization, Instruction and Data, Interfacing with memory. **I/O interfacing**: I/O devices, I/O controllers, Parallel Buses, Serial Transmission, I/O software.	**L2, L3**
Module -5	

Accelerators: Concepts, case study, Verification of accelerators. **Design Methodology**: Design flow, Design optimization, Design for test.	**L2, L3**

Course outcomes: After studying this course, students will be able to:

- Design embedded systems, using small microcontrollers, larger CPUs/DSPs, or hard or soft processor cores.
- Design construct the combinational circuits using discrete gates and programmable logic devices.
- Describe Verilog model for sequential circuits and test pattern generation
- Explore the different types of semiconductor memories and their usage for specific chip design
- Synthesis different types of processor and I/O controllers that are used in embedded system design

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using VERILOG", Elesvier, 2010.

Reference Book:

Verilog HDL: A Guide to Digital Design and Synthesis, Second Edition by Samir Palnitkar.

NANOELECTRONICS

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	16EVE152	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hours per Module)	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to:

- Enhance basic engineering science and technological knowledge of nanoelectronics.
- Explain basics of top-down and bottom-up fabrication process, devices and systems.
- Describe technologies involved in modern day electronic devices.
- Appreciate the complexities in scaling down the electronic devices in the future.

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).	**L1, L2**
Module -2	
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques (Text1).	**L1,L2,L3**
Module -3	

Characterization: spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties. **Inorganic semiconductor nanostructures:** overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text1).	**L1-L3**
Module -4	
Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly techniques. **Physical processes:** modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intraband absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text1).	**L1-L3**
Module -5	
Methods of measuring properties: atomic, crystollography, microscopy, spectroscopy (Text 2). **Applications**: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP's, NEMS, MEMS (Text 1).	**L1-L3**

Course outcomes: After studying this course, students will be able to:

- Know the principles behind Nanoscience engineering and Nanoelectronics.
- Apply the knowledge to prepare and characterize nanomaterials.
- Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials.
- Design the process flow required to fabricate state of the art transistor technol ogy.
- Analyze the requirements for new materials and device structure in the future technologies.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, “Nanoscale Science and Technology”, John Wiley, 2007.
2. Charles P Poole, Jr, Frank J Owens, “Introduction to Nanotechnology”, John Wiley, Copyright 2006, Reprint 2011.

Reference Book:

Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, “Hand Book of Nanoscience Engineering and Technology”, CRC press, 2003.

ASIC DESIGN

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	16EVE153	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to:

- Explain ASIC methodologies and programmable logic cells to implement a function on IC.
- Analyse back-end physical design flow, including partitioning, floor-planning, placement, and routing.
- Gain sufficient theoretical knowledge for carrying out FPGA and ASIC designs.
- Design CAD algorithms and explain how these concepts interact in ASIC design.

Modules	Revised Bloom's Taxonomy (RBT)Level
Module -1	
Introduction to ASICs, Full custom, Semi-custom and Programmable ASICs, ASIC Design flow, ASIC cell libraries. **CMOS Logic:** Datapath Logic Cells**:** Data Path Elements, Adders: Carry skip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier (Booth encoding), Data path Operators, I/O cells.	**L1,L2**
Module -2	
ASIC Library Design: Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages. **Programmable ASIC Logic Cells:** MUX as Boolean function generators, Actel ACT: ACT 1, ACT 2 and ACT 3 Logic Modules, Xilinx LCA: XC3000 CLB, Altera FLEX and MAX.	**L1-L3**
Module -3	
Programmable ASIC I/O Cells: Xilinx and Altera I/O Block. **Low-level design entry:** Schematic entry: Hierarchical design, Netlist screener. **ASIC Construction:** Physical Design, CAD Tools. **Partitioning:** Goals and objectives, Constructive Partitioning, Iterative Partitioning Improvement, KL, FM and Look Ahead algorithms.	**L1-L4**
Module -4	
Floor planning and placement: Goals and objectives, Floor planning tools, Channel definition, I/O and Power planning and Clock planning. Placement**:** Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Physical Design Flow.	**L1-L3**

Module -5	
Routing: Global Routing: Goals and objectives, Global Routing Methods, Back-annotation. Detailed Routing: Goals and objectives, Measurement of Channel Density, Left-Edge and Area-Routing Algorithms. Special Routing, Circuit extraction and DRC.	**L1-L3**

Course outcomes:

After studying this course, students will be able to:

- Describe the concepts of ASIC design methodology, data path elements, logical effort and FPGA architectures.
- Analyze the design of FPGAs and ASICs suitable for specific tasks, perform design entry and explain the physical design flow.
- Design data path elements for ASIC cell libraries and compute optimum path delay.
- Create floor plan including partition and routing with the use of CAD algorithms.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Michael John Sebastian Smith, “Application - Specific Integrated Circuits” Addison-Wesley Professional; 2005.

Reference Books:

1. Neil H.E. Weste, David Harris, and Ayan Banerjee, “CMOS VLSI Design: A Circuits and Systems Perspective”, 3rd edition, Addison Wesley/ Pearson education, 2011.
2. Vikram Arkalgud Chandrasetty, “VLSI Design: A Practical Guide for FPGA and ASIC Implementations”, Springer, 2011, ISBN: 978-1-4614-1119-2.
3. Rakesh Chadha, BhaskerJ., “An ASIC Low Power Primer”, Springer, ISBN: 978-1-4614-4270-7.

ADVANCED COMPUTER ARCHITECTURE [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16ELD154	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Understand the basic concepts for parallel processing
- Analyze program partitioning and flow mechanisms
- Apply pipelining concept for the performance evaluation
- Learn the advanced processor architectures for suitable applications

Modules	**Revised Bloom's Taxonomy (RBT) Level**
Module -1	
Parallel Computer Models: Classification of parallel computers, Multiprocessors and multicomputers, Multivector and SIMD computers. Program and Network Properties, Conditions of parallelism, Data and resource Dependences, Hardware and software parallelism. **(Text 1)**	**L2, L3, L4**
Module -2	
Program partitioning and scheduling, Grain Size and latency, Program flow mechanisms, Control flow versus data flow, Data flow Architecture, Demand driven mechanisms, Comparisons of flow mechanisms, Principles of Scalable Performance, Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches. **(Text 1)**	**L2, L3, L4**
Module -3	
Advanced Processors: Advanced processor technology, Instruction-set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar Processors, VLIW Architectures, Pipelining, Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline design. **(Text 1)**	**L1, L2, L3**
Module -4	
Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch Handling techniques, branch prediction, Arithmetic Pipeline Design, Computer arithmetic principles, Static Arithmetic pipeline, Multifunctional arithmetic pipelines. **(Text 1)**	**L2, L3, L4**
Module -5	

Multithread and Dataflow Architecture: Principles of Multithreading, Scalable and Multithreaded Architecture, Dataflow Architecture, Symmetric shared memory architecture, distributed shared memory architecture. **(Text 1 & 2)**	**L1, L2, L3**

Course outcomes: At the end of this course, the students will be able to:

- Understand the basic concepts for parallel processing
- Analyze program partitioning and flow mechanisms
- Apply pipelining concept for the performance evaluation
- Learn the advanced processor architectures for suitable applications

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Kai Hwang, “Advanced computer architecture”, TMH. 2007.
2. Kai Hwang and Zu, “Scalable Parallel Computers Architecture”, MGH, 2008.

Reference Books:

1. M.J. Flynn, “Computer Architecture, Pipelined and Parallel Processor Design”, Narosa Publishing, 2002.
2. D.A.Patterson, J.L.Hennessy, “Computer Architecture: A quantitative approach”, Morgan Kauffmann feb,2002.

<table>
<tr><td colspan="5" align="center">DIGITAL ELECTRONICS LAB -1
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I</td></tr>
<tr><td>Laboratory Code</td><td>16ELDL16</td><td>IA Marks</td><td colspan="2">20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>01Hr Tutorial (Instructions) + 02 Hours Laboratory</td><td>Exam Marks</td><td colspan="2">80</td></tr>
<tr><td></td><td></td><td>Exam Hours</td><td colspan="2">03</td></tr>
<tr><td colspan="5" align="center">CREDITS – 02</td></tr>
<tr><td colspan="5">Course objectives: This laboratory course enables students to get practical experience on the
• Design tool such as Cadence OrCAD/ OrCAD Lite /EDA tool
• Design of analog and digital circuits using the simulation tool
• FPGA Design and testing for digital circuits
• Verilog programming and design of digital circuits
• Design, verification and performance testing</td></tr>
<tr><td colspan="4">Laboratory Experiments</td><td>Revised Bloom's Taxonomy (RBT) Level</td></tr>
<tr><td colspan="4">1.Using Cadence OrCAD or OrCAD Lite or any EDA Tool, design and verify the following:

a) 3½ Digit Digital Voltmeter
b) Monolithic function Generator
c) Regulated Power supplies
d) Batch counter using TTL ICs.
e) DAC and ADC
f) P, PI, PID and ON/OFF Controllers
g) Programmable Timers
h) Filters and Resonance Circuits</td><td>L2,L3,L4</td></tr>
</table>

2. Develop Verilog Program for design and testing the following digital circuits (for 4/8 bits) using FPGA/CPLD. Use logic analyzer/Chipscope for the verification of results. **(Note:** Programming can be done using any complier. Down load the programs on FPGA/CPLD boards and performance testing may be done using pattern generator (32 channels and logic analyzer)/Chipscope pro. Implementing the above designs on Xilinx/Altera/Cypress/equivalent based FPGA/CPLD kits.) a. Carry skip and carry look ahead adder b. BCD adder and subtractor c. Array Multiplication (signed and unsigned) d. Booth multiplication (radix-4) e. Magnitude comparator f. LFSR g. Parity generator h. Universal Shift Register i. Sequence generation (11101 say) using Mealy/Moore FSM	**L2, L3, L4**

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Design an analog and digital systems using Cadence OrCAD, OrCAD Lite or any EDA tool.
- Develop Verilog Programs for Digital Circuit design simulation.
- Design and implement digital systems on FPGA/CPLD
- Testing and validation of digital systems using Logic analyzer/Chipscope

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. For examination, two questions using different tool to be set.
3. Students are allowed to pick one experiment from the lot.
4. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
5. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

M.Tech – DE & E - SECOND SEMESTER SYLLABUS

<table>
<tr><td colspan="4" align="center"><u>Advanced DSP</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>16ECS21</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• Understand Multirate digital signal processing principles and its applications.
• Estimate the various spectral components present in the received signal using different spectral estimation methods such as Parametric and Nonparametric.
• Design and implement an optimum adaptive filter using LMS and RLS algorithms.
• Understand the concepts and mathematical representations of Wavelet transforms.</td></tr>
</table>

Modules	RBT Level
Module 1	
Multirate Digital Signal Processing: Introduction, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion, Applications of multirate signal processing, Digital filter banks, two channel quadrature mirror filter banks, M-channel QMF bank. (Text 1)	L1,L2,L3
Module 2	
Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters. (Text 1)	L1,L2,L3
Module 3	
Adaptive filters: Applications of adaptive filters- Adaptive channel equalization,, Adaptive noise cancellation, Linear Predictive coding of Speech Signals, Adaptive direct form FIR filters-The LMS algorithm, Properties of LMS algorithm. **Adaptive direct form filters-** RLS algorithm. (Text 1)	L1,L2,L3
Module 4	
Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods. **Parametric Methods for Power Spectrum Estimation:** Relationship between the auto correlation and the model	

parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Model parameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methods for the AR Model parameters, ARMA Model for Power Spectrum Estimation. (Text 1)	L1,L2,L3
Module 5	
WAVELET TRANSFORMS:T he Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future. **Continuous Wavelet and Short Time Fourier Transform:** Wavelet Transform, Mathematical preliminaries, Properties of wavelets. **Discrete Wavelet Transform**: Haar scaling functions, Haar wavelet function, Daubechies Wavelets. (Chapters 1, 3 & 4 of Text 2)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Design adaptive filters for a given application
- Design multirate DSP Systems
- Implement adaptive signal processing algorithm
- Design active networks
- Understand important advanced signal processing techniques, including multi-rate processing and time-frequency analysis techniques

Question paper pattern:

The question paper will have ten questions.

- Each full question consists of 16marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The Students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. “Digital Signal Processing, Principles, Algorithms and Applications”, John G.Proakis, Dimitris G.Manolakis, Fourth edition, Pearson-2007.
2. Insight into Wavelets- from Theory to Practice”, K.P Soman, Ramachandran, Resmi- PHI Third Edition-2010.

Reference Books:

1. "Modern Digital signal processing", Robert. O. Cristi, Cengage Publishers, India, 2003.
2. "Digital signal processing: A Practitioner's approach", E.C. Ifeachor, and B. W. Jarvis, , Second Edition, Pearson Education, India, 2002, Reprint.
3. “Wavelet Transforms, Introduction to Theory and applications”, Raghuveer. M. Rao, Ajit S.Bopardikar, Pearson Education, Asia, 2000.

Error Control Coding [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – II			
Subject Code	16ECS22	IA Marks	20
Number of Lecture Hours/Week	04	Exam marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Explain the Entropy, information rate and capacity for the Discrete memoryless channel.
- Apply modern algebra and probability theory for the coding.
- Compare Block codes such as Linear Block Codes, Cyclic codes etc and Convolutional codes.
- Detect and correct errors for different data communication and storage systems.
- Implement different Block code encoders and decoders.
- Analyse and implement convolutional encoders and decoders.
- Analyse and apply soft and hard Viterbi algorithm for decoding of convolutional codes.

Modules	**RBT Level**
Module 1	
Information theory: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem.(Chap. 5 of Text 1) **Introduction to algebra**: Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2^m) and its properties, (Only statements of theorems without proof) Computation using Galois filed GF (2^m) arithmetic, Vector spaces and Matrices. (Chap. 2 of Text 2)	L1,L2,L3
Module 2	
Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes(SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes. (Chap. 3 of Text 2)	L1,L2,L3
Module 3	
Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes.(Chap. 4 of Text2)	L1,L2,L3
Module 4	
BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic, Implementation of error correction. (Chap. 6 of Text 2) **Reed -Solomon codes.** (Chap. 7 of Text 2)	

Majority Logic decodable codes: One -step majority logic decoding, One-step majority logic decodable codes, Two-step majority logic, decoding, Multiple-step majority logic. (Chap. 8 of Text 2)	L1,L2,L3
Module 5	
Convolution codes: Convolutional Encoding, Convolutional Encoder Representation, Formulation of the Convolutional Decoding Problem, Properties of Convolutional Codes: Distance property of convolutional codes, Systematic and Nonsystematic Convolutional Codes, Performance Bounds for Convolutional Codes, Coding Gain. Other Convolutional Decoding Algorithms: Sequential Decoding, Feedback Decoding.(Chap. 7 of Text 3)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Analyse a discrete memoryless channel, given the source and transition probabilities.
- Apply the concept of modern linear algebra for the error control coding technique.
- Implement efficient LBC, Cyclic codes etc encoder and decoders.
- Apply decoding algorithms for efficient decoding of Block codes and Convolutional codes.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Simon Haykin, ”Digital Communication systems”, First edition, Wiley India Private. Ltd, 2014. ISBN 978-81-265-4231-4
2. Shu Lin and Daniel J. Costello. Jr, "Error control coding", Pearson, Prentice Hall, 2nd edition, 2004.
3. Bernard Sklar, ”Digital Communications - Fundamentals and Applications”, 2nd Edition Pearson Education (Asia) Ptv. Ltd, 2001.

Reference Books:

1. Blahut. R. E, "Theory and practice of error control codes", Addison Wesley, 1984.
2. 2. Salvatore Gravano, “Introduction to Error control coding”, Oxford university press, 2007.

Advances in VLSI Design [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16EVE23	IA Marks	20
Number of Lecture Hours/Week	04	Exam marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable the students to:

- Learn circuit-oriented approach towards digital design
- Illustrate the impact of interconnect wiring on the functionality and performance of a digital gate.
- Infer different approaches to digital timing and clocking circuits
- Understand the impact of clock skew on the behaviour of digital synchronous circuits
- Explain the role of peripheral circuitry such as the decoders, sense amplifiers, drivers and control circuitry in the design of reliable and fast memories

Modules	**RBT Level**
Module 1	
Implementation Strategies For Digital ICS: Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Standard Cell, Compiled Cells, Macrocells, Megacells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Pre-wired Arrays, Perspective-The Implementation Platform of the Future.	L1,L2,L3
Module 2	
Coping With Interconnect: Introduction, Capacitive Parasitics, Capacitance and Reliability-Cross Talk, Capacitance and Performance in CMOS, Resistive Parasitics, Resistance and Reliability-Ohmic Voltage Drop, Electromigration, Resistance and Performance-RC Delay, Inductive Parasitics, Inductance and Reliability-Voltage Drop, Inductance and Performance-Transmission Line Effects, Advanced Interconnect Techniques, Reduced-Swing Circuits, Current-Mode Transmission Techniques, Perspective: Networks-on-a-Chip.	L1,L2,L3
Module 3	
Timing Issues In Digital Circuits: Introduction, Timing Classification of Digital Systems, Synchronous Interconnect, Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect, Synchronous Design — An In-depth Perspective, Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques, Latch-Based Clocking, Self-Timed Circuit Design, Self-Timed Logic - An Asynchronous Technique, Completion-Signal Generation, Self-Timed Signaling, Practical Examples of Self-Timed Logic, Synchronizers and Arbiters,	L1,L2,L3

Synchronizers-Concept and Implementation, Arbiters, Clock Synthesis and Synchronization Using a Phase-Locked Loop, Basic Concept, Building Blocks of a PLL.	
Module 4	
Designing Memory and Array Structures: Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read-Only Memories, Nonvolatile Read-Write Memories, Read-Write Memories (RAM), Contents-Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers, Timing and Control.	L1,L2,L3
Module 5	
Designing Memory and Array Structures: Memory Reliability and Yield, Signal-to-Noise Ratio, Memory yield, Power Dissipation in Memories, Sources of Power Dissipation in Memories, Partitioning of the memory, Addressing the Active Power Dissipation, Data-retention dissipation, Case Studies in Memory Design: The Programmable Logic Array (PLA), A 4 Mbit SRAM, A 1 Gbit NAND Flash Memory, Perspective: Semiconductor Memory Trends and Evolutions.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Apply design automation for complex circuits using the different implementation methodology like custom versus semi-custom, hardwired versus fixed, regular array versus ad-hoc.
- Use the approaches to minimize the impact of interconnect parasitics on performance, power dissipation and circuit reliability
- Impose the ordering of the switching events to meet the desired timing constraints using synchronous, clocked approach.
- Infer the reliability of the memory.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Jan M Rabey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits-A Design Perspective", PHI, 2nd Edition.

Reference Books:

1. M. Smith, " Application Specific Integrated circuits", Addison Wesley, 1997
2. H. Veendrick, " MOS IC's: From Basics to ASICs, Wiley-VCH, 1992.
3. Anantha P. Chandrakasan , Robert W. Brodersen, "Low Power Digital CMOS Design", Kluwer Academic Publisher, 1995.

<table>
<tr><td colspan="4"><u>Real Time Operating System</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>16EVE24</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable the students to:

• Introduce the fundamental concepts of Real Time Operating Systems and the real time embedded system
• Apply concepts relating to operating systems such as Scheduling techniques, Thread Safe Reentrant Functions, Dynamic priority policies.
• Describe concepts related to Multi resource services like blocking, Deadlock, live lock & soft real-time services.
• Discuss Memory management concepts, Embedded system components, Debugging components and file system components.
• Study programs for multithreaded applications using suitable data structures.</td></tr>
<tr><td colspan="3">Modules</td><td>RBT Level</td></tr>
<tr><td colspan="4">Module 1</td></tr>
<tr><td colspan="3">Real-Time Systems and Resources: Brief history of Real Time Systems, A brief history of Embedded Systems. System Resources, Resource Analysis, Real-Time Service Utility, Scheduler concepts, Real-Time OS, State transition diagram and tables, Thread Safe Reentrant Functions. (Text 1: Selected sections from Chap. 1, 2)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="4">Module 2</td></tr>
<tr><td colspan="3">Processing with Real Time Scheduling: Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies with timing diagrams and problems and issues, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies, Alternative to RM policy. (Text 1: Chap. 2,3,7)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="4">Module 3</td></tr>
<tr><td colspan="3">Memory and I/O: Worst case execution time, Intermediate I/O, Shared Memory, ECC Memory, Flash file systems. Multi-resource Services, Blocking, Deadlock and live lock, Critical sections to protect shared resources, Missed deadline, QoS, Reliability and Availability, Similarities and differences, Reliable software, Available software.
(Text 1: Selected topics from Chap. 4,5,6,7,11)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="4">Module 4</td></tr>
<tr><td colspan="3">Firmware Components: The 3 firmware components, RTOS system software mechanisms, Software application components. Debugging Components, Exceptions, assert, Checking return codes, Single-step debugging, kernel scheduler traces, Test access ports, Trace</td><td>L1,L2,L3</td></tr>
</table>

Ports, External test equipment. (Text 1: Selected topics from Chap. 8,9)	
Module 5	
Process and Threads: Process and thread creations, Simple Programs, Programs related to semaphores, message queue, shared buffer applications involving inter task/thread communication using multiple threads. (Text 2: Chap. 11)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Develop programs for real time services, firmware and RTOS, using the fundamentals of Real Time Embedded System, real time service utilities, debugging methodologies and optimization techniques.
- Select the appropriate system resources (CPU, I/O, Memory, Cache, ECC Memory, Microcontroller/FPGA/ASIC to improve the system performance.
- Apply priority based static and dynamic real time scheduling techniques for the given specifications.
- Analyse deadlock conditions, shared memory problem, critical section problem, missed deadlines, availability, reliability and QoS.
- Develop programs for multithreaded applications using suitable techniques and data structure

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Sam Siewert, "Real-Time Embedded Systems and Components", Cengage Learning India Edition, 2007.
2. Dr. K.V.K.K Prasad, Embedded/Real Time Systems, Concepts, Design and Programming, Black Book, DreamTech Press, New edition, 2010.

Reference Books:

1. James W S Liu, "Real Time System", Pearson education, 2008.
2. DreamTech Software Team, "Programming for Embedded Systems", John Wiley, India Pvt. Ltd., 2008.

Automotive Electronics [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16ELD251	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Understand the complete dynamics of automotive electronics
- Design and implement the electronics that attributes the smartness to the automobiles by way of unprecedented safety, add-on features, and comforts.

Modules	**RBT Level**
Module 1	
Automotive Fundamentals, the Systems Approach to Control and Instrumentation: Use Of Electronics In The Automobile, Antilock Brake Systems, (ABS), Electronic steering control, Power steering, Traction control, Electronically controlled suspension. (Chap.1 and 2 of Text)	L1,L2
Module 2	
Automotive instrumentation Control: Sampling, Measurement and signal conversion of various parameters. (Chap. 4 of Text)	L1,L2, L3
Module 3	
The basics of Electronic Engine control: Integrated body: Climate controls, Motivation for Electronic Engine Control, Concept of An Electronic Engine Control System, Definition of General Terms, Definition of Engine Performance Terms, Electronic fuel control system, Engine control sequence, Electronic Ignition, Sensors and Actuators, Applications of sensors and actuators, air flow rate sensor, Indirect measurement of mass air flow, Engine crankshaft angular position sensor, Automotive engine control actuators, Digital engine control, Engine speed sensor, Timing sensor for ignition and fuel delivery, Electronic ignition control systems, Safety systems, Interior safety, Lighting, Entertainment systems. (Chap. 5 and 6 of Text)	L1,L2,L3
Module 4	

Vehicle Motion Control and Automotive diagnostics: Cruise control system, Digital cruise control, Timing light, Engine analyzer, On-board and off-board diagnostics, Expert systems. Stepper motor-based actuator, Cruise control electronics, Vacuum - antilock braking system, Electronic suspension ystem Electronic steering control, Computer-based instrumentation system, Sampling and Input\output signal conversion, Fuel quantity measurement, Coolant temperature measurement, Oil pressure measurement, Vehicle speed measurement, Display devices, Trip-Information-Computer, Occupant protection systems. (Chap. 8 and 10 of Text)	L1,L2, L3
Module 5	
Future automotive electronic systems: Alternative Fuel Engines, Collision Wide Range Air/Fuel Sensor, Alternative Engine, Low Tire Pressure Warning System, Collision avoidance Radar Warning Systems, Low Tire Pressure Warning System, Radio Navigation, Advance Driver information System. Alternative-Fuel Engines , Transmission Control , Collision Avoidance Radar Warning System, Low Tire Pressure Warning System, Speech Synthesis Multiplexing in Automobiles, Control Signal Multiplexing, Navigation Sensors, Radio Navigation, Sign post Navigation , Dead Reckoning Navigation Future Technology, Voice Recognition Cell Phone Dialing Advanced Driver information System, Automatic Driving Control. (Chap. 11 of Text)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:
- Implement various control requirements in the automotive system.
- Comprehend dashboard electronics and engine system electronics.
- Identify various physical parameters that are to be sensed and monitored for maintaining the stability of the vehicle under dynamic conditions.
- Understand and implement the controls and actuator system pertaining to the comfort and safety of commuters.
- Design sensor network for mechanical fault diagnostics in an automotive vehicle.

Question paper pattern:
- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:
William B. Ribbens , "Understanding Automotive Electronics", SAMS/Elsevier publishing, 6th Edition, 1997.

Reference Book:
Robert Bosch Gmbh, "Automotive Electrics and Automotive Electronics-Systems and Components, Networking and Hybrid Drive", Springer Vieweg, 5th Edition, 2007.

Multimedia over Communication Links [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16ECS252	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Gain fundamental knowledge in understanding the basics of different multimedia networks, applications, media types like text and image.
- Analyse media types like audio and video and gain knowledge on multimedia systems.
- Analyse Audio compression techniques required to compress Audio.
- Analyse compression techniques required to compress video.
- Gain fundamental knowledge about the Multimedia Communications in different Networks.

Modules	**RBT Level**
Module 1	
Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology. (Chap. 1 of Text1) **Information Representation**: Introduction, Text, Images. (Chap. 2- Sections 2.2 and 2.3 of Text 1)	L1, L2, L3
Module 2	
Information Representation: Audio and Video. (Chap. 2 - Sections 2.4 and 2.5 of Text 1) **Distributed multimedia systems**: Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems. (Chap. 4 - Sections 4.1 to 4.5 of Text 2)	L1, L2, L3
Module 3	
Multimedia Processing in Communication: Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders. (Chap. 3 - Sections 3.1, 3.2, 3.6, 3.7 of Text 2)	L1, L2, L3
Module 4	
Multimedia Communication Standards: Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4. (Chap. 5 - Sections 5.1 to 5.4 and 5.5.1 of Text 2)	L1, L2, L3
Module 5	
Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks. (Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Understand basics of different multimedia networks, applications.
- Analyse media types like audio and video to represent in digital form.
- Understand different compression techniques to compress audio.
- Understand different compression techniques to compress audio video.
- Describe the basics of Multimedia Communication Across Networks

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Fred Halsall, "Multimedia Communications", Pearson education, 2001, ISBN -9788131709948.
2. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004. ISBN - 9788120321458.

Reference Book:

Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002, ISBN -9788177584417.

<table>
<tr><td colspan="4" align="center"><u>Micro Electro Mechanical Systems</u>
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>16ELD253</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40
(8 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 03</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
• Understand overview of microsystems, their fabrication and application areas.
• Working principles of several MEMS devices.
• Develop mathematical and analytical models of MEMS devices
• Know methods to fabricate MEMS devices
Various application areas where MEMS devices can be used.</td></tr>
</table>

<table>
<tr><td>Modules</td><td align="center">RBT Level</td></tr>
<tr><td colspan="2">Module 1</td></tr>
<tr><td>Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.</td><td>L1, L2</td></tr>
<tr><td colspan="2">Module 2</td></tr>
<tr><td>Working Principles of Microsystems:
Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics.
Engineering Science for Microsystems Design and Fabrication.
Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.</td><td>L1, L2</td></tr>
<tr><td colspan="2">Module 3</td></tr>
<tr><td>Engineering Mechanics for Microsystems Design:
Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.</td><td>L1,L2,L3</td></tr>
<tr><td colspan="2">Module 4</td></tr>
<tr><td>Scaling Laws in Miniaturization:
Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.</td><td>L1,L2, L3</td></tr>
<tr><td colspan="2">Module 5</td></tr>
<tr><td>Overview of Micromanufacturing:
Introduction, Bulk Micromanufacturing, Surface Micromachining, The LIGA Process, Summary on Micromanufacturing.</td><td>L1,L2, L3</td></tr>
</table>

Microsystem Design: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.	

Course Outcomes: After studying this course, students will be able to:

- Appreciate the technologies related to Micro Electro Mechanical Systems.
- Understand design and fabrication processes involved with MEMS devices.
- Analyse the MEMS devices and develop suitable mathematical models
- Know various application areas for MEMS device

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

1. Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2^{nd} Ed, Wiley.

Reference Books:

1. Hans H. Gatzen, Volker Saile, Jurg Leuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Micro Electromechanical Systems (MEMS), Cenage Learning.

Cryptography and Network Security [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16ECS254	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Understand the basics of symmetric key and public key cryptography.
- Understand some basic mathematical concepts and pseudorandom number generators required for cryptography.
- Authenticate and protect the encrypted data.
- Enrich knowledge about Email, IP and Web security.

Modules	**RBT Level**
Module 1	
Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6) **SYMMETRIC CIPHERS:** Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, Chapter 4)	L1,L2,L3
Module 2	
Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5) Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8, Chapter 9: Section 9.1, 9.3, 9.4)	L1, L2, L3
Module 3	
Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP (Text 2: Chapter 16)	L1, L2, L3
Module 4	
One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA],One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4)	L1, L2, L3
Module 5	
E-mail Security: Pretty Good Privacy-S/MIME (Text 1: Chapter 17: Section 17.1, 17.2). **IP Security:** IP Security Overview, IP Security Policy, Encapsulation	L1, L2, L3

Security Payload (ESP),Combining security Associations. (Text 1: Chapter 18: Section 18.1 to 18.4). **Web Security:** Web Security Considerations, SSL(Text 1: Chapter 15: Section 15.1, 15.2).	

Course Outcomes: After studying this course, students will be able to:

- Use basic cryptographic algorithms to encrypt the data.
- Generate some pseudorandom numbers required for cryptographic applications.
- Provide authentication and protection for encrypted data.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. William Stallings , "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3
2. Bruce Schneier, "Applied Cryptography Protocols, Algorithms, and Source code in C", Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X

Reference Books:

1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, Atul Kahate, TMH, 2003.

<table>
<tr><td colspan="4" align="center"><u>Digital Electronics Lab -2</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II</td></tr>
<tr><td>Laboratory Code</td><td>16ELDL26</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>01Hr Tutorial (Instructions) + 02 Hours Laboratory</td><td>Exam Marks</td><td>80</td></tr>
<tr><td></td><td></td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 02</td></tr>
<tr><td colspan="4">Course objectives: This laboratory course enables students to
1. Design and simulate digital electronic circuits using graphical programming tool LabVIEW.
2. Create user friendly interfaces using LabVIEW and analyze the input and output data for various digital circuits.
3. Use of assembly level programming for different applications using ARM-CORTEX M3 Kit and Keil uVision-4 tool.
4. Practice the different concepts and applications of C programming environment with ARM CORTEX M3.</td></tr>
</table>

Laboratory Experiments	**Revised Bloom's Taxonomy (RBT) Level**
PART-A: Graphical Programming using LabVIEW a) Design of 4 bit Adders (CLA, CSA, CMA, Parallel adders) b) Design of Binary Subtractors c) Design of Encoder (8X3), Decoder(3X8) d) Design of Multiplexer (8X1), and Demultiplexer (1X8) e) Design of code converters & Comparator f) Design of FF (SR, D, T, JK, and Master Slave with delays) g) Design of registers using latches and flip-flops h) Design of 8 bit Shift registers i) Design of Asynchronous & Synchronous Counters	L3

PART-B: ARM-CORTEX M3 **[Programming to be done using Keil uVision 4 and download the program on to a M3 evaluation board such as NXP LPC1768 or ATMEL ATSAM3U]** a) Write an Assembly language program to calculate 10+9+8+.........+1 b) Write a Assembly language program to link Multiple object files and link them together. c) Write a Assembly language program to store data in RAM. d) Write a C program to Output the "Hello World" message using UART. e) Write a C program to Design a Stopwatch using interrupts. f) Write an Exception vector table in C g) Write an Assembly Language Program for locking a Mutex. h) Write a SVC handler in C. Use the wrapper code to extract the correct stack frame starting location. The C handler can then use this to extract the stacked PC location and the stacked register values.	L3

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Design and simulate the digital circuits using graphical programming tool LabVIEW.
- Build user friendly interfaces to interact with the digital circuits and to observe the outputs.
- Develop assembly programs for different applications using ARM Cortex M3 and Keil uVision-4 tool.
- Develop C Programs for different applications using ARM-Cortex M3 and Keil uVision-4 tool.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. For examination, one question each to be set from PART-A and PART-B.
3. Students are allowed to pick one experiment from the lot.
4. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
5. Change of experiment is allowed only once and Marks allotted to the procedure part will be made zero.

M.Tech – DE & E - FOURTH SEMESTER SYLLABUS

<table>
<tr><td colspan="4"><u>Synthesis and Optimization of Digital Circuits</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – IV</td></tr>
<tr><td>Subject Code</td><td>16ELD41</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
</table>

Course Objectives: This course will enable students to:

- Understand the need for optimization and dimensions of optimization for digital circuits.
- Understand basic optimization techniques used in circuits design
- Understand advanced tools and techniques in digital systems design including Hardware Modeling and Compilation Techniques.
- Explain details of Logic-Level synthesis and optimization techniques for combinational and sequential circuits.
- Explain the concept of scheduling and resource binding for optimization.

Modules	**RBT Level**
Module 1	
Introduction to Synthesis and optimization: Design of Microelectronics circuits, Computer aided Synthesis and Optimization. **Hardware Modeling**: HDLs for Synthesis, Abstract models, Compilation and Behavioral Optimization. (Text1: Topics from Chap. 1,3)	L1, L2, L3
Module 2	
Graph theory for CAD for VLSI: Graphs, Combinatorial Optimization, Graph Optimization problems and Algorithms, Boolean Algebra and Applications. **Architectural Synthesis and Optimization:** Fundamental Architectural Synthesis problems, Area and Performance Estimation, Strategies for Architectural Optimization, Datapath Synthesis, Control Path Synthesis.(Text1: Topics From Chap. 2,4)	L1, L2, L3
Module 3	
Two level Combinational Logic Optimization: Introduction, Logic Optimizations, Operations on Two level Logic Covers, Algorithms for Logic Minimization, Symbolic Minimization and Encoding Problems. **Multiple Level Combinational Logic Optimization**: Introduction, Models and Transformations for Combinational Networks, The Algebraic Model, The Boolean Model. (Text1: Chap. 7, 8)	L1, L2, L3
Module 4	
Sequential Logic Optimization: Introduction, Sequential Logic Optimization using State based Models, Sequential Logic Optimization using Network Models,	L1, L2, L3

Implicit FSM Traversal Methods, Testability concerns for Synchronous Circuits. (Text 1: Chap. 9)	
Module 5	
Scheduling Algorithms: Introduction, A Model for Scheduling problems, Scheduling with Resource Constraints, Scheduling without Resource Constraints, Scheduling Algorithms for Extended Sequencing Models, Scheduling Pipelined Circuits. **Resource Sharing and Binding:** Sharing and Binding for Resource dominated circuits, Sharing and Binding for General Circuits, Concurrent Binding and Scheduling, Resource sharing and Binding for Non – Scheduled Sequencing Graphs. (Text1: Chap. 5,6)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Understand the process of synthesis and optimization in a top down approach for digital circuits models using HDLs.
- Understand the terminologies of graph theory and its algorithms to optimize a Boolean equation.
- Apply different two level and multilevel optimization algorithms for combinational circuits
- Apply the different sequential circuit optimization methods using state models and network models.
- Apply different scheduling algorithms with resource binding and without resource binding for pipelined sequential circuits and extended sequencing models.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Giovanni De Micheli, “Synthesis and Optimization of Digital Circuits”, Tata McGraw-Hill, 2003.

Reference Book:

Edwars M.D., Automatic Logic synthesis Techniques for Digital Systems, Macmillan New Electronic Series, 1992.

CMOS RF Circuit Design [As per Choice Based credit System (CBCS) Scheme SEMESTER – IV			
Subject Code	16EVE421	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Learn basic concepts in RF and microwave design emphasizing the effects of nonlinearity and noise.
- Appreciate communication system, multiple access and wireless standards necessary for RF circuit design.
- Deal with transceiver architecture, various receiver and transmitter designs, their merits and demerits.
- Understand the design of RF building blocks such as Low Noise Amplifiers and Mixers.

Modules	**RBT Level**
Module 1	
Introduction to RF Design and Wireless Technology: **Basic concepts in RF design(I):** General considerations, Effects of Nonlinearity, Noise, Sensitivity and dynamic range.	L1,L2,L3
Module 2	
Basic concepts in RF design (II): Passive impedance transformation, scattering parameters, analysis of nonlinear dynamic systems	L1,L2,L3
Module 3	
Communication Concepts: General concepts, analog modulation, digital modulation, spectral re-growth, Mobile RF communications, Multiple access techniques, Wireless standards	L1,L2,L3
Module 4	
Transceiver Architecture(I): General considerations, Receiver architecture.	L1,L2,L3
Module 5	
Transceiver Architecture(II): Transmitter architectures **Low Noise Amplifiers:** LNA topologies: common-source stage with inductive load, common-source stage with resistive feedback. **Mixers:** General considerations, passive down conversion mixers.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Analyse the effect of nonlinearity and noise in RF and microwave design.
- Exemplify the approaches taken in actual RF products.

- Minimize the number of off-chip components required to design mixers and Low-Noise Amplifiers.
- Explain various receivers and transmitter topologies with their merits and drawbacks.
- Demonstrate how the system requirements define the parameters of the circuits and how the performance of each circuit impacts that of the overall transceiver.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

B. Razavi, "**RF Microelectronics**", PHI, second edition.

Reference Books:

1. R. Jacob Baker, H.W. Li, D.E. Boyce "**CMOS Circuit Design, layout and Simulation**", PHI 1998.
2. Thomas H. Lee "**Design of CMOS RF Integrated Circuits**" Cambridge University press 1998.
3. Y.P. Tsividis, "**Mixed Analog and Digital Devices and Technology**", TMH 1996

Advances in Image Processing
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – IV

Subject Code	16ECS422	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 03

Course Objectives: This course will enable students to:

- Acquire fundamental knowledge in understanding the representation of the digital image and its properties
- Equip with some pre-processing techniques required to enhance the image for further analysis purpose.
- Select the region of interest in the image using segmentation techniques.
- Represent the image based on its shape and edge information.
- Describe the objects present in the image based on its properties and structure.

Modules	**RBT Level**
Module 1	
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.	L1
Module 2	
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.	L1, L2
Module 3	
Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.	L1, L2, L3
Module 4	
Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.	L1, L2, L3
Module 5	
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds.	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:
- Understand the representation of the digital image and its properties

- Apply pre-processing techniques required to enhance the image for its further analysis.
- Use segmentation techniques to select the region of interest in the image for analysis
- Represent the image based on its shape and edge information.
- Describe the objects present in the image based on its properties and structure.
- Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Cengage Learning, 2013, ISBN: 978-81-315-1883-0

Reference Books:

1. Geoff Doughertry, Digital Image Processing for Medical Applications, Cambridge university Press, 2010
2. S.Jayaraman, S Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, 2011

Communication System Design using DSP Algorithms [As per Choice Based credit System (CBCS) Scheme SEMESTER – IV				
Subject Code	16ECS423	IA Marks		20
Number of Lecture Hours/Week	03	Exam marks		80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours		03
	CREDITS – 03			

Course Objectives: This course will enable students to:

- Understand communication systems, including algorithms that are particularly suited to DSP implementation.
- Understand Software and hardware tools, as well as FIR and IIR digital filters and the FFT.
- Discuss modulators and demodulators for classical analog modulation methods such as amplitude modulation (AM), double-sideband suppressed-carrier amplitude modulation (DSBSC-AM), single sideband modulation (SSB), and frequency modulation (FM).
- Explore digital communication methods leading to the implementation of a telephone-line modem.

Modules	RBT Level
Module 1	
Introduction to the course: Digital filters, Discrete time convolution and frequency responses, FIR filters - Using circular buffers to implement FIR filters in C and using DSP hardware, Interfacing C and assembly functions, Linear assembly code and the assembly optimizer. IIR filters - realization and implementation, FFT and power spectrum estimation: DTFT window function, DFT and IDFT, FFT, Using FFT to implement power spectrum.	L1,L2
Module 2	
Analog modulation scheme: Amplitude Modulation - Theory, generation and demodulation of AM, Spectrum of AM signal. Envelope detection and square law detection. Hilbert transform and complex envelope, DSP implementation of amplitude modulation and demodulation. **DSBSC:** Theory generation of DSBSC, Demodulation, and demodulation using coherent detection and Costas loop. Implementation of DSBSC using DSP hardware. **SSB:** Theory, SSB modulators, Coherent demodulator, Frequency translation, Implementation using DSP hardware. (Text 1, 2)	L1,L2
Module 3	
Frequency modulation: Theory, Single tone FM, Narrow band FM, FM bandwidth, FM demodulation, Discrimination and PLL methods, Implementation using DSP hardware. **Digital Modulation scheme:** PRBS, and data scramblers: Generation of PRBS, Self -synchronizing data scramblers, Implementation of PRBS and data scramblers. RS-232C protocol and BER tester: The	L1,L2

protocol, error rate for binary signaling on the Gaussian noise channels, Three bit error rate tester and implementation.	
Module 4	
PAM and QAM: PAM theory, baseband pulse shaping and ISI, Implementation of transmit filter and interpolation filter bank. Simulation and theoretical exercises for PAM, Hardware exercises for PAM. **QAM fundamentals:** Basic QAM transmitter, 2 constellation examples, QAM structures using passband shaping filters, Ideal QAM demodulation, QAM experiment. QAM receivers-Clock recovery and other frontend sub-systems. Equalizers and carrier recovery systems.	L1, L2,L3
Module 5	
Experiment for QAM receiver frontend. Adaptive equalizer, Phase splitting, Fractionally spaced equalizer. Decision directed carrier tracking, Blind equalization, Complex cross coupled equalizer and carrier tracking experiment. Echo cancellation for full duplex modems: Multicarrier modulation, ADSL architecture, Components of simplified ADSL transmitter, A simplified ADSL receiver, Implementing simple ADSL Transmitter and Receiver.	L1, L2,L3

Course outcomes: After studying this course, students will be able to:

- Implement DSP algorithms on TI DSP processors
- Implement FIR, IIR digital filtering and FFT methods
- Implement modulators and demodulators for AM,DSBSC-AM,SSB and FM
- Design digital communication methods leading to the implementation of a line communication system.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

1. Tretter, Steven A., "**Communication System Design Using DSP Algorithms With Laboratory Experiments for the TMS320C6713™ DSK",** Springer USA, *2008.*

Reference Books:

1. Robert. O. Cristi, "**Modern Digital signal processing",** Cengage Publishers, India, 2003.
2. S. K. Mitra, "**Digital signal processing: A computer based approach",** 3rd edition, TMH, India, 2007.
3. E.C. Ifeachor, and B. W. Jarvis, "**Digital signal processing: A Practitioner's approach",** Second Edition, Pearson Education, India, 2002,
4. Proakis, and Manolakis, "**Digital signal processing**", 3rd edition, Prentice Hall, 1996.

<table>
<tr><td colspan="4" align="center"><u>Reconfigurable Computing</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – IV</td></tr>
<tr><td>Subject Code</td><td>16ELD424</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40
(8 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 03</td></tr>
</table>

Course Objectives: The aim of this course is to enable the students to

- Acquire fundamental knowledge and understanding of principles and practice in reconfigurable architecture.
- Understand the FPGA design principles, and logic synthesis.
- Integrate hardware and software technologies for reconfiguration computing focusing on partial reconfiguration design.
- Focus on different domains of applications on reconfigurable computing.

Modules	RBT Level
Module 1	
Introduction: History, Reconfigurable Vs Processor based system, RC Architecture. **Reconfigurable Logic Devices**: Field Programmable Gate Array, Coarse Grained Reconfigurable Arrays. **Reconfigurable Computing System**: Parallel Processing on Reconfigurable Computers, A survey of Reconfigurable Computing System. (Text 1)	LI, L2
Module 2	
Languages and Compilation: Design Cycle, Languages, HDL, High Level Compilation, Low level Design flow, Debugging Reconfigurable Computing Applications. (Text 1)	L1,L2
Module 3	
Implementation: Integration, FPGA Design flow, Logic Synthesis. **High Level Synthesis for Reconfigurable Devices:** Modelling, Temporal Partitioning Algorithms. (Text 2)	L1, L2, L3
Module 4	
Partial Reconfiguration Design: Partial Reconfiguration Design, Bitstream Manipulation with JBits, The modular Design flow, The Early Access Design Flow, Creating Partially Reconfigurable Designs, Partial Reconfiguration using Hansel-C Designs, Platform Design. (Text 2)	L1,L2
Module 5	
Signal Processing Applications: Reconfigurable computing for DSP, DSP application building blocks, Examples: Beamforming, Software Radio, Image and video processing, Local Neighbourhood functions, Convolution. (Text 1) **System on a Programmable Chip:** Introduction to SoPC, Adaptive Multiprocessing on Chip. (Text 2)	L1, L2,L3

Course Outcomes:: After studying this course, students will be able to:

- Synthesize the reconfigurable computing architectures.
- Use the reconfigurable architectures for the design of a digital system.
- Design of digital systems for a variety of applications on signal processing

and system on chip configurations.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. M. Gokhale and P. Graham, “Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays”, Springer, 2005.
2. C. Bobda, “Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications”, Springer, 2007.

Reference Books:

1. D. Pellerin and S. Thibault, “Practical FPGA Programming in C”, Prentice-Hall, 2005.
2. W. Wolf, “FPGA Based System Design”, Prentice-Hall, 2004.
3. R. Cofer and B. Harding, “Rapid System Prototyping with FPGAs: Accelerating the Design Process”, Newnes, 2005.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examination and Syllabus
M.Tech POWER EECRTONICS (EPE)

Eligibility: Bachelor's degree in Engineering or Technology in
(a)Electrical and Electronics Engineering (b) Electronics and Communication Engineering
(c) Electronics and Telecommunication Engineering (d) Telecommunication Engineering
(e) Electronics and Instrumentation Engineering (f) Instrumentation Engineering
(g) Biomedical Engineering (h) Medical Electronics (i) AMIE in appropriate branch
(i) GATE: EC, IT, EE

(Effective from Academic year 2016-17)

BOARD OF STUDIES IN ELECTRICAL AND ELECTRONICS ENGINEERING

December 2016

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech POWER EECRTONICS (EPE)

CHOICE BASED CREDIT SYSTEM (CBCS)

(Total number of credits prescribed for the programme - 85)

I SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EEE11	Applied Mathematics	04	--	03	20	80	100	4
2	16EPE12	Power Semiconductor Devices and Components	04	--	03	20	80	100	4
3	16EPE13	Power Electronic Converters	04	--	03	20	80	100	4
4	16EPE14	Modelling and Design of Controllers	04	--	03	20	80	100	4
5	16EPE15X	Elective -1	03	--	03	20	80	100	3
6	16EPEL16	Power Electronics Laboratory - 1	-	3	03	20	80	100	2
7	16EPE17	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**06**	**18**	**220**	**480**	**700**	**22**

Number of credits completed at the end of I semester: 22

Elective - 1

Course Code under 16EPE15X	Title
16EPE151	Embedded Systems
16EPE152	Power System Harmonics
16EPE153	Advanced Control Systems
16EPE154	EMC in Power Electronics

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech POWER EECRTONICS (EPE)

CHOICE BASED CREDIT SYSTEM (CBCS)

(Total number of credits prescribed for the programme - 85)

II SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EPE21	Electric Drives	04	--	03	20	80	100	4
2	16EPE22	Switched - Mode Power Supplies	04	--	03	20	80	100	4
3	16EPE23	Modelling and Analysis of Electrical Machines	04	--	03	20	80	100	4
4	16EPE24	FACTS Controllers	04	--	03	20	80	100	4
5	16EPE25X	Elective - 2	03	--	03	20	80	100	3
6	16EPEL26	Power Electronics Laboratory - 2	-	3	03	20	80	100	2
7	16EPE27	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**06**	**18**	**220**	**480**	**700**	**22**

Number of credits completed at the end of II semester: 22+ 22 = 44

Elective - 2

Course Code under 16EPE25X	Title
16EPE251	Converters for Solar and Wind Power Systems
16EPE252	Uninterruptible Power Supply
16EPE253	Power Quality Problems and Mitigation
16EPE254	Hybrid Electric Vehicles

Note: Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
SCHEME OF TEACHING AND EXAMINATION - 2016-17
M.Tech POWER EECRTONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
(Total number of credits prescribed for the programme - 85)

III SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EPE31	Seminar / Presentation on Internship. (After 8 weeks from the date of commencement)			--	25	--	25	20
2	16EPE32	Report on Internship	--	--	--	25	--	25	
3	16EPE33	Evaluation and Viva-Voce of Internship	--	--	--	--	50	50	
4	16EPE34	Evaluation of Project phase -1	--	--	--	50	--	50	1
TOTAL			--	--	--	**100**	**50**	**150**	**21**

Number of credits completed at the end of III semester: 22+ 22 + 21 = 65

Note:
Internship of 16 weeks shall be carried out during III semester.
Major part of the Project work shall also be carried out during the III semester in consultation with the Guide/s.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech POWER EECRTONICS (EPE)

CHOICE BASED CREDIT SYSTEM (CBCS)

(Total number of credits prescribed for the programme - 85)

IV SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EPE41	HVDC power Transmission	04	--	03	20	80	100	4
2	16EPE42X	Elective - 3	03	--	03	20	80	100	3
3	16EPE43	Evaluation of Project phase - 2	--	--	--	50	-	50	3
4	16EPE44	Evaluation of Project and Viva-Voce	--	--	--	--	100 + 100	200	10
TOTAL			**07**	**--**	**06**	**90**	**360**	**450**	**20**

Number of credits completed at the end of IV semester: 22+ 22 + 21 + 20 = 85

Elective - 3

Course Code under 16EPE42X	Title
16EPE421	Digital Power Electronics
16EPE422	MPPT in Solar Systems
16EPE423	Multi-Terminal DC Grids
16EPE424	Multilevel Converters for Industrial Applications

Note: 1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee comprising of HoD as Chairman, Guide and Senior faculty of the department.

3.**Project Evaluation**: Evaluation shall be taken up at the end of 4th semester. Project work evaluation and Viva-Voce examination shall conducted

4**. Project evaluation:**

a. Internal Examiner shall carry out the evaluation for 100 marks.

b. External Examiner shall carry out the evaluation for 100 marks.

c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.

d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks.

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - I

APPLIED MATHAMATICS (Core Course)

Course Code	16EEE11	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- The objectives of this course is to acquaint the students with principles of advanced mathematics through linear algebra, transform methods for differential equations, calculus of variations and linear and non-linear programming, that serve as an essential tool for applications of electrical engineering sciences. ■

Module-1		Teaching Hours
Numerical Methods: Solution of algebraic and transcendental equations- iterative methods based on second degree equation – Muller method(no derivation), Chebyshev method. Fixed point iteration method (first order), acceleration of convergence- Δ^2 - Aitken's method. System of non-linear equations – Newton-Raphson method. Complex roots by Bairstow's method.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying	
Module-2		
Numerical Solution of Partial Differential Equations: Classification of second order equations, parabolic equations-solution of one dimensional heat equation, explicit method, Crank-Nicolson method. Hyperbolic equations- solution of one dimensional wave equation and two-dimensional Laplace equation by explicit method. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying	
Module-3		
Linear Algebra: Vector spaces, linear dependent, independence, basis and dimension, elementary properties, examples. **Linear Transformations**: Definition, properties, range and null space, rank and nullity, algebra of linear transformations-invertible, singular and non-singular transformations, representation of transformations by matrices.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding	
Module-4		
System of linear algebraic equations and Eigen value problems: Iterative methods - Gauss-Seidal method, SOR method, Eigen value problems – Gerschgorian circle theorem, Eigen values and Eigen vectors of real symmetric matrices -Jacobi method. **Interpolation:** Hermite interpolation, spline interpolation, numerical solution of differential equations – Numerov method. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying	
Module-5		
Optimization: Linear programming- formulation of the problem, general linear programming problem, simplex method, artificial variable technique, Big M-method. **Graph Theory:** Basic terminologies, types of graphs, sub graphs, graphs isomorphism, connected graphs-walks, paths, circuits, connected and disconnected graphs, operations on graphs, Eulerian paths and circuits, Hamiltonian paths and circuits, applications to electrical circuits. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
16EEE11 APPLIED MATHAMATICS (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

1. Employ numerical techniques in order to achieve more accurate values in the computation of roots of algebraic and non-linear equations.
2. Utilize analytical and numerical schemes to solve partial differential equations applicable to engineering problems.
3. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
4. Apply standard iterative methods to compute Eigen values and solve ordinary differential equations.
5. Employ linear and non-linear programming techniques in simulation of network systems and optimization of electrical circuits. ■

Graduate Attributes (As per NBA):

Critical Thinking, Problem Solving, Research Skill, Usage of Modern Tools.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Text/Reference Books

1	Linear Algebra and its Applications	David C.Lay et al	Pearson	5th Edition,2015
2	Numerical methods in Engineering and Science (with C, C++ & MATLAB)	B.S.Grewal	Khanna Publishers	2014
3	Graph Theory with Applications to Engineering and Computer Science	Narsingh Deo	PHI	2012
4	Numerical Methods for Scientific and Engineering Computation	M. K. Jain et al	New Age International	9^{th} Edition, 2014
5	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43^{rd} Edition,2015
6	Linear Algebra	K.Hoffman et al	PHI	2011
7	**Web links:** 1. *http://nptel.ac.in/courses.php?disciplineId=111* 2. *http://www.class-central.com/Course/math(MOOCs)* 3. *www.wolfram.com*			

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - I

POWER SEMICONDUCTOR DEVICES AND COMPONETS (Core Course)

Course Code	16EPE12	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To enhance the knowledge of fundamentals of semiconductor physics, power electronics and power computation in circuits
- To enhance the knowledge of fundamentals of various semiconductor devices, their operation and characteristics.
- To explain the design and operation of drive circuits and snubber circuits.
- To explain the controlling of temperature rise of the semiconductor devices and designing of magnetic components used for the power electronic circuits. ■

Module-1	Teaching Hours
Power Electronics: Introduction, Converter Classification, Power Electronics Concepts, Electronic Switches, Switch Selection, Spice, PSpice and Capture, Representation of switches in Pspice -The Voltage-Controlled Switch, Transistors, Diodes and Thyristors (SCRs). **Power Computations**: Introduction, Power and Energy, Inductors and Capacitors, Energy Recovery, Effective Values, Apparent Power and Power Factor, Power Computations for Sinusoidal AC Circuits, Power Computations for Nonsinusoidal Periodic Waveforms, Power Computations Using Pspice. **Basic Semiconductor Physics:** Introduction, Conduction Processes in Semiconductors pn Junctions, Charge Control Description of pn-Junction Operation, Avalanche Breakdown. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Power Diodes: Introduction, Basic Structure and I – V characteristics, Breakdown Voltage Considerations, On –State Losses, Switching Characteristics, Schottky Diodes. **Bipolar Junction Transistors:** Introduction, Vertical Power Transistor Structures, Z-V Characteristics, Physics of BJT Operation, Switching Characteristics, Breakdown Voltages, Second Breakdown, On-State Losses, Safe Operating areas. **Power MOSFETs :** Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Operating Limitations and Safe Operating Areas. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-3	
Thyristors: Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Methods of Improving di/dt and dv/dt Ratings. **Gate Turn-Off Thyristors:** Introduction, Basic Structure and Z-V Characteristics, Physics of Turn-Off Operation, GTO Switching Characteristics, Overcurrent Protection of GTOs. **Insulated Gate Bipolar Transistors:** Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Latchup in IGBTs, Switching Characteristics, Device Limits and SOAs. **Emerging Devices and Circuits:** Introduction, Power Junction Field Effect Transistors, Field-Controlled Thyristor, JFET-Based Devices versus Other Power Devices, MOS-Controlled Thyristors, Power Integrated Circuits, New Semiconductor Materials for Power Devices. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
16EPE12 POWER SEMICONDUCTOR DEVICES AND COMPONETS (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-4		**Teaching Hours**
Snubber Circuits: Function and Types of Snubber Circuits, Diode Snubbers, Snubber Circuits for Thyristors, Need for Snubbers with Transistors, Turn-Off Snubber, Overvoltage Snubber, Turn-On Snubber, Snubbers for Bridge Circuit Configurations, GTO Snubber Considerations. **Gate and Base Drive Circuits:** Preliminary Design Considerations, dc-Coupled Drive Circuits, Electrically Isolated Drive Circuits, Cascode-Connected Drive Circuits, Thyristor Drive Circuits, Power Device Protection in Drive Circuits, Circuit Layout Considerations ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Component Temperature Control and Heat Sinks: Control of Semiconductor Device Temperatures, Heat Transfer by Conduction, Heat sinks, Heat Transfer by Radiation and Convection. **Design of Magnetic Components:** Magnetic Materials and Cores, Copper Windings, Thermal Considerations, Analysis of a Specific Inductor Design, Inductor Design Procedures, Analysis of a Specific Transformer Design, Eddy Currents, Transformer Leakage Inductance, Transformer Design Procedure, Comparison of Transformer and Inductor Sizes. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss power electronic concepts, electronic switches and semiconductor physics.
- Explain representation of switches in P-spice and power computations.
- Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; power diodes, power BJT, power MOSFET.
- Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; thyristors, power IGBT, power FET.
- Design Snubber circuits for the protection of power semiconductor devices.
- Design gate and base drive circuits for power semiconductor devices
- Design a heat sink to control the temperature rise of semiconductor devices
- Design magnetic components inductors and transformers used in the power electronic circuits. ■

Graduate Attributes (As per NBA):

Engineering Knowledge Problem, Analysis, Design / development of solutions, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power Electronics	Daniel W Hart	McGraw Hill	
2	Power Electronics Converters, Applications, and Design	Ned Mohan et al	Wiley	3rd Edition,2014
3	Semiconductor Device Modeling with Spice	G. Massobrio, P. Antognetti	McGraw-Hill	2nd Edition, 2010
4	Power Semiconductor Devices	B. Jayant Baliga	Springer	2008

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
POWER ELECTRONIC CONVERTERS (Core Course)			
Course Code	16EPE13	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To impart knowledge of PWM techniques in controlling the converter operation.
- To impart knowledge of designing and analyzing DC – DC PWM converters and control modules.
- To impart knowledge of designing and analyzing DC – AC and AC – DC converters.
- To impart knowledge of analyzing different types of resonant converters and their control.
- To impart knowledge of AC –AC converters and multilevel controllers. ■

Module-1		**Teaching Hours**
PWM DC/DC Converters: Forward Converters - Analysis of the Basic Circuit, Galvanically Isolated Forward Converter, Boost Converter - Analysis of the Basic Scheme, Variation of the Output Voltage, Boundary Between the Continuous and the Discontinuous Mode , Discontinuous Mode Power Losses, Indirect Converter - Boundary Between the Continuous and the Discontinuous Mode, Discontinuous Mode, Indirect Converter with Galvanic Separation, Push – Pull (Symmetric) Converters - Analysis of Idealized Circuit in Continuous Mode, Output Characteristics, Selection of Components, DC Premagnetization of the Core, Half-Bridge Converter, Bridge Converter, Hamilton Circuit, Ćuk Converters - Elimination of the Current Ripple, Ćuk Converters with Galvanic Isolation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Control Modules: Basic Principles and Characteristics of PWM Control Modules - Circuit Analysis, Simple PWM, Voltage-Controlled PWM, Current-Controlled PWM- Compensated PWM, IC Control Modules - Control Module TL494, Control Module SG1524/2524/3524, Control Module TDA 1060. **DC/AC Converters – Inverters:** Single-Phase Voltage Inverters - Pulse-Controlled Output Voltage, Pulse-Width Modulated Inverters - Unipolar PWM, Three-Phase Inverters-Overmodulation ($m_a > 1$), Asynchronous PWM, Space Vector Modulation - Space Vector Modulation: Basic Principles, Application of Space Vector Modulation Technique, Direct and Inverse Sequencing, Real Drive Influence. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
AC/DC Converters – Rectifiers: Half-Wave Single-Phase Rectifiers , Full-Wave Rectifiers - Commutation of Current, Output Filters - Capacitive Filter, L Filter,Voltage Doublers, Three-Phase Rectifiers, Phase Controlled Rectifiers - Full-Wave Thyristor Rectifiers, Three-Phase Thyristor Bridge Rectifiers, Twelve-Pulse Rectifiers, Rectifiers with Circuit for Power Factor Correction, Active Rectifier - Active Rectifier with Hysteresis Current Controller, PWM Rectifiers - Advanced Control Techniques of PWM Rectifiers , PWM Rectifier with Current Output, PWM Rectifiers in Active Filters, Some Topologies of PWM Rectifiers, Applications of PWM Rectifiers. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	

M.TECH POWER ELECTRONICS (EPE)
16EPE13 POWER ELECTRONIC CONVERTERS (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-4		**Teaching Hours**
Resonant Converters: Resonant Circuits - Resonant Converters of Class D, Series Resonant Converters, Parallel Resonant Converters, Series – Parallel Resonant Converter, Series Resonant Converters Based on GTO Thyristors, Class E Resonant Converters, DC/DC Converters Based on Resonant Switches - ZCS Quasi-resonant Converters, ZVS Quasi-resonant Converters, Multiresonant Converters, ZVS Resonant DC/AC Converters, Soft Switching PWM DC/DC Converters -Phase Shift Bridge Converters, Resonant Transitions PWM Converters, Control Circuits of Resonant Converters - Integrated Circuit Family UCx861-8, Integrated Circuits for Control of Soft, Switching PWM Converters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
AC/AC Converters: Single-Phase AC/AC Voltage Converters - Time Proportional Control Three-Phase Converters, Frequency Converters, Direct Frequency Converters, Introduction to AC/AC Matrix Converters - Basic Characteristics, Bidirectional Switches, Realization of Input Filter, Current Commutation, Protection of Matrix Converter, Application of Matrix Converter. **Introduction to Multilevel Converters:** Basic Characteristics -Multilevel DC/DC Converters, Time Interval: nT < t < nT + DT, n = 0, 1, 2,Time Interval: nT + DT < t < (n + 1)T , Multilevel Inverters - Cascaded H-Bridge Inverters, Diode-Clamped Multilevel Inverters, Flying Capacitor Multilevel Inverter, Other Multilevel Inverter Topologies, Control of Multilevel Inverters - Multilevel SPWM, Space Vector Modulation, Space Vector Control, Selective Harmonic Elimination. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Use the knowledge of PWM techniques in controlling different power electronic converters.
- Apply the knowledge of power electronics in design and analysis of DC –DC PWM converters.
- Design and analyze DC –AC and AC – DC converters and control their operation using PWM techniques.
- Design and analyze different resonant converters and their control circuits.
- Analyze AC – AC converters and multilevel converters. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power Electronics Converters and Regulators	Branko L. Doki ć Branko Blanu š a	Springer (International Publishing, Switzerland)	3rd Edition, 2015
2	Power Electronics Converters, Applications, and Design	Ned Mohan at el	Wiley	3rd Edition,2014

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - I

MODELLING AND DESIGN OF CONTROLLERS (Core Course)

Course Code	16EPE14	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To impart knowledge required for modeling and computer simulation of power electronic converters and systems.
- To explain control system essentials in representing system in digital domain.
- To explain the designing of digital controllers by different methods.
- To explain the design and analysis of optimal and robust controllers by different methods.
- To impart knowledge of discrete computation essentials. ■

Module-1		Teaching Hours
Computer Simulation of Power Electronic Converters and Systems: Introduction, Challenges in Computer Simulation, Simulation Process, Mechanics of Simulation, Solution Techniques for Time-Domain Analysis, Widely Used, Circuit-Oriented Simulators, Equation Solvers. **Modelling of Systems:** Input-Output relations, Differential Equations and Linearization, State Space Representation, Transfer Function Representation, Block Diagrams, Lagrange method, Circuit Averaging, Bond Graphs, Space Vector Modelling. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Control System Essentials: Representation of system in digital Domain, The Z – Transform, Digital Filter, Mapping between s – plane and z – plane, Effect of Sampling, Continuous to Discrete Domain Conversion, Control System Basics, Control Principles, State - Space Method. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Digital Controller Design: Controller Design Techniques, Bode Diagram Method, PID Controller, Root Locus Method, State Space Method, Full State Feedback, Regulator Design by Pole Placement, Estimation Design, Tracker : Controller Design. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Digital Controller Design (continued): Controlling Voltage, Controlling Current, Control of Induction motor, Output Feedback, Induction motor Control with Output Feedback. **Optimal and Robust Controller Design:** Least Squares Principle, Quadratic Forms, Minimum Energy Principle, Least Square Solution, Weighted Least Squares, Recursive Least Squares, Optimal Control: Linear Quadratic, Induction motor example, Robust Controller Design. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
16EPE14 MODELLING AND DESIGN OF CONTROLLERS (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5	**Teaching Hours**
Discrete Computation Essentials: Numeric Formats, Tracking the Base Point in the Fixed Point System, Normalization And Scaling, Arithmetic Algorithms. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Describe the role of computer simulations in the analysis and design of power electronics systems.
- Understand the functional modeling of static systems.
- Use sampling technique to determine a digital equivalent to a continuous time system.
- Understand the control basics of digital systems.
- Design digital controllers in discrete time and frequency domain.
- Design optimal and robust controllers by different methods.
- Explain essentials of discrete computation. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power Electronics Converters, Applications, and Design	Ned Mohan, Tore M. Undeland, William P. Robbins	Wiley	3rd Edition,2014
2	Power Electronics Essentials and Applications	L.Umanand	Wiley	1st Edition,2014

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
EMBEDDED SYSTEMS (Elective Course)			
Course Code	16EPE151	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To impart knowledge of embedded systems with suitable examples, explanation of process, classification of embedded systems.
- To explain the processor architecture, memory organization, communication with processor and interrupt services.
- To explain the program modeling concepts, inter-process communication and synchronization of processes. ■

Module-1		Teaching Hours
Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Embedded Systems – on –chip (Soc) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design of Process in Embedded System, Formulation of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skill required for an Embedded System Designer.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Processor Architecture and Memory Organisation: 8051 Architecture, Real world Interfacing, Introduction to Advanced Architecture, Processor and Memory Organization, Instruction Level Parallelism, Performance Metrics, Memory – Types, Memory – Maps and Addresses, Processor Selection, Memory Selection. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Devices and Communication Buses, Interrupt Services: IO Types and Examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing Features in Device Ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Serial Bus Device Protocols – Parallel Communication Network Using ISA,PCI, PCI –X and Advanced Protocols. **Device Drivers and Interrupts Service Mechanisms:** Programmed – I/O Busy – wait Approach without Interrupt Service Mechanism, ISR Concept, Interrupt Sources, Interrupt Servicing Mechanism, Direct Memory Access.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Program Modelling concepts: Program Models, DFG Models, State Machine Programming Models for Event – controlled Program Flow, Modelling of Multiprocessor Systems, UML Modelling. **Interprocess Communication and Synchronization of Processes, Threads and Tasks:** Multiple Processes in an Application, Multiple Threads in an Application, Tasks, Task Status, Task and Data, Clear – cut Distention Between Functions, ISRS and Tasks by their Characteristics, Concept of Semaphores, Shared Data, Interprocess Communication, Signal Function, Semaphore Functions, Message Queue Functions, Mailbox Functions, Pipe Functions, Socket Functions, RPC Functions. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
16EPE151 EMBEDDED SYSTEMS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Real - Time Operating Systems: OS Services, Process Management, Timer Functions, Event Functions, Memory management, Device, File and IO Subsystems Management , Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real – time Operating Systems, Basic Design Using an RTOS, Rtos Task Scheduling Models, Interrupt Latency and Response of the task as performance Metrics, OS Security Issues. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Explain design process in embedded system and formulation of system design.
- Describe processor architecture and memory organization.
- Describe the devices; serial port, parallel port devices, timing devices, devices for synchronous iso-synchronous and asynchronous communication.
- Describe device drivers and interrupt mechanisms.
- Explain the programming concepts and source code engineering tools for embedded programming.
- Explain real time programming and program modeling concepts during single and multi-processor system software development process.
- Describe real time operating systems concepts. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Embedded Systems: Architecture, Programming and Design	Raj Kamal	Mc Graw Hill	2nd Edition,2014

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
POWER SYSTEM HARMONICS (Elective Course)			
Course Code	16EPE152	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain about different sources of harmonics in power system.
- To explain effects of harmonics and mitigation of harmonics.
- To explain modeling of power system components for harmonic studies.
- Introducing different methods of harmonic studies. ■

Module-1		Teaching Hours
Fundamentals of Harmonics: Introduction, Examples of harmonic waveforms, characteristics of harmonics in power systems, measurement of harmonic distortion, power in passive elements, calculation of passive elements, resonance, capacitor banks and reactive power supply, capacitor banks and power factor correction, bus voltage rise and resonance, harmonics in transformers. **Harmonics in Power system:** Introduction, sources of harmonics, transformers, rotating machines, fluorescent lights, static var compensators, cycloconverters. Single phase controlled rectifiers, three phase converters. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Effects of Harmonic Distortion on Power System: Introduction, thermal losses in a harmonic environment, harmonic effects on power system equipment, capacitor banks, transformers, rotating machines, protection, communication and electronic equipment. **Mitigation of Power system Harmonics:** Introduction, harmonic filters, power converters, transformers, rotating machines, capacitor banks, harmonic filter design, active filters. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Limits of Harmonic Distortion: Introduction, voltage harmonic distortion limits, current harmonic distortion limits. **Harmonic studies – Modelling of System Components:** Introduction, impedance in the presence of harmonics, skin effect, modelling of the high voltage grid, generator modelling, modelling of shunt capacitor banks, series capacitor banks, load models, induction motor modelling. **Transformer Modelling:** Introduction, modelling of two winding transformers, phase sequence admittance matrices, transmission of voltage and current across two winding transformers, transmission matrices and phase admittance matrix, modelling of three and four winding transformers. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Modelling of Transmission lines/Cables: Introduction, skin effect, modelling of power lines, Line's series impedance, mutual coupling between conductors, mutually coupled lines, line's shunt capacitance, surge impedance and velocity of propagation, line's series impedance and shunt capacitance – single phase equivalents, the transmission (ABCD) matrix, the admittance matrix, conversion between the transmission and admittance matrices, the nominal pi model – single phase equivalent, the equivalent pi model – voltage and current the line, line losses, the equivalent pi model – single phase equivalent, variations in the network's short circuit capacity, examples – the nominal and equivalent models. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
16EPE152 POWER SYSTEM HARMONICS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Power System Harmonic Studies: Introduction, harmonic analysis using a computer program, harmonic analysis using spread sheet, harmonic distortion limits, harmonic filter rating, and practical considerations. Harmonic study of simple system, 300 -22 kV power system and low voltage system. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the fundamentals that facilitate the understanding of the issues of harmonics.
- Explain the causes for generation of harmonics.
- Explain the effects of harmonics distortion on power system equipment and loads and suppression of harmonics in power systems.
- Discuss standard limits of harmonic distortion and modeling of power system components for harmonic analysis study.
- Model transmission lines and cables for harmonic analysis.
- Discuss implementation of harmonic studies. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power System Harmonics	George J Wakileh	Springer	Reprint, 2014
2	Power System Harmonic Analysis	Jos Arrillaga et al	Wiley	Reprint, 2014
3	Power System Harmonic	J. Arrillaga, N.R. Watson	Wiley	2nd Edition, 2003
4	Harmonics and Power Systems	Francisco C. DE LA Rosa	CRC Press	1st Edition, 2006

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
ADVANCED CONTROL SYSTEMS (Elective Course)			
Course Code	16EPE153	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To impart basic knowledge about digital control through signal conversion, their representation, z – transform, stability analysis in the z – plane, signal reconstruction .etc.
- Development of models of systems in the digital domain, and their implementation.
- To perform state variable method of analysis of digital control systems.
- To impart knowledge of optimal control system analysis in continuous and discrete time domains.
- To impart knowledge about the analysis of nonlinear control systems. ■

Module-1		**Teaching Hours**
Digital Control: Control System Terminology, Need of Digital control, Configurations of the Basic Digital Control Scheme, Principle of Signal Conversion, Basic Discrete – Time Signals, Time Domain Models for Discrete – Time Systems, The z – Transform, Transfer Function Models, Frequency Response, Stability on the z – Plane and Jury Stability Criterion, Sample and Hold Systems, Sampled Spectra and Aliasing, Reconstruction of Analog Signals, Practical Aspects of the choice of Sampling Rate, Principle of Discretization. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Models of Digital Control Devices and Systems: Introduction, z – Domain Description of Sampled Continuous – time Plants, z – Domain Description of Samples with Dead – Time, Implementation of Digital Controllers, Tunable PID Controllers, Digital Temperature and Position Control Systems, Stepping Motors and their Control. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
State Variable Analysis of Digital Control Systems: Introduction, State Description of Digital Processors, State Description of Sampled continuous – Time Plants, State Description of Systems with Dead Time, Solution of State Difference Equations, Controllability and Observability, Multivariable Systems. **Pole Placement Design and State Observers:** Introduction, Stability Improvement by State Feedback, Necessary and sufficient Conditions for Arbitrary Pole – Placement, State Regulator Design, Design of State Observers, Compensator Design by the Separation Principle, Servo Design – Introduction of the reference Input by Feedforward Control, State Feedback with Integral Control, Digital Control Systems with State Feedback, Deadbeat control by State Feedback and Deadbeat Observers. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Quadratic Optimal Control: Introduction, The Concept of Lyapunov Stability, Lyapunov Functions for Linear Systems, Parameter Optimization and Optimal Control Problems, Quadratic Performance Index, Control Configurations, Optimal State Regulator, Optimal Digital Control Systems, Constrained State Feedback Control. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
16EPE153 ADVANCED CONTROL SYSTEMS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Nonlinear System Analysis: Introduction, Common nonlinear System Behaviours, Common nonlinearities in Control Systems, Describing Function Fundamentals, Describing Function of Common nonlinearities, Stability Analysis by the Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Evaluate Z transform of a continuous time signal.
- Assess the stability of a system in Z domain.
- Explain the process of reconstructing the analog signal from a digital signal.
- Model the digital systems to analyze them in the digital domain.
- Use state variable representation to design control law and observers for a system in both continuous and discrete time domains.
- Solve optimal control problems.
- Construct Lyapunov functions to evaluate the stability of a system.
- Use describing function, phase plane methods and Lyapunov method to assess the stability of the nonlinear system. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Digital Control and State Variable Methods (Conventional and Intelligent Control Systems)	M Gopal	Mc Graw Hill	3rd Edition, 2008
2	Discrete – Time Control Systems	Katsuhiko Ogata	Pearson	2nd Edition, 2015
3	Digital Control Systems	Benjamin C Kuo	Oxford University Press	2nd Edition, 2007
4	Control System Engineering	I.J. Nagrath M.Gopal	New Age International	5th Edition, 2007

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
EMC IN POWER ELECTRONICS (Elective Course)			
Course Code	16EPE154	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain different electromagnetic disturbances and their classification.
- To explain measurement of the high frequency characteristics of EMI filter elements, their selection and measurement.
- To explain suppression of noise in relay systems.
- To explain designing and analysis of EMI filters.
- To explain conduction of test as per IEC specifications and reducing internal EMI. ■

Module-1		**Teaching Hours**
Electromagnetic Disturbances: Introduction, Classification of disturbances by frequency content, by character and transmission mode. **Conducted EMI Measurement:** Introduction, EMI measuring instruments, Basic terms and conducted EMI references, Measuring the interference voltage and current, Spectrum analysers, EMI measurements for consumer applications, Measuring impulse like EMI. **EMI in Power Electronic Equipment:** EMI from power semiconductors, controlled rectifier circuits, EMI calculation for semiconductor equipment. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
EMI Filter Elements: Measuring High Frequency Characteristics OF EMI Filter Elements, Capacitors, Choke Coils, Resistors. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Noise Suppression: Noise Suppression in Relay Systems, Application of AC Switching Relays, Application of RC – Snubbers to Power Semiconductors, Shielded Transformers, Capacitor Filters, EMI Generation and Reduction at its Source, Influence of Layout and Control of Parasitics. **EMI Filter Circuit selection and measurement:** Definition of EMI Filter Parameters, ENI Filter Circuits, Insertion Loss Test Methods. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
EMI Filter Design: EMI Filter Design for Insertion Loss, Calculation of Worst – case Insertion Loss, Design Method for Mismatched Impedance Condition, Design Method for EMI Filters with Common – Mode Choke Coils, Damped EMI Filters and Lossy Filter Elements, HF Characteristics of Noise Filter Circuit Elements, EMI Filter Layout. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Testing for Susceptibility to Power Line Disturbances: Surge Voltages in AC Power Mains, EMC Tests per IEC Specifications, Other EMS Test Methods. **Reduction Techniques for internal EMI:** Conductive Noise Coupling, Electromagnetic Coupling, Electromagnetic Coupling Reduction Methods, Wiring Layout Methods to Reduce EMI Coupling, PCB Design Considerations. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
16EPE154 EMC IN POWER ELECTRONICS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

- Describe Electromagnetic interference and its classification and measurement of conducted high frequency disturbance.
- Survey electromagnetic interference specific to power electronic equipment.
- Explain the characteristics of circuit elements used for noise suppression.
- Explain EMI suppression methods used in semiconductor and electromechanical devices.
- Explain design of EMI filter circuits and filtering methods.
- Explain susceptibility and noise withstand capability test.
- Explain EMS reduction techniques for power electronic equipment. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Electromagnetic Compatibility in Power Electronics	Laszlo Tihanyi	Newnes	1st Edition, 1995

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
POWER ELECTRONIS LABORATORY-1			
Course Code	16EPEL16	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	40	Exam Marks	80
Credits - 02			

Course objectives:

- To conduct experiment on various power electronic devices to analyze their static and dynamic characteristics.
- To conduct experiments and enhance understanding of different power electronic converters. ■

Sl. NO	Experiments
1	Analysis of static and dynamic characteristic of MOSFET and IGBT.
2	Performance of single phase fully controlled and semi-controlled converter for RL load for continuous current mode.
3	Performance of single phase fully controlled and semi-controlled converter for RL load for discontinuous current mode.
4	Study of effect of source inductance on the performance of single phase fully controlled converter.
5	Performance analysis of three phase fully controlled and semi-controlled converter for RL load for continuous current mode.
6	Performance analysis of three phase fully controlled and semi-controlled converter for RL load for discontinuous current mode.
7	Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation.
8	Performance analysis of two quadrant chopper.
9	Diode clamped multilevel inverter.
10	ZVS operation of a Synchronous buck converter.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Analyze the static and dynamic characteristics of various semiconductor devices.
- Apply the knowledge of converters in assessing the performance of single phase and three phase fully controlled and semi controlled converters for RL load for continuous current modes.
- Apply the knowledge of converters in assessing the performance of single phase and three phase fully controlled and semi controlled converters for RL load for discontinuous current modes.
- Assess the performance of single phase bridge inverter for RL load and control the voltage by pulse width modulation.
- Apply the knowledge of power electronics in performance analysis of chopper and synchronous buck converter. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Modern Tool Usage, Individual and Team work, Communication.

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
SEMINAR			
Course Code	16EPE17	IA Marks	100
No. of Lecture Hours/Week	--	Exam Hours	--
Number of contact Hours/week	03	Number of Tutorial Hours/week	--
Total No. of contact Hours	--	Exam Marks	--
Credits - 01			

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.
Each student, under the guidance of a Faculty, is required to

- Choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The Internal Assessment marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman. ■

Marks distribution for internal assessment of the course 16EPE17 seminar:
Seminar Report: 30 marks
Presentation skill:50 marks
Question and Answer:20 marks

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

*** END ***

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech POWER EECRTONICS (EPE)

CHOICE BASED CREDIT SYSTEM (CBCS)

(Total number of credits prescribed for the programme - 85)

II SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EPE21	Electric Drives	04	--	03	20	80	100	4
2	16EPE22	Switched - Mode Power Supplies	04	--	03	20	80	100	4
3	16EPE23	Modelling and Analysis of Electrical Machines	04	--	03	20	80	100	4
4	16EPE24	FACTS Controllers	04	--	03	20	80	100	4
5	16EPE25X	Elective - 2	03	--	03	20	80	100	3
6	16EPEL26	Power Electronics Laboratory - 2	-	3	03	20	80	100	2
7	16EPE27	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**06**	**18**	**220**	**480**	**700**	**22**

Number of credits completed at the end of II semester: 22+ 22 = 44

Elective - 2

Course Code under 16EPE25X	Title
16EPE251	Converters for Solar and Wind Power Systems
16EPE252	Uninterruptible Power Supply
16EPE253	Power Quality Problems and Mitigation
16EPE254	Hybrid Electric Vehicles

Note: Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II

ELECTRIC DRIVES (Core Course)

Course Code	16EPE21	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To give an introduction to drive, their characteristics and breaking.
- To explain the basic elements of drives, classification of drives, their dynamics and speed control
- To explain selection of drive for a specific application.
- To explain control of an electric drive using microprocessor. ■

Module-1		Teaching Hours
Characteristics Electric motors: Introduction, Characteristics of DC motors, Three phase Induction Motors and Synchronous Motors, Braking of Electric Motors.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Dynamics of Electric Drives: Introduction, Classification of Electric Drives, Basic Elements of an Electric Drive, Dynamic Conditions of Drive System, Stability Considerations of Electric Drive. **Control of Electric Motors:** Induction Motor Drives. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Control of Electric Motors (continued): Synchronous Motor Drives, DC Drives. Permanent Magnet Synchronous Motor, Classification of Permanent Magnet Synchronous Motor, Cycloconverters fed Synchronous Motor. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Control of Electric Motors (continued): Permanent Magnet Synchronous Motor, Classification of Permanent Magnet Synchronous Motor, Cycloconverters fed Synchronous Motor. **Applications:** Drive Considerations foe Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives, Cement Mills, Sugar Mills, Machine Tools, Paper Mills, Coal Mines, Centrifugal Pumps, Turbo - compressors. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Microprocessors and Control of Electrical Drives: Introduction, Dedicated Hardware Systems versus Microprocessor Control, Applications Area and Functions of Microprocessors in Drive Technology, Control of Electric Drives using Microprocessors,Control System Design of Microprocessors based Variable Speed Drives, Stepper motors. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
16EPE21 ELECTRIC DRIVES (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

- Explain characteristics of DC motors, induction motors and synchronous motors.
- Explain braking of electric motors.
- Classify electric drives.
- Discuss dynamics conditions and stability considerations of Electric drive.
- Control the speed of electric motors.
- Suggest a drive for a specific application.
- Explain using microprocessor in the control of an electric drive. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Electric Drives Concepts and Applications	Vedam Subrahmanyam	Mc Graw Hill	2^{nd} Edition, 2016

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II

SWITCHED - MODE POWER SUPPLIES (Core Course)

Course Code	16EPE22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To give an overview on SMPS, its characteristics, new technologies, basic principles and control modes.
- To introduce the topology of DC/DC converter used and the method of selecting key peripheral components of SMPS.
- To explain the power factor correction circuit design of SMPS, the design of high-frequency transformer, the examples of SMPS optimization design, and the key design points of SMPS.
- To introduce the SMPS testing technology and the protection circuit design of SMPS. ■

Module-1	Teaching Hours
Switching-Mode Power Supply (SMPS): Overview, Classification of Integrated Regulated Power Supply, Characteristics of SMPS, New Development Trend of SMPS, Basic Principles of SMPS, Control Mode Type of SMPS, Working Mode of SMPS, Feedback Type of SMPS, Load Characteristics of SMPS. **Topologies of the DC/DC Converter:** Topologies of the DC/DC Converter, Basic Principle of Buck Converter, Basic Principle of - Boost Converter, Buck-Boost Converter, Charge Pump Converter, (Single-ended primary inductor converter)SEPIC, Flyback Converter, Forward Converter, Push-Pull Converter, Half/Full Bridge Converter, Soft Switching Converter, Half-Bridge LLC Resonant Converter,2-Switch Forward Converter. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Method for Selecting Key Peripheral Components of SMPS: Selection Method for - Fixed Resistor, Capacitors, Inductor Characteristics and Selection Method for Magnetic Beads, Selection Method for EMI Filter - Input Bridge Rectifier, Output Rectifier, Transient Voltage Suppressor (TVS), Power Switching Tube, Optical Coupler, Adjustable Precision Shunt Regulator, SMPS Protection Elements. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-3	
Power Factor Correction Circuit Design of SMPS: Brief Introduction to Power Factor Correction (PFC), Basic Principle of Passive PFC Circuit, Design Examples of Passive PFC Circuit, Basic Principle of Active PFC Circuit, Design Examples of Active PFC Circuit, Principle and Application of High-Power PFC, Measures to Suppress PFC Electromagnetic Interference, PFC Configuration Scheme. **Design of High-Frequency Transformer:** Selection Method for Magnetic Cores by the Empirical Formula or Output Power Table, Waveform Parameters of the High-Frequency Transformer Circuit, Formula Derivation of Selecting High-Frequency Transformer Magnetic Core Based on AP Method, Design of Flyback High-Frequency Transformer, Design of Forward High-Frequency Transformer, Loss of High-Frequency Transformer. ■	**10**
Revised Bloom's Taxonomy Level: L_1 - Remembering, L_2 - Understanding, L_3 – Applying.	

M.TECH POWER ELECTRONICS (EPE)
16EPE22 SWITCHED - MODE POWER SUPPLIES (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-4		**Teaching Hours**
Key Design Points of SMPS: SMPS Design Requirements, Design of High-Efficiency SMPS, Methods of Reducing No-Load and Standby Power Consumption of SMPS, Stability Design of Optocoupler Feedback Control Loop SMPS Layout and Wiring, Design of Constant Voltage/Current SMPS, Design of Precision Constant Voltage/Current SMPS, Design of Remote Turn-Off Circuit for SMPS,Typical Application and Printed Circuit Design of New Single-Chip SMPS, Electromagnetic Interference Waveform Analysis and Safety Code Design of SMPS, Radiator Design of Single-Chip SMPS, Radiator Design of Power Switching Tube (MOSFET), Common Troubleshooting Methods of SMPS. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-5		
SMPS Testing Technology: Parameter Testing of SMPS, Performance Testing of SMPS, SMPS Measurement Skills, Accurate Measurement Method of Duty Ratio, Method to Detect the Magnetic Saturation of High-Frequency Transformer with Oscilloscope, Digital Online Current/Resistance Meter, Electromagnetic Compatibility Measurement of SMPS, Waveform Test and Analysis of SMPS. **Protection and Monitoring Circuit Design of SMPS:** Design of Drain Clamp Protection Circuit, Overvoltage Protection Circuit Constituted by Discrete Components, Application of Integrated Overvoltage Protector, Design of Undervoltage Protection Circuit, Design of Overcurrent and Overpower Protection Circuit, Design of Soft-Start Circuit, Mains Voltage Monitor, Transient Interference and Audio Noise Suppression Technology of SMPS, Design of Overheating Protection Component and Cooling Control System. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain a SMPS, its characteristics, new technologies, basic principles and control modes.
- Suggest a suitable DC/DC converter for an SMPS.
- Explain the method of selecting key peripheral components of SMPS.
- Design the power factor correction circuit of SMPS.
- Explain selection of magnetic core and designing of high-frequency transformer.
- Explain designing of different SMPS.
- Explain testing technology of SMPS.
- Design protection and monitoring circuit for SMPS.■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Ethics, Communication.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Optimal Design of Switching Power Supply	Zhanyou Sha et al	Wiley	2015

<table>
<tr><td colspan="4" align="center">M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II</td></tr>
<tr><td colspan="4" align="center">MODELLING AND ANALYSIS OF ELECTRICAL MACHINES (Core Course)</td></tr>
<tr><td>Subject Code</td><td>16EPE23</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 04</td></tr>
</table>

Course objectives:

- To provide basic concepts of modelling of dc and ac machines.
- To provide knowledge of theory of transformation of three phase variable to two phase variable.
- To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modelling.
- To provide modeling concepts of single phase and three phase transformers.
- To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modelling. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Basic Concepts of Modelling: Basic two pole machine representation of commutator machines, 3-phase synchronous machine with and without damper bar and 3-phase induction machine, Kron’s primitive machine-voltage, current and torque equations.
DC Machine Modelling: Mathematical model of separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor, linearization techniques for small perturbations. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Reference Frame Theory: Real time model of a two phase induction machine, transformation to obtain constant matrices, three phase to two phase transformation, power equivalence.
Dynamic Modelling of Three Phase Induction Machine: Generalized model in arbitrary frame, electromagnetic torque, deviation of commonly used induction motor models-stator reference frames model, rotor reference frames model, synchronously rotating reference frames model, equations in flux linkages, per unit model, dynamic simulation. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Small Signal Equations of the Induction Machine: Derivation of small signal equations of induction machine, space phasor model, DQ flux linkages model derivation, control principle of the induction motor.
Transformer Modelling: Introduction, single phase transformer model, three phase transformer connections, per phase analysis, normal systems, per unit normalization, per unit three phase quantities, change of base, per unit analysis of normal system, regulating transformers for voltage and phase angle control, auto transformers, transmission line and transformers. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Modelling of Synchronous Machines: Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park’s equations, torque equations in substitute variables, rotor angle and angle between rotors, per unit system, analysis of steady state operation. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

M.TECH POWER ELECTRONICS (EPE)
16EPE23 MODELLING AND ANALYSIS OF ELECTRICAL MACHINES (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5	**Teaching Hours**
Dynamic Analysis of Synchronous Machines: Dynamic performance during sudden change in input torque and during a 3-phase fault at the machine terminals, approximate transient torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque; first swing transient stability limit, comparison of actual and approximate transient torque-angle characteristics during a 3-phase fault at the machine terminals, critical clearing time, equal area criterion, computer simulation. ■	**10**

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.

Course outcomes:

At the end of the course the student will be able to:

- Explain the basic concepts of modeling.
- Develop mathematical models for DC motors for transient state analysis.
- Use reference frame theory to transform three phase to two phase.
- Develop dynamic model for three phase induction motor in stator ad rotor reference frames.
- Develop mathematical model of single phase transformers.
- Model synchronous machine using Park's transformation for the analysis of steady state operation.
- Model synchronous machine to perform dynamic analysis under different conditions. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Ethics,

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Generalized Theory of Electrical Machines	P.S.Bimbra	Khanna Publications	5th Edition,1995
2	Electric Motor Drives - Modelling, Analysis & Control	R. Krishnan	PHI Learning Private Ltd	Indian Edition, 2009
3	Analysis of Electrical Machinery and Drive Systems	P.C.Krause, et al	Wiley	2nd Edition,2010
4	Power System Analysis	Arthur R Bergen and Vijay Vittal	Pearson	2nd Edition,2009
5	Power System Stability and Control	Prabha Kundur	Mc Graw Hill	1st Edition,1994
6	Dynamic Simulation of Electric Machinery using Matlab / Simulink	Chee-Mun Ong	Prentice Hall	1998

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II

FACTS CONTROLLERS (Core Course)

Course Code	16EPE24	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To discuss the growth of complex electrical power networks and to introduce the lack of controllability of the active- and reactive-power flows in energized networks.
- To describe the conventional controlled systems and introduce the basic operating principles of new FACTS devices
- To describe the various components of a general SVC, its control system, an overview of the voltage-control characteristics of SVC and the principles of design of the SVC voltage regulator.
- To explain the concepts of SVC control in such applications as stability enhancement, damping subsynchronous oscillations, improvement of HVDC link performance and the basic issues relating to the design of SVC controllers in different applications.
- To explain the concepts of series compensation, TCSC controller and its operation, characteristics, modeling and applications.
- To introduce voltage source converter based facts devices. ■

Module-1		Teaching Hours
Control Mechanism of Transmission System: Background, Electrical Transmission Networks, Conventional Control Mechanisms, Flexible ac Transmission Systems (FACTS), Emerging Transmission Networks. **Reactive-Power Control in Electrical Power Transmission Systems:** Reactive Power, Uncompensated Transmission Lines, Passive Compensation. **Principles of Conventional Reactive-Power Compensators:** Introduction, Synchronous Condensers, The Saturated Reactor (SR), The Thyristor-Controlled Reactor (TCR), The Thyristor-Controlled Transformer (TCT). ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Principles of Conventional Reactive-Power Compensators (continued): The Fixed Capacitor–Thyristor-Controlled Reactor (FC–TCR), The Mechanically Switched Capacitor–Thyristor-Controlled Reactor (MSC–TCR), The Thyristor-Switched Capacitor (TSC), The Thyristor-Switched Capacitor–Thyristor-Controlled Reactor (TSC–TCR), A Comparison of Different SVCs. **SVC Voltage Control:** Introduction Voltage Control. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
SVC Voltage Control (continued): Effect of Network Resonances on the Controller Response, The 2nd Harmonic Interaction between the SVC and ac Network, Application of the SVC to Series-Compensated ac Systems, 3rd Harmonic Distortion, Voltage-Controller Design Studies. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
SVC Applications: Introduction, Increase in Steady-State Power-Transfer Capacity, Enhancement of Transient Stability, Augmentation of Power-System Damping - Principle of the SVC, Auxiliary Control, Torque Contributions of SVC Controllers, Effect of the Power System, Effect of the SVC, SVC Mitigation of Subsynchronous Resonance (SSR) - Principle of SVC Control, Configuration and Design of the SVC Controller, Rating of an SVC, Prevention of Voltage Instability- Principles of SVC Control- A Case Study, Configuration and Design of the SVC Controller, Rating of an SVC.		**10**

M.TECH POWER ELECTRONICS (EPE) 16EPE24 FACTS CONTROLLERS (Core Course) (continued) CHOICE BASED CREDIT SYSTEM (CBCS)		
Module-4 (continued)		**Teaching Hours**
The Thyristor-Controlled Series Capacitor (TCSC): Series Compensation, The TCSC Controller, Operation of the TCSC, The TSSC, Analysis of the TCSC, Capability Characteristics, Harmonic Performance, Losses, Response of the TCSC, Modelling of the TCSC. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
TCSC Applications: Introduction, Open-Loop Control, Closed-Loop Control, Improvement of the System-Stability Limit, Enhancement of System Damping, Subsynchronous Resonance (SSR) Mitigation, Voltage-Collapse Prevention. **VSC based FACTS Controllers:** Introduction, The STATCOM, The SSSC, The UPFC, Comparative Evaluation of Different FACTS Controllers. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the growth of complex electrical power networks, the lack of controllability of the active- and reactive-power flows in energized networks.
- Describe the conventional controlled systems and the basic operating principles of FACTS.
- Describe the various components of a general SVC, its control system, control characteristics and the design of the SVC voltage regulator.
- Explain the use of SVC in stability enhancement, damping subsynchronous oscillations, improvement of HVDC link performance.
- Explain the concepts of series compensation, TCSC controller and its operation, characteristics, modeling and applications.
- Explain the operation of voltage source converter based FACTS. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Thyristor-Based FACTs Controllers for Electrical Transmission Systems	R. Mohan Mathur Rajiv K. Varma	Wiley	2002
2	Understanding FACTS : concepts and technology of flexible AC Transmission systems	Narain G. Hingorani Laszlo Gyugyi.	Wiley	2000
3	Facts Controllers in Power Transmission and Distribution	K. R. Padiyar	New Age International	2007

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
CONVERTERS FOR SOLAR AND WIND POWER SYSTEMS (Elective Course)			
Course Code	16EPE251	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To give an overview of the latest developments in the PV and WT penetrations in the worldwide power systems.
- To discusses the various high-efficiency topologies for PV inverters as well as some generic control structures.
- To describe the grid requirements for PV installations, to give a deep analysis of the basic PLL and to discuss different quadrature signal generator methods,
- To discuss islanding detection methods and to describe the most typical WT grid converter topologies together with generic control structures, the most recent grid requirements for WT grid connection and the grid codes.
- To extrapolate the knowledge of single-phase PLL structure for three-phase systems, new robust synchronization structures to cope with the unbalance grid or frequency adaptation.
- To explain the most used grid converter control structures for WT and to extrapolate the control issue for the case of grid faults.
- To explain designing of grid interface filters, methods actively used to damp the resonance for LCL filters and methods for controlling the grid current. ■

Module-1		**Teaching Hours**
Introduction: Wind Power Development, Photovoltaic Power Development, The Grid Converter – The Key Element in Grid Integration of WT and PV Systems. **Photovoltaic Inverter Structures:** Introduction, Inverter Structures Derived from H-Bridge Topology, Inverter Structures Derived from NPC Topology, Typical PV Inverter Structures, Three-Phase PV Inverters, Control Structures, Conclusions and Future Trends. **Grid Requirements for PV:** Introduction, International Regulations, Response to Abnormal Grid Conditions, Power Quality, Anti-islanding Requirements. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Grid Synchronization in Single-Phase Power Converters: Introduction, Grid Synchronization Techniques for Single-Phase Systems, Phase Detection Based on In-Quadrature Signals, Some PLLs Based on In-Quadrature Signal Generation, Some PLLs Based on Adaptive Filtering, The SOGI Frequency-Locked Loop. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Islanding Detection: Introduction, Non-detection Zone, Overview of Islanding Detection Methods, Passive Islanding Detection Methods, Active Islanding Detection Methods. **Grid Converter Structures for Wind Turbine Systems:** Introduction, WTS Power Configurations, Grid Power Converter Topologies, WTS Control. **Grid Requirements for WT Systems:** Introduction, Grid Code Evolution (Germany), Frequency and Voltage Deviation under Normal Operation, Active Power Control in Normal Operation, Reactive Power Control in Normal Operation (Germany), Behaviour under Grid Disturbances (Germany), Discussion of Harmonization of Grid Codes. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
16EPE251 CONVERTERS FOR SOLAR AND WIND POWER SYSTEMS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-4		**Teaching Hours**
Grid Synchronization in Three-Phase Power Converters: Introduction, The Three-Phase Voltage Vector under Grid Faults, The Synchronous Reference Frame PLL under Unbalanced and Distorted Grid Conditions, The Decoupled Double Synchronous Reference Frame PLL (DDSRF-PLL), The Double Second-Order Generalized Integrator FLL (DSOGI-FLL). **Grid Converter Control for WTS:** Introduction, Model of the Converter, AC Voltage and DC Voltage Control, Voltage Oriented Control and Direct Power Control, Stand-alone, Micro-grid, Droop Control and Grid Supporting. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Control of Grid Converters under Grid Faults: Introduction, Overview of Control Techniques for Grid-Connected Converters under Unbalanced Grid Voltage Conditions, Control Structures for Unbalanced Current Injection, Power Control under Unbalanced Grid Conditions, Flexible Power Control with Current Limitation. **Grid Filter Design:** Introduction, Filter Topologies, Design Considerations, Practical Examples of LCL Filters and Grid Interactions, Resonance Problem and Damping Solutions, Nonlinear Behaviour of the Filter. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:

At the end of the course the student will be able to:

- Explain developments in the PV and WT penetrations in the worldwide power systems.
- Discuss the various high-efficiency topologies for PV inverters and generic control structures.
- Describe the grid requirements for PV installations, and different quadrature signal generator methods,
- Explain grid synchronization techniques for single phase power converters.
- Explain islanding detection methods and typical WT grid converter topologies, control structures, the grid requirements for WT grid connection and the grid codes.
- Explain grid synchronization of three phase power converters and new robust synchronization structures to cope with the unbalance and distorted grid conditions.
- Explain the grid converter control structures for WT and the control issue for the case of grid faults.
- Design grid interface filters used to damp the resonance for LCL filters and methods for controlling the grid current. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Grid Converters for Photovoltaic and Wind Power Systems	Remus Teodorescu at al	Wiley	2011

<table>
<tr><td colspan="4" align="center">M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II</td></tr>
<tr><td colspan="4" align="center">UNINTERRUPTIBLE POWER SUPPLY (Elective Course)</td></tr>
<tr><td>Course Code</td><td>16EPE252</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 03</td></tr>
</table>

Course objectives:

- To explain the classification of UPS, batteries for UPS, parallel operation and performance evaluation and control of UPS systems.
- To describe sources of harmonics, effects of harmonics in UPS, and their mitigation using active filters.
- To describe different topologies of active filters, their applications, configurations, control methods, modelling and analysis, and stability issues.
- To explain the analysis, control, and steady-state operation of unified power quality conditioners.
- To give the concept of reduced parts converters, their operation, modelling, simulation and analysis.
- To explain reduced part active filters and power quality conditioners, modelling, analysis and design of digital control. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Uninterruptible Power Supplies: Classification, Batteries for UPS Applications, Flywheels for UPS Applications, Comparative Analysis of Flywheels and Electrochemical Batteries, Applications of UPS Systems, Parallel Operation, Performance Evaluation of UPS Systems, Power Factor Correction in UPS Systems, Control of UPS Systems, Converters for UPS Systems, Battery Charger/Discharger. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Active Filters: Harmonic Definition, Harmonic Sources in Electrical Systems, Effects of Harmonics, Harmonic Mitigation Methods, Classification of Active Filters, Active Filters for DC/DC Converters, Modelling and Analysis, Control Strategies, Stability Assessment. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Unified Power Quality Conditioners: Series–Parallel Configuration, Current Control, Voltage Control, Power Flow and Characteristic Power.
Reduced-Parts Uninterruptible Power Supplies: Concept of Reduced-Parts Converters Applied to Single-Phase On-Line UPS Systems, New On-Line UPS Systems Based on Half-Bridge Converters. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">New On-Line UPS Systems Based on a Novel AC/DC Rectifier: New Three-Phase On-Line UPS System with Reduced Number of Switches, New Single-Phase to Three-Phase Hybrid Line-Interactive/On-Line UPS System. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-5</td></tr>
<tr><td colspan="2">Reduced-Parts Active Filters: Reduced-Parts Single-Phase and Three-Phase Active Filters, Reduced-Parts Single-Phase Unified Power Quality Conditioners, Reduced-Parts Single-Phase Series–Parallel Configurations, Reduced-Parts Three-Phase Series–Parallel Configurations.
Modelling, Analysis, and Digital Control: Systems Modelling Using the Generalized State Space Averaging Method, Digital Control. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

M.TECH POWER ELECTRONICS (EPE)
16EPE252 UNINTERRUPTIBLE POWER SUPPLY (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

- Explain classification of UPS, batteries for UPS, parallel operation and performance evaluation and control of UPS systems.
- Describe sources of harmonics and their mitigation using active filters.
- Describe topologies of active filters, their applications, control methods, modeling analysis, and stability issues.
- Explain steady-state operation and control of unified power quality conditioners.
- Explain an on-line ups system based on novel AC/DC rectifier.
- Explain the concept of reduced parts active filters, their modeling and control. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Uninterruptible Power Supplies and Active Filters	Ali Emadi et al	CRC Press	2005
2	Uninterruptible Power Supplies and Standby Power Systems	Alexander C King, William Knight	McGraw-Hill	2003

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II

POWER QUALITY PROBLEMS AND MITIGATION (Elective Course)

Course Code	16EPE253	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To give an introduction on power quality (PQ), causes and effects of PQ problems, requirement of PQ improvements, and mitigation aspects of PQ problems.
- To give PQ definitions, terminologies, standards, benchmarks, monitoring requirements through numerical problems.
- To explain passive shunt and series compensation using lossless passive LC components, active shunt compensation using DSTATCOM (distribution static compensators), active series compensation using DVR (dynamic voltage restorer), and combined compensation using UPQC (unified power quality compensator) for mitigation of current-based PQ problems.
- To explain classification, modeling and analysis of various nonlinear loads which cause the power quality problems. ■

Module-1		Teaching Hours
Power Quality: Introduction, State of the Art on Power Quality, Classification of Power Quality Problems, Causes of Power Quality Problems, Effects of Power Quality Problems on Users, Classification of Mitigation Techniques for Power Quality Problems. **Power Quality Standards and Monitoring:** Introduction, State of the Art on Power Quality Standards and Monitoring, Power Quality Terminologies, Power Quality Definitions, Power Quality Standards, Power Quality Monitoring, Numerical Examples. **Passive Shunt and Series Compensation:** Introduction, State of the Art on Passive Shunt and Series Compensators, Classification of Passive Shunt and Series Compensators, Principle of Operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators, Modelling, Simulation, and Performance of Passive Shunt and Series Compensators, Numerical Examples. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Active Shunt Compensation: Introduction, State of the Art on DSTATCOMs, Classification of DSTATCOMs, Principle of Operation and Control of DSTATCOMs, Analysis and Design of DSTATCOMs, Modelling, Simulation, and Performance of DSTATCOMs, Numerical Examples. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Active Series Compensation: Introduction, State of the Art on Active Series Compensators, Classification of Active Series Compensators, Principle of Operation and Control of Active Series Compensators, Analysis and Design of Active Series Compensators, Modelling, Simulation, and Performance of Active Series Compensators, Numerical Examples. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Unified Power Quality Compensators: Introduction, State of the Art on Unified Power Quality Compensators, Classification of Unified Power Quality Compensators, Principle of Operation and Control of Unified Power Quality Compensators, Analysis and Design of Unified Power Quality Compensators, Modelling, Simulation, and Performance of UPQCs, Numerical Examples (from 6.01 to 6.10). ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
16EPE253 POWER QUALITY PROBLEMS AND MITIGATION (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Unified Power Quality Compensators (continued): Numerical Examples (from 6.11to 20). **Loads That Cause Power Quality Problems:** Introduction, State of the Art on Nonlinear Loads, Classification of Nonlinear Loads, Power Quality Problems Caused by Nonlinear Loads, Analysis of Nonlinear Loads, Modelling, Simulation, and Performance of Nonlinear Loads, Numerical Examples. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain causes, effects of PQ problems and classification of mitigation techniques for PQ problems.
- Explain PQ standards, terminology and monitoring requirements through numerical problems.
- Explain passive shunt and series compensation using lossless passive components.
- Explain the design, operation and modeling of active shunt compensation equipment.
- Explain the design, operation and modeling of active series compensation equipment.
- Explain the design operation and modeling of unified power quality compensators.
- Discuss mitigation of power quality problems due to nonlinear loads. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Engineers and society, Ethics, Individual and Team work, Communication, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Power Quality Problems and Mitigation Techniques	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad	Wiley	2015

<table>
<tr><td colspan="4" align="center">M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II</td></tr>
<tr><td colspan="4" align="center">HYBRID ELECTRIC VEHICLES (Elective Course)</td></tr>
<tr><td>Course Code</td><td>16EPE254</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 03</td></tr>
</table>

Course objectives:

- To explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
- To explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.
- To discuss various electric drives suitable for hybrid electric vehicles
- To discuss different energy storage technologies used for hybrid electric vehicles and their control.
- To explain modeling and simulation of electric hybrid vehicles by different techniques, sizing of components and design optimization and energy management. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Introduction: Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs.
Hybridization of the Automobile: Vehicle Basics, Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs).
HEV Fundamentals: Introduction, Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Plug-in Hybrid Electric Vehicles: Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs, Vehicle-to-Grid Technology.
Power Electronics in HEVs: Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC–DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC–DC Converter, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Modelling and Simulation of HEV Power Electronics, Emerging Power Electronics Devices, Circuit Packaging, Thermal Management of HEV Power Electronics. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Electric Machines and Drives in HEVs: Introduction, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Batteries, Ultracapacitors, Fuel Cells, and Controls: Introduction, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Modelling Based on Equivalent Electric Circuits, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

M.TECH POWER ELECTRONICS (EPE)
16EPE254 HYBRID ELECTRIC VEHICLES (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Modelling and Simulation of Electric and Hybrid Vehicles: Introduction, Fundamentals of Vehicle System Modelling, HEV Modelling Using ADVISOR, HEV Modelling Using PSAT, Physics-Based Modelling, Bond Graph and Other Modelling Techniques, Consideration of Numerical Integration Methods, Conclusion. **HEV Component Sizing and Design Optimization**: Introduction, Global Optimization Algorithms for HEV Design, Model-in-the-Loop Design Optimization Process, Parallel HEV Design Optimization Example, Series HEV Design Optimization Example, Conclusion. **Vehicular Power Control Strategy and Energy Management:** A Generic Framework, Definition, and Needs, Methodology to Implement, Benefits of Energy Management. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
- Explain plug – in hybrid electric vehicle architecture, design and component sizing.
- Explain the use of different power electronics devices in hybrid electric vehicles.
- Suggest a suitable electric drive for a specific type of hybrid electric vehicle.
- Explain the use of different energy storage devices used for hybrid electric vehicles, their technologies and control.
- Simulate electric hybrid vehicles by different techniques for the performance analysis. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Modern Tool Usage, Individual and Team work, Communication.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Hybrid Electric Vehicles principles and Applications with Practical Perspectives	Chris Mi,M. Abul Masrur,David Wenzhong Gao	Wiley	2011

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
POWER ELECTRONIS LABORATORY-2			
Course Code	16EPEL26	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	40	Exam Marks	80
Credits - 02			

Course objectives:

- To conduct experiments to assess the performance of separately excited DC motor fed by single phase and three phase fully controlled converter in continuous and discontinuous current modes.
- To conduct experiments to assess the performance of Chopper fed DC drives for class A and class C commutation in continuous current mode.
- To simulate different converters and analyze the waveform in continuous and discontinuous current modes.
- To simulate forward converter, fly back converter and resonant converter to study their performance. ■

Sl. NO	Experiments
1	Study and performance analysis of single phase fully controlled converter fed separately excited DC Motor for continuous current mode.
2	Study and performance analysis of single phase fully controlled converter fed separately excited DC Motor for discontinuous current mode.
3	Study and performance analysis of three phase fully controlled converter fed separately excited DC Motor for continuous current mode.
4	Study and performance analysis of three phase fully controlled converter fed separately excited DC Motor for discontinuous current mode.
5	Performance analysis of a practical chopper fed DC Drives system for class-A and class-C commutation and analysis of wave forms in continuous mode.
6	Simulation study of buck, boost and buck- boost converter (basic topologies) and analysis of wave forms for continuous current mode (CCM).
7	Simulation study of buck, boost and buck-boost converter (basic topologies) and analysis of wave forms for discontinuous current mode (DCM).
8	Simulation study of forward converter and fly back converter and performance analysis of various wave forms.
9	Resonant converter simulation study and analysis.
10	Closed loop operation of a buck and boost converter.

Revised Bloom's Taxonomy Level	L_1- Remembering, L_2 – Understanding L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.

Course outcomes:

At the end of the course the student will be able to:

- Conduct experiments on single phase / three phase fully controlled converter fed separately excited DC motor to assess the performance in continuous and discontinuous current modes.
- Conduct experiments to assess the performance of Chopper fed DC drives for class A and class C commutation in continuous current mode.
- Simulate different converters for analyzing the waveform in continuous and discontinuous current modes.
- Simulate forward converter, fly back converter and resonant converter to study their performance. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Modern Tool Usage, Individual and Team work, Communication.

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
SEMINAR			
Course Code	16EPE27	IA Marks	100
No. of Lecture Hours/Week	--	Exam Hours	--
Number of contact Hours/week	03	Number of Tutorial Hours/week	--
Total No. of contact Hours	--	Exam Marks	--
Credits - 01			

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The Internal Assessment marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman. ■

Marks distribution for internal assessment of the course 16EPE27 seminar:

Seminar Report: 30 marks
Presentation skill:50 marks
Question and Answer:20 marks

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech POWER EECRTONICS (EPE)

CHOICE BASED CREDIT SYSTEM (CBCS)

(Total number of credits prescribed for the programme - 85)

III SEMESTER

<table>
<tr><th rowspan="2">Sl. No</th><th rowspan="2">Course Code</th><th rowspan="2">Title</th><th colspan="2">Teaching Hours /Week</th><th colspan="4">Examination</th><th rowspan="2">Credits</th></tr>
<tr><th>Theory</th><th>Practical/ Field work/ Assignment</th><th>Duration in hours</th><th>I.A. Marks</th><th>Theory/ Practical Marks</th><th>Total Marks</th></tr>
<tr><td>1</td><td>16EPE31</td><td>Seminar / Presentation on Internship. (After 8 weeks from the date of commencement)</td><td></td><td></td><td>--</td><td>25</td><td>--</td><td>25</td><td rowspan="3">20</td></tr>
<tr><td>2</td><td>16EPE32</td><td>Report on Internship</td><td>--</td><td>--</td><td>--</td><td>25</td><td>--</td><td>25</td></tr>
<tr><td>3</td><td>16EPE33</td><td>Evaluation and Viva-Voce of Internship</td><td>--</td><td>--</td><td>--</td><td>--</td><td>50</td><td>50</td></tr>
<tr><td>4</td><td>16EPE34</td><td>Evaluation of Project phase -1</td><td>--</td><td>--</td><td>--</td><td>50</td><td>--</td><td>50</td><td>1</td></tr>
<tr><td colspan="3">TOTAL</td><td>--</td><td>--</td><td>--</td><td>100</td><td>50</td><td>150</td><td>21</td></tr>
</table>

Number of credits completed at the end of III semester: 22+ 22 + 21 = 65

Note:

Internship of 16 weeks shall be carried out during III semester.

Major part of the Project work shall also be carried out during the III semester in consultation with the Guide/s.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech POWER EECRTONICS (EPE)

CHOICE BASED CREDIT SYSTEM (CBCS)

(Total number of credits prescribed for the programme - 85)

IV SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EPE41	HVDC power Transmission	04	--	03	20	80	100	4
2	16EPE42X	Elective - 3	03	--	03	20	80	100	3
3	16EPE43	Evaluation of Project phase - 2	--	--	--	50	-	50	3
4	16EPE44	Evaluation of Project and Viva-Voce	--	--	--	--	100 + 100	200	10
TOTAL			**07**	**--**	**06**	**90**	**360**	**450**	**20**

Number of credits completed at the end of IV semester: 22+ 22 + 21 + 20 = 85

Elective - 3

Course Code under 16EPE42X	Title
16EPE421	Digital Power Electronics
16EPE422	MPPT in Solar Systems
16EPE423	Multi-Terminal DC Grids
16EPE424	Multilevel Converters for Industrial Applications

Note: 1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee comprising of HoD as Chairman, Guide and Senior faculty of the department.

3. **Project Evaluation**: Evaluation shall be taken up at the end of 4th semester. Project work evaluation and Viva-Voce examination shall conducted

4**. Project evaluation:**

a. Internal Examiner shall carry out the evaluation for 100 marks.

b. External Examiner shall carry out the evaluation for 100 marks.

c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.

d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks.

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

HVDC POWER TRANSMISSION (Core Course)

Course Code	16EPE41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To give an introduction to DC power transmission and describe the basic components of a converter, and describe the methods for compensating the reactive power demanded by the converter and the methods for simulation of HVDC systems
- To describe the types of filters for removing harmonics and the characteristics of the system impedance resulting from AC filter designs and different methods of control of HVDC converter and system.
- To explain the design techniques for the main components of an HVDC system.
- To explain the protection of HVDC system and other converter configurations used for the HVDC transmission and the recent trends for HVDC applications. ■

Module-1		Teaching Hours
HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, Review of the HVDC System Reliability, HVDC Characteristics and Economic Aspects. **Power Conversion:** Thyristor, 3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Harmonics of HVDC and Removal: Introduction, Determination of Resulting Harmonic Impedance, Active Power Filter. **Control of HVDC Converter and System:** Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Control of HVDC Converter and System (continued): HVDC Control Functions, Reactive Power and Voltage Stability. **Interactions between AC and DC Systems**: Definition of Short Circuit Ratio and Effective Short Circuit Ratio, Interaction between HVDC and AC Power System. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Main Circuit Design: Converter Circuit and Components, Converter Transformer, Cooling System, HVDC Overhead Line, HVDC Earth Electrodes, HVDC Cable, HVDC Telecommunications Current Sensors, HVDC Noise and Vibration. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Fault Behaviour and Protection of HVDC System: Valve Protection Functions, Protective Action of an HVDC System, Protection by Control Actions, Fault Analysis. **Other Converter Configurations for HVDC Transmission**: Introduction, Voltage Source Converter (VSC), CCC and CSCC HVDC System, 10.4 Multi-Terminal DC Transmission. **Trends for HVDC Applications:** Wind Farm Technology, Modern Voltage Source Converter (VSC) HVDC Systems, 800 kV HVDC System. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
16EPE41 HVDC POWER TRANSMISSION (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

- Explain importance of DC power transmission.
- Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter
- Explain the methods for simulation of HVDC systems and its control.
- Describe filters for eliminating harmonics and the characteristics of the system impedance resulting from AC filter designs
- Explain the design techniques for the main components of an HVDC system.
- Explain the protection of HVDC system and other converter configurations used for the HVDC transmission.
- Explain the recent trends for HVDC applications. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	HVDC Transmission: Power Conversion Applications in Power Systems	Chan-Ki Kim et al	Wiley	2009
2	Direct Current Transmission	E.W. Kimbark	Wiley	1971
3	High Voltage Direct Current Transmission	Arrilaga	IET	2nd Edition, 1998
4	HVDC Transmission	S. Kamakshaiah et al	Mc Graw Hill	2011
5	HVDC and FACTs Controllers; Applications of Static Converters in Power Systems	Vijay K Sood	BSP Books	2013
6	HVDC Power Transmission Systems	K. R. Padiyar	New Age International	2012

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

DIGITAL POWER ELECTRONICS (Elective Course)

Course Code	16EPE421	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To give introduction to multi quadrant operation and choppers, digital power electronic circuits, power semiconductor devices applied in power electronics and the important factors involved in digital power electronics.
- To explain basic mathematics of digital control systems and mathematical modeling of digitally controlled power electronic devices such as rectifiers, inverters and converters
- To explain open loop and closed loop control of power electronic devices and energy factor application of AC and DC motor drives. ■

Module-1	Teaching Hours
Introduction: Historical review, Traditional parameters, Multiple-quadrant operations and choppers, Digital power electronics: pump circuits and conversion Technology, Shortage of analog power electronics and conversion technology, Power semiconductor devices applied in digital power electronics. **Energy Factor (EF) and Sub-sequential Parameters:** Introduction, Pumping energy (PE), Stored energy (SE), Energy factor (EF), Variation energy factor (EFV),Time constant, τ, and damping time constant, τd, Examples of applications, Small signal analysis. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Module-2	
Basic Mathematics of Digital Control Systems: Introduction, Digital Signals and Coding, Shannon's sampling theorem, Sample-and-hold devices, Analog-to-digital conversion, Digital-to-analog conversion, Energy quantization, Introduction to reconstruction of sampled signals, Data conversion: the zero-order hold, The first-order hold, The second-order hold, The Laplace transform (the s-domain), The z-transform (the z-domain), **Mathematical Modelling of Digital Power Electronics:** Introduction, A zero-order hold (ZOH) for AC/DC controlled rectifiers, A first-order transfer function for DC/AC pulse-width-modulation Inverters, A second-order transfer function for DC/DC converters, A first-order transfer function for AC/AC (AC/DC/AC) converters. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Module-3	
Digitally Controlled DC/AC Inverters: Introduction, Mathematical modelling for DC/AC PWM inverters, Single-phase half-wave VSI, Single-phase full-bridge PWM VSI, Three-phase full-bridge PWM VSI, Three-phase full-bridge PWM CSI, Multistage PWM inverter, Multilevel PWM inverter. **Digitally Controlled DC/DC Converters:** Introduction, Mathematical Modelling for power DC/DC converters, Fundamental DC/DC converter, Developed DC/DC converters, Soft-switching converters, Multi-element resonant power converters. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Module-4	
Digitally Controlled AC/AC Converters: Introduction, Traditional modelling for AC/AC (AC/DC/AC) converters, Single-phase AC/AC converter, Three-phase AC/AC voltage controllers, SISO cycloconverters, TISO cycloconverters, TITO cycloconverters, AC/DC/AC PWM converters, Matrix converters. **Open-loop Control for Digital Power Electronics:** Introduction, Stability analysis, Unit-step function responses, Impulse responses.	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

M.TECH POWER ELECTRONICS (EPE)
16EPE421 DIGITAL POWER ELECTRONICS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Closed-Loop Control for Digital Power Electronics: Introduction, PI control for AC/DC rectifiers, PI control for DC/AC inverters and AC/AC (AC/DC/AC) converters, PID control for DC/DC converters. **Energy Factor Application in AC and DC Motor Drives:** Introduction, Energy storage in motors, A DC/AC voltage source, An AC/DC current source, AC motor drives, DC motor drives. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:
At the end of the course the student will be able to:
- Explain traditional parameters computation, multiple quadrant operation and choppers.
- Explain the disadvantages of analog power electronics and conversion technology, energy factor and sub-sequential parameters.
- Explain basic mathematics of digital control systems and mathematical modeling of digitally controlled power electronic devices such as rectifiers, inverters and converters.
- Describe mathematical modeling of AC/DC rectifiers, DC/AC inverters, DC/DC converters and AC/AC (AC/DC/AC) converters are working in the discrete-time state.
- Discuss DC/AC pulse-width-modulation (PWM) inverters and AC /AC converters modeled as a first-order-hold (FOH) element in digital control systems.
- Discuss DC/DC converter modeled as a second order-hold (SOH) element in digital control systems.
- To explain open loop and closed loop control of power electronic devices and energy factor application of AC and DC motor drives.■

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Digital Power Electronics and Applications	Fang Lin Luo, Hong Ye, Muhammad Rashid	Elsevier	2005

M.TECH POWER ELECTRONICS (EPE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - IV			
MPPT IN SOLAR SYSTEMS (Elective Course)			
Course Code	16EPE422	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain the PV cell, its characteristics and its models, equivalent circuits and circuit parameter calculations.
- To explain different methods of tracking maximum power point and effect of noise on MPPT and reduction of noise.
- To explain distributed Maximum Power Point Tracking of PV arrays and its analysis.
- To explain the design of high energy efficiency power converters for PV MPPT. ■

Module-1		**Teaching Hours**
PV Modelling: From the Photovoltaic Cell to the Field, The Electrical Characteristic of a PV Module, The Double-Diode and Single-Diode Models, From Data Sheet Values to Model Parameters, Example: PV Module Equivalent Circuit Parameters Calculation, The Lambert W Function for Modelling a PV Field, Example. **Maximum Power Point Tracking:** The Dynamic Optimization Problem, Fractional Open-Circuit Voltage and Short-Circuit Current, Soft Computing Methods, The Perturb and Observe Approach. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Maximum Power Point Tracking (continued): Improvements of the P&O Algorithm, Evolution of the Perturbative Method, PV MPPT via Output Parameters, MPPT Efficiency. **MPPT Efficiency: Noise Sources and Methods for Reducing their Effects:** Low-Frequency Disturbances in Single-Phase Applications, Instability of the Current-Based MPPT Algorithms, Sliding Mode in PV System, Analysis of the MPPT Performances in a Noisy Environment, Numerical Example. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Distributed Maximum Power Point Tracking of Photovoltaic Arrays: Limitations of Standard MPPT, A New Approach: Distributed MPPT, DC Analysis of a PV Array with DMPPT, Optimal Operating Range of the DC Inverter Input Voltage. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Distributed Maximum Power Point Tracking of Photovoltaic Arrays (continued): AC Analysis of a PV Array with DMPPT. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Design of High-Energy-Efficiency Power Converters for PV MPPT Applications: Introduction, Power, Energy, Efficiency, Energy Harvesting in PV Plant Using DMPPT Power Converters, Losses in Power Converters, Losses in the Synchronous FET Switching Cells, Conduction Losses, Switching Losses. ■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying	

M.TECH POWER ELECTRONICS (EPE)
16EPE422 MPPT IN SOLAR SYSTEMS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

- Explain the PV cell, its characteristics and its models, equivalent circuits and circuit parameter calculations.
- Explain different methods of tracking maximum power point.
- Explain the sources of noise, effect of noise on MPPT and reduction of noise.
- Explain Distributed Maximum Power Point Tracking of PV arrays.
- Conduct DC analysis of PV array with DMPPT.
- Conduct AC analysis of PV array with DMPPT.
- Explain the use of high energy efficiency power converters for PV MPPT application. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Power electronics and Control Techniques for Maximum energy harvesting in Photovoltaic systems	Nicola Femia et al	CRC Press	2013

M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

MULTI-TERMINAL DC GRIDS (Elective Course)

Course Code	16EPE423	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To provide the fundamentals of MTDC grids, their network architectures, components and control modes and basics of voltage sourced converters.
- To explain modeling, simulation and analysis of AC- MTDC grids
- To explain the concept of power sharing in MTDC grid, load flow solution and post contingency operation
- To explain protection issues of MTDC grids, including the DC circuit breakers and fault blocking VSC systems and protection strategies. ■

Module	Teaching Hours
Module-1	
Fundamentals: Introduction, Rationale behind MTDC Grids, Network Architectures of MTDC Grids, Enabling Technologies and Components of MTDC Grids, Control Modes in MTDC Grid, Challenges for MTDC Grids, Configurations of MTDC Converter Stations, Research Initiatives on MTDC Grids. **Voltage-Sourced Converter (VSC)**: Introduction, Ideal Voltage-Sourced Converter, Practical Voltage-Sourced Converter.■	**08**
Revised Bloom's Taxonomy Level: L_1 - Remembering, L_2 - Understanding, L_3 - Applying.	
Module-2	
Voltage-Sourced Converter (continued): Control, Simulation. **Modelling, Analysis, and Simulation of AC–MTDC Grids:** Introduction, MTDC Grid Model. ■	**08**
Revised Bloom's Taxonomy Level: L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 – Analysing.	
Module-3	
Modelling, Analysis, and Simulation of AC–MTDC Grids (continued): AC Grid Model, AC–MTDC Load flow Analysis, AC–MTDC Grid Model for Nonlinear Dynamic Simulation, Small-signal Stability Analysis of AC–MTDC Grid, Transient Stability Analysis of AC–MTDC Grid. ■	**08**
Revised Bloom's Taxonomy Level: L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 – Analysing.	
Module-4	
Modelling, Analysis, and Simulation of AC–MTDC Grids (continued): Case Study 1: The North Sea Benchmark System, Case Study 2: MTDC Grid Connected to Equivalent AC Systems, Case Study 3: MTDC Grid Connected to Multi-machine AC System. **Autonomous Power Sharing:** Introduction, Steady-state Operating Characteristics, Concept of Power Sharing, Power Sharing in MTDC Grid, AC–MTDC Grid Load flow Solution, Post-contingency Operation, Linear Model, Case Study. ■	**08**
Revised Bloom's Taxonomy Level: L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 – Analysing.	
Module-5	
Frequency Support: Introduction, Fundamentals of Frequency Control, Inertial and Primary Frequency Support from Wind Farms, Wind Farms in Secondary Frequency Control (AGC), Modified Droop Control for Frequency Support, AC–MTDC Load Flow Solution, Post-Contingency Operation, Case Study. **Protection of MTDC Grids:** Introduction, Converter Station Protection, DC Cable Fault Response, Fault-blocking Converters, DC Circuit Breakers, Protection Strategies. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
16EPE423 MULTI-TERMINAL DC GRIDS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

- Explain the fundamentals of MTDC grids, their network architectures, components and control modes
- Differentiate ideal and practical voltage sourced converters.
- Simulate AC- MTDC grids for the analysis.
- Explain the concept of power sharing in MTDC grid, load flow solution and post contingency operation.
- Explain frequency support from wind farms.
- Explain protection issues of MTDC grids, including the DC circuit breakers and fault blocking VSC systems and protection strategies. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Modern Tool Usage, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Multi-Terminal Direct-Current Grids Modelling, Analysis, and Control	Nilanjan Ray Chaudhuri et al	Wiley	2014

<table>
<tr><td colspan="5">M.TECH POWER ELECTRONICS (EPE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV</td></tr>
<tr><td colspan="5">MULTILEVEL CONVERTERS FOR INDUSTRIAL APPLICATIONS (Elective Course)</td></tr>
<tr><td colspan="2">Course Code</td><td>16EPE424</td><td>IA Marks</td><td>20</td></tr>
<tr><td colspan="2">Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="2">Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="5">Credits - 03</td></tr>
<tr><td colspan="5">Course objectives:
• To provide an overview of medium-voltage power converters and their applications.
• To describe the generalized multilevel converter topology and to derive the classic converters with a common DC bus and to analyze the common characteristics of the symmetric topologies.
• Explain the analysis of the operation of the diode-clamped multilevel converter, and a multilevel space vector modulation and to characterize the balancing boundary of the passive front-end converter
• To describe the operation and analysis of the flying capacitor multilevel converter.
• To explain asymmetric topology with hybrid modulation and a common DC source called a cascade asymmetric multilevel converter (CAMC) with five voltage levels and its advantages.
• To analysee the behaviour of the CAMC as a distribution static compensator (DSTATCOM) and shunt active power filter in improving the power quality in medium-voltage distribution systems as custom power devices.
• To analyse the behaviour of the diode-clamped topology configured as a back-to-back converter for several working conditions. ■</td></tr>
<tr><td colspan="4">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="4">Converters: Introduction, Medium-Voltage Power Converters, Multilevel Converters, Applications.
Multilevel Topologies: Introduction, Generalized Topology with a Common DC Bus, Converters Derived from the Generalized Topology, Symmetric Topologies without a Common DC Link, Summary of Symmetric Topologies, Asymmetric Topologies. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating</td></tr>
<tr><td colspan="5">Module-2</td></tr>
<tr><td colspan="4">Diode-Clamped Multilevel Converter: Introduction, Converter Structure and Functional Description, Modulation of Multilevel Converters, Voltage Balance Control, Effectiveness Boundary of Voltage Balancing in DCMC Converters, Performance Results. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating</td></tr>
<tr><td colspan="5">Module-3</td></tr>
<tr><td colspan="4">Flying Capacitor Multilevel Converter: Introduction, Flying Capacitor Topology, Modulation Scheme for the FCMC, Dynamic Voltage Balance of the FCMC.
Cascade Asymmetric Multilevel Converter (CAMC): Introduction, General Characteristics of the CAMC, CAMC Three-Phase Inverter, Comparison of the Five-Level Topologies. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating</td></tr>
<tr><td colspan="5">Module-4</td></tr>
<tr><td colspan="4">Case Study 1: DSTATCOM Built with a Cascade Asymmetric Multilevel Converter: Introduction, Compensation Principles, CAMC Model, Reactive Power and Harmonics Compensation. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating</td></tr>
<tr><td colspan="5">Module-5</td></tr>
<tr><td colspan="4">Case Study 2: Medium-Voltage Motor Drive Built with DCMC: Introduction, Back-to-Back DCMC Converter, Unified Predictive Controller of the Back-to-Back DCMC in an IM Drive Application, Performance Evaluation. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating</td></tr>
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</table>

M.TECH POWER ELECTRONICS (EPE)
16EPE424 MULTILEVEL CONVERTERS FOR INDUSTRIAL APPLICATIONS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

At the end of the course the student will be able to:

- Explain the working of medium-voltage power converters and their applications.
- Explain multilevel, symmetric and asymmetric topologies.
- Explain the structure and operation of the diode-clamped multilevel converter, and a multilevel space vector modulation.
- Characterize the balancing boundary of the passive front-end converter.
- Describe the operation and analysis of the flying capacitor multilevel converter.
- Discuss the characteristics topologies of the Cascade Asymmetric Multilevel Controller.
- Explain the working of a distribution static compensator (DSTATCOM) built with CAMC for reactive power and harmonic compensation.
- Evaluate the performance of back-to-back converter in an induction motor drive for several working conditions. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Multilevel Converters for Industrial Applications	Sergio Alberto González, Santiago Andrés Verne, María Inés Valla	CRC Press	2014

*** END ***

SCHEME OF TEACHING AND EXAMINATION
M.Tech in VLSI DESIGN AND EMBEDDED SYSTEMS

I SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16ELD11	Advanced Engineering Mathematics	4	-	3	20	80	100	4
2	16EVE12	Digital VLSI Design	4	-	3	20	80	100	4
3	16EVE13	Advanced Embedded System	4	-	3	20	80	100	4
4	16EVE14	Low Power VLSI Design	4	-	3	20	80	100	4
5	16EXX15X	Elective-1	3	-	3	20	80	100	3
6	16EVEL16	VLSI and ES Lab -1		3	3	20	80	100	2
7	16EVE17	Seminar on advanced topics from refereed journals	-	3	-	100	-	100	1
TOTAL			**19**	**6**	**18**	**220**	**480**	**700**	**22**

Elective -1	
16 EVE151	Digital System Design Using Verilog
16 EVE152	Nanoelectronics
16 EVE153	ASIC Design
16 ELD154	Advanced Computer Architecture

M.Tech in VLSI DESIGN AND EMBEDDED SYSTEMS

II SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	**Practical/Field Work/ Assignment**	**Duration**	**I.A. Marks**	**Theory/ Practical Marks**	**Total Marks**	
1	16EVE21	Design of Analog and Mixed mode VLSI Circuits	4	-	3	20	80	100	4
2	16EVE22	VLSI Testing	4	-	3	20	80	100	4
3	16EVE23	Advances in VLSI Design	4	-	3	20	80	100	4
4	16EVE24	Real Time Operating System	4	-	3	20	80	100	4
5	16EXX25X	Elective –2	3	-	3	20	80	100	3
6	16EVEL26	VLSI and ES Lab -2		3	3	20	80	100	2
7	16EVE27	Seminar on Advanced topics from refereed journals	-	3	-	100	-	100	1
TOTAL			**19**	**6**	**18**	**220**	**480**	**700**	**22**

Elective -2	
16EVE251	System Verilog
16EVE252	VLSI Design for Signal processing
16ELD253	Micro Electro Mechanical Systems
16EVE254	SoC Design

M.Tech in VLSI DESIGN AND EMBEDDED SYSTEMS

III SEMESTER: Internship

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EVE31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	-	-	-	25	-	25	20
2	16EVE32	Report on Internship	-	-	-	25	-	25	
3	16EVE33	Evaluation and Viva-Voce of Internship	-	-	-	-	50	50	
4	16EVE34	Evaluation of Project phase -1	-	-	-	50	-	50	1
TOTAL			**-**	**-**	**-**	**100**	**50**	**150**	**21**

M.Tech. in VLSI DESIGN AND EMBEDDED SYSTEMS

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16ELD41	Synthesis and Optimization of Digital Circuits	4	-	3	20	80	100	4
2	16EXX42X	Elective-3	3	-	3	20	80	100	3
3	16EVE43	Evaluation of Project phase -2	-	-	-	50	-	50	3
4	16EVE44	Evaluation of Project and Viva-Voce	-	-	-	-	100+100	200	10
TOTAL			**-**	**-**	**6**	**90**	**360**	**450**	**20**

Elective -3	
16EVE421	CMOS RF Circuit Design
16ECS422	Advances in Image Processing
16EVE423	High Speed VLSI Design
16ELD424	Reconfigurable Computing

Note:

1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee constituted comprising of HoD as Chairman, Guide and Senior faculty of the department.

3. **Project Evaluation**: Evaluation shall be taken up at the end of 4thsemester. Project work evaluation and Viva-Voce examination shall be conducted.

a. Internal Examiner shall carry out the evaluation for 100 marks.

b. External Examiner shall carry out the evaluation for 100 marks.

c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.

d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks.

M.Tech-VLSI & ES-2016-FIRST SEMESTER SYLLABUS

<table>
<tr><td colspan="4"><u>ADVANCED ENGINEERING MATHEMATICS</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I</td></tr>
<tr><td>Subject Code</td><td>16ELD11</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam Marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
</table>

Course objectives: This course will enable students to:

- Acquaint with principles of linear algebra, calculus of variations, probability theory and random process.
- Apply the knowledge of linear algebra, calculus of variations, probability theory and random process in the applications of electronics and communication engineering sciences.

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Linear Algebra-I Introduction to vector spaces and sub-spaces, definitions, illustrative examples and simple problems. Linearly independent and dependent vectors-definition and problems. Basis vectors, dimension of a vector space. Linear transformations- definition, properties and problems. Rank-Nullity theorem(without proof). Matrix form of linear transformations-Illustrative examples.**(Text 1 & Ref. 1)**	**L1,L2**
Module -2	
Linear Algebra-II Computation of Eigen values and Eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process. QR decomposition, singular value decomposition, least square approximations.**(Text 1 & Ref. 1)**	**L1,L2**
Module -3	
Calculus of Variations Concept of functional-Eulers equation. functional dependent on first and higher order derivatives, functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries.**(Text 2 & Ref. 2)**	**L1,L2**
Module -4	

Probability Theory Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Binomial, Poisson, Exponential, Gaussian and Rayleigh distributions-examples.**(Text 3 & Ref. 3)**	**L1,L2**
Module -5	
Joint probability distributions Definition and properties of CDF, PDF, PMF, conditional distributions. Expectation, covariance and correlation. Independent random variables. Statement of central limit theorem-Illustrative examples. Random process- Classification, stationary and ergodic random process. Auto correlation function-properties, Gaussian random process.**(Text 3 & Ref. 3)**	**L1,L2**

Course Outcomes: After studying this course, students will be able to:

- Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
- Apply the techniques of QR and singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.
- Utilize the concepts of functionals and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.
- Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.
- Apply the idea of joint probability distributions and the role of parameter-dependent random variables in random process.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. David C.Lay, Steven R.Lay and J.J.McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.
2. E. Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley, 2015.
3. Scott L.Miller, Donald G. Childers: “Probability and Random Process with application to Signal Processing”, Elsevier Academic Press, 2nd Edition,2013.

Reference books:

1. Richard Bronson: “Schaum’s Outlines of Theory and Problems of Matrix Operations”, McGraw-Hill, 1988.
2. Elsgolts, L.: ”Differential Equations and Calculus of Variations”, MIR Publications, 3rd Edition, 1977.
3. T.Veerarajan: “Probability, Statistics and Random Process“, 3rd Edition, Tata McGraw Hill Co.,2008.

Web links:

1. http://nptel.ac.in/courses.php?disciplineId=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://ocw.mit.edu/courses/mathematics/
4. www.wolfram.com

DIGITAL VLSI DESIGN [As per Choice Based Credit System (CBCS) scheme] SEMESTER –I			
Subject Code	16EVE12	IA Marks	20
Number	04	Exam Marks	80
Total Number of	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Explain VLSI Design Methodologies
- Learn Static and Dynamic operation principles, analysis and design of inverter circuit.
- Infer state of the art Semiconductors Memory circuits.
- Outline the comprehensive coverage of Methodologies and Design practice that are used to reduce the Power Dissipation of large scale digital circuits.
- Illustrate VLSI and ASIC design.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
Module -1	
MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects. **MOS Inverters-Static Characteristics**: Introduction, Resistive-Load Inverter, Inverters with n_Type MOSFET Load.	**L1, L2**
Module -2	
MOS Inverters-Static Characteristics: CMOS Inverter. **MOS Inverters**: Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definition, Calculation of Delay Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.	**L2, L3**
Module -3	

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Nonvolatile Memory, Flash Memory, Ferroelectric Random Access Memory (FRAM).	**L1, L2, L3**
Module -4	
Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits. **BiCMOS Logic Circuits**: Introduction, Bipolar Junction Transistor (BJT): Structure and Operation, Dynamic Behavior of BJTs, Basic BiCMOS Circuits: Static Behavior, Switching Delay in BiCMOS Logic Circuits, BiCMOS Applications.	**L1,L2, L3**
Module -5	
Chip Input and Output (I/O) Circuits: Introduction, ESD Protection, Input Circuits, Output Circuits and L(di/dt) Noise, On-Chip Clock Generation and Distribution, Latch-Up and Its Prevention. **Design for Manufacturability**: Introduction, Process Variations, Basic Concepts and Definitions, Design of Experiments and Performance Modeling.	**L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Analyse issues of On-chip interconnect Modelling and Interconnect delay calculation.
2. Analyse the Switching Characteristics in Digital Integrated Circuits.
3. Use the Dynamic Logic circuits in state-of-the-art VLSI chips.
4. Study critical issues such as ESD protection, Clock distribution, Clock buffering, and Latch phenomenon
5. Use Bipolar and Bi-CMOS circuits in very high speed design.

Question Paper Pattern

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Sung Mo Kang & Yosuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, Tata McGraw-Hill, Third Edition.

Reference Books:

1. Neil Weste and K. Eshragian, “Principles of CMOS VLSI Design: A System Perspective”, Second Edition, Pearson Education (Asia) Pvt. Ltd. 2000.
2. Wayne, Wolf, “Modern VLSI Design: System on Silicon” Prentice Hall PTR/Pearson Education, Second Edition, 1998.
3. Douglas A Pucknell & Kamran Eshragian, “Basic VLSI Design” PHI 3rd Edition (original Edition – 1994).

ADVANCED EMBEDDED SYSTEM [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16EVE13	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Describe the hardware software co-design and firmware design approaches
- Explain the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Program ARM CORTEX M3 using the various instructions, for different applications.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
Module -1	
Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems (Text 1: Selected Topics from Ch -1, 2, 3).	**L1, L2, L3**
Module -2	
Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Text 1: Selected Topics From Ch-7, 9, 12, 13).	**L1, L2, L3**

Module -3	
ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 2: Ch 1, 2, 3)	**L1, L2, L3**
Module -4	
Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Text 2: Ch-4, 5, 6)	**L1, L2, L3**
Module -5	
Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Text 2: Ch-7, 8, 10)	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Explain the hardware software co-design and firmware design approaches.
- Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.
2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2ndedn, Newnes, (Elsevier), 2010.

Reference Book:

James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008.

LOW POWER VLSI DESIGN [As per Choice Based Credit System (CBCS) scheme] SEMESTER –I			
Subject Code	16EVE14	IA Marks	20
Number o f Lecture	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:
- Know the basics and advanced techniques in low power design which is a hot topic in today's market where the power plays a major role.
- Describe the various power reduction and the power estimation methods.
- Explain power dissipation at all layers of design hierarchy from technology, circuit, logic, architecture and system
- Apply State-of-the art approaches to power estimation and reduction.
- Practice the low power techniques using current generation design style and process technology

Modules	**Revised Bloom's Taxonom**
Module -1	
Introduction: Need for low power VLSI chips, charging and discharging capacitance, short circuit current in CMOS leakage current, static current, basic principles of low power design, low power figure of merits. **Simulation power analysis**: SPICE circuit simulation, discrete transistor modeling and analysis, gate level logic simulation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. (Text 1)	**L1, L2**
Module -2	
Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. **Circuit**: Transistor and gate sizing, equivalent pin ordering, network restructuring and reorganization, special latches and flip flops, low power digital cell library, adjustable device threshold voltage. (Text 1)	**L1, L2, L3**
Module -3	
Logic: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic (Text 1). **Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network (Text 2).	**L1, L2, L3**
Module -4	

Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation (Text 1). **Low power arithmetic components:** Introduction, circuit design style, adders, multipliers, division (Text 2).	**L1- L4**
Module -5	
Low power memory design: Introduction, sources and reductions of power dissipation in memory subsystem, sources of power dissipation in DRAM and SRAM (Text 2). **Algorithm & Architectural Level Methodologies:** Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis (Text 2). **Advanced Techniques:** Adiabatic computation, pass transistor, Asynchronous circuits (Text 1).	**L1-L4**

Course outcomes: After studying this course, students will be able to:

- Identify the sources of power dissipation in CMOS circuits.
- Perform power analysis using simulation based approaches and probabilistic analysis.
- Use optimization and trade-off techniques that involve power dissipation of digital circuits.
- Make the power design a reality by making power dimension an integral part of the design process
- Use practical low power design techniques and their analysis at various levels of design abstraction and analyse how these are being captured in the latest design automation environments.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, Kluwer Academic, 1998.
2. Jan M.Rabaey, Massoud Pedram, “Low Power Design Methodologies”, Kluwer Academic, 2010.

Reference Books:

1. Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley, 2000
2. A.P.Chandrasekaran and R.W.Broadersen, “Low power digital CMOS design”, Kluwer Academic,1995.
3. A Bellamour and M I Elmasri, “ Low power VLSI CMOS circuit design”, Kluwer Academic,1995.

DIGITAL SYSTEM DESIGN USING VERILOG [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16EVE151	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Understand the concepts of Verilog Language
- Design the digital systems as an activity in a larger systems design context.
- Study the design and operation of semiconductor memories frequently used in application specific digital system.
- Inspect how effectively IC's are embedded in package and assembled in PCB's for different application
- Design and diagnosis of processors and I/O controllers they can be used in embedded systems

Modules	**Revised Bloom's Taxonomy (RBT)**
Module -1	
Introduction and Methodology: Digital Systems and Embedded Systems, Binary representation and Circuit Elements, Real-World Circuits, Models, Design Methodology.	**L1, L2**
Module -2	
Number Basics: Unsigned and Signed Integers, Fixed and Floating-point Numbers. **Sequential Basics**: Storage elements, Counters, Sequential Data paths and Control, Clocked Synchronous Timing Methodology.	**L1, L2**
Module -3	
Memories: Concepts, Memory Types, Error Detection and Correction. **Implementation Fabrics**: ICs, PLDs, Packaging and Circuit Boards, Interconnection and Signal Integrity.	**L1, L2**
Module -4	
Processor Basics: Embedded Computer Organization, Instruction and Data, Interfacing with memory. **I/O interfacing**: I/O devices, I/O controllers, Parallel Buses, Serial Transmission, I/O software.	**L2, L3**
Module -5	

Accelerators: Concepts, case study, Verification of accelerators. **Design Methodology**: Design flow, Design optimization, Design for test.	**L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Design embedded systems, using small microcontrollers, larger CPUs/DSPs, or hard or soft processor cores.
- Design the combinational circuits using discrete gates and programmable logic devices.
- Describe Verilog model for sequential circuits and test pattern generation
- Explore the different types of semiconductor memories and their usage for specific chip design
- Synthesis different types of processor and I/O controllers that are used in embedded system design

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Peter J. Ashenden, “Digital Design: An Embedded Systems Approach Using VERILOG”, Elesvier, 2010.

Reference Book:

Verilog HDL: A Guide to Digital Design and Synthesis, Second Edition by Samir Palnitkar.

NANOELECTRONICS [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	16EVE152	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Enhance basic engineering science and technological knowledge of nanoelectronics.
- Explain basics of top-down and bottom-up fabrication process, devices and systems.
- Describe technologies involved in modern day electronic devices.
- Appreciate the complexities in scaling down the electronic devices in the future.

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).	**L1, L2**
Module -2	
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques (Text1).	**L1,L2,L3**
Module -3	

Characterization: spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties. **Inorganic semiconductor nanostructures:** overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text1).	**L1-L3**
Module -4	
Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly techniques. **Physical processes:** modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text1).	**L1-L3**
Module -5	
Methods of measuring properties: atomic, crystollography, microscopy, spectroscopy (Text 2). **Applications**: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP's, NEMS, MEMS (Text 1).	**L1-L3**
Course outcomes: After studying this course, students will be able to: • Know the principles behind Nanoscience engineering and Nanoelectronics. • Apply the knowledge to prepare and characterize nanomaterials. • Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials. • Design the process flow required to fabricate state of the art transistor technol ogy. • Analyze the requirements for new materials and device structure in the future technologies.	
Question paper pattern: • The question paper will have 10 full questions carrying equal marks. • Each full question consists of 16 marks with a maximum of four sub questions. • There will be 2 full questions from each module covering all the topics of the module • The students will have to answer 5 full questions, selecting one full question from each module.	

Text Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.
2. Charles P Poole, Jr, Frank J Owens, "Introduction to Nanotechnology", John Wiley, Copyright 2006, Reprint 2011.

Reference Book:

Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, "Hand Book of Nanoscience Engineering and Technology", CRC press, 2003.

ASIC DESIGN [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16EVE153	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Explain ASIC methodologies and programmable logic cells to implement a function on IC.
- Analyse back-end physical design flow, including partitioning, floor-planning, placement, and routing.
- Gain sufficient theoretical knowledge for carrying out FPGA and ASIC designs.
- Design CAD algorithms and explain how these concepts interact in ASIC design.

Modules	**Revised Bloom's Taxonomy (RBT)Level**
Module -1	
Introduction to ASICs, Full custom, Semi-custom and Programmable ASICs, ASIC Design flow, ASIC cell libraries. **CMOS Logic:** Datapath Logic Cells**:** Data Path Elements, Adders: Carry skip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier (Booth encoding), Data path Operators, I/O cells.	**L1,L2**
Module -2	
ASIC Library Design: Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages. **Programmable ASIC Logic Cells:** MUX as Boolean function generators, Actel ACT: ACT 1, ACT 2 and ACT 3 Logic Modules, Xilinx LCA: XC3000 CLB, Altera FLEX and MAX.	**L1-L3**
Module -3	
Programmable ASIC I/O Cells: Xilinx and Altera I/O Block. **Low-level design entry:** Schematic entry: Hierarchical design, Netlist screener. **ASIC Construction:** Physical Design, CAD Tools. **Partitioning:** Goals and objectives, Constructive Partitioning, Iterative Partitioning Improvement, KL, FM and Look Ahead algorithms.	**L1-L4**
Module -4	
Floor planning and placement: Goals and objectives, Floor planning tools, Channel definition, I/O and Power planning and Clock planning. Placement**:** Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Physical Design Flow.	**L1-L3**

Module -5	
Routing: Global Routing: Goals and objectives, Global Routing Methods, Back-annotation. Detailed Routing: Goals and objectives, Measurement of Channel Density, Left-Edge and Area-Routing Algorithms. Special Routing, Circuit extraction and DRC.	**L1-L3**

Course outcomes:

After studying this course, students will be able to:

- Describe the concepts of ASIC design methodology, data path elements, logical effort and FPGA architectures.
- Analyze the design of FPGAs and ASICs suitable for specific tasks, perform design entry and explain the physical design flow.
- Design data path elements for ASIC cell libraries and compute optimum path delay.
- Create floor plan including partition and routing with the use of CAD algorithms.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Michael John Sebastian Smith, “Application - Specific Integrated Circuits” Addison-Wesley Professional; 2005.

Reference Books:

1. Neil H.E. Weste, David Harris, and Ayan Banerjee, “CMOS VLSI Design: A Circuits and Systems Perspective”, 3rd edition, Addison Wesley/ Pearson education, 2011.
2. Vikram Arkalgud Chandrasetty, “VLSI Design: A Practical Guide for FPGA and ASIC Implementations”, Springer, 2011, ISBN: 978-1-4614-1119-2.
3. Rakesh Chadha, Bhasker J., “An ASIC Low Power Primer”, Springer, ISBN: 978-1-4614-4270-7.

ADVANCED COMPUTER ARCHITECTURE [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16ELD154	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Understand the basic concepts for parallel processing
- Analyze program partitioning and flow mechanisms
- Apply pipelining concept for the performance evaluation
- Learn the advanced processor architectures for suitable applications

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Parallel Computer Models: Classification of parallel computers, Multiprocessors and multicomputers, Multivector and SIMD computers. Program and Network Properties, Conditions of parallelism, Data and resource Dependences, Hardware and software parallelism. **(Text 1)**	**L2, L3, L4**
Module -2	
Program partitioning and scheduling, Grain Size and latency, Program flow mechanisms, Control flow versus data flow, Data flow Architecture, Demand driven mechanisms, Comparisons of flow mechanisms, Principles of Scalable Performance, Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches. **(Text 1)**	**L2, L3, L4**
Module -3	
Advanced Processors: Advanced processor technology, Instruction-set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar Processors, VLIW Architectures, Pipelining, Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline design. **(Text 1)**	**L1, L2, L3**
Module -4	
Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch Handling techniques, branch prediction, Arithmetic Pipeline Design, Computer arithmetic principles, Static Arithmetic pipeline, Multifunctional arithmetic pipelines. **(Text 1)**	**L2, L3, L4**
Module -5	

Multithread and Dataflow Architecture: Principles of Multithreading, Scalable and Multithreaded Architecture, Dataflow Architecture, Symmetric shared memory architecture, distributed shared memory architecture. **(Text 1 & 2)**	**L1, L2, L3**

Course outcomes: At the end of this course, the students will be able to:

- Understand the basic concepts for parallel processing
- Analyze program partitioning and flow mechanisms
- Apply pipelining concept for the performance evaluation
- Learn the advanced processor architectures for suitable applications

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Kai Hwang, “Advanced computer architecture”, TMH. 2007.
2. Kai Hwang and Zu, “Scalable Parallel Computers Architecture”, MGH, 2008.

Reference Books:

1. M.J. Flynn, “Computer Architecture, Pipelined and Parallel Processor Design”, Narosa Publishing, 2002.
2. D.A.Patterson, J.L.Hennessy, “Computer Architecture: A quantitative approach”, Morgan Kauffmann feb,2002.

VLSI and ES LAB - 1

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Laboratory Code	16EVEL16	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
		Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to:

- Learn Verilog Code Programming for the design of digital circuits
- Use FPGA/CPLD board and Logic Analyzer or Chipscope to verify the results
- Learn Assembly language programming for different applications using ARM- Cortex M3 Kit and Keil uVision- 4 tool.
- Learn C language programming for different applications using ARM- Cortex M3 Kit and Keil uVision-4 tool.

Laboratory Experiments:	**Revised Bloom's Taxonomy**
1) **Digital Design Experiments**: Using Verilog code and any Compiler. Download code to FPGA/CPLD board and verify the output using Logic Analyzer or Chipscope a) Design and verify an 8 to 3 programmable priority encoder b) Design and verify 3-bit Arbitrary Counter and repeat the given sequence c) Design and Verify BCD adder and subtractor d) Design and verify a sequential block to generate a sequence (say 11101) using appropriate FSM. e) Design and verify 8 bit Ripple carry adder and Carry skip adder. f) Design and verify a Linear feedback shift register based on a given polynomial expression g) Design and verify the following 8 bit multipliers. Also report on area delay trade-off i) Serial Multiplier ii) Parallel Multiplier h) Design and verify a parameterized FIFO i) Design and verify register file which has 32-entry 3-ports having explicit address decoder. The ports are dedicated for read and write and will take one clock cycle for read or write operation	**L2,L3,L4**

2) **ARM Cortex M3 Programs**: (Programming to be done using Keil uVision 4 and download the program on to a M3 evaluation board such as NXP LPC1768 or ATMEL ATSAM3U) a) Write an Assembly language program to calculate the sum and display the result for the addition of first ten numbers. SUM = 10+9+8+.........+1 b) Write a Assembly language program to link multiple object files and link them together c) Write an Assembly language program to store data in RAM d) Write a C program to Output the "Hello World" message using UART e) Write a C program to Design a Stopwatch using interrupts	**L2,L3,L4**

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Develop Verilog Code for the design of digital circuits
- Use FPGA/CPLD board and Logic Analyzer or Chipscope to verify the results
- Develop Assembly language programs for different applications using ARM-Cortex M3 Kit and Keil uVision-4 tool.
- Develop C language programs for different applications using ARM-Cortex M3 Kit and Keil uVision-4 tool

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination, two questions using different tool to be set.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

M.Tech-VLSI & ES-2016-SECOND SEMESTER SYLLABUS

Design of Analog and Mixed Mode VLSI Circuits [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16EVE21	IA Marks	20
Number of Lecture Hours/Week	04	Exam marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable students to:

- Describe basic physics and operation of MOS devices.
- Exemplify single-stage and differential amplifiers and current mirrors
- Describe operational amplifiers
- Learn the design of phase-locked-loops
- Know the role of Data converters in an ever-increasing digital world.

Modules	**RBT Level**
Module 1	
Basic MOS Device Physics: General considerations, MOS I/V Characteristics, second order effects, MOS device models. **Single stage Amplifier:** Basic Concepts, Common Source stage.(Text 1)	L1, L2
Module 2	
Single stage Amplifier: Source follower, common-gate stage, Cascode Stage, choice of device models. **Differential Amplifiers:** Single ended and differential operation, Basic differential pair, Common mode response, Differential pair with MOS loads, Gilbert cell. (Text 1)	L1,L2
Module 3	
Passive and Active Current Mirrors: Basic current mirrors, Cascode Current mirrors, Active Current mirrors. **Operational Amplifiers (part-1):** General Considerations**,** One Stage OP-Amp, Two Stage OP-Amp, Gain boosting. (Text 1)	L1,L2,L3
Module 4	
Operational Amplifiers (part-2): Common Mode Feedback, Slew rate, Power Supply Rejection. **Phase Locked Loops:** Simple PLL, Charge pump PLLs, Non-ideal effects in PLLs, Delay-Locked Loops, Applications. (Text 1)	L1,L2,L3
Module 5	
Data Converter Architectures: DAC & ADC Specifications, Current Steering DAC, Charge Scaling DAC, Cyclic DAC, Pipeline DAC, Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC. (Text 2)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Use efficient analytical tools for quantifying the behaviour of basic circuits by inspection.
- Design high-performance, stable operational amplifiers with the trade-offs between speed, precision and power dissipation.
- Design and study the behaviour of phase-locked-loops for the applications.
- Identify the critical parameters that affect the analog and mixed-signal VLSI circuits' performance
- Perform calculations in the digital or discrete time domain, more sophisticated data converters to translate the digital data to and from inherently analog world.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", TMH, 2007.
2. R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", Second Edition, Wiley.

Reference Book:

Phillip E. Allen, Douglas R. Holberg, "CMOS Analog Circuit Design", Second Edition, Oxford University Press.

VLSI Testing [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16EVE22	IA Marks	20
Number of Lecture Hours/Week	04	Exam marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable students to:

- Learn various types of faults and fault modeling
- Comprehend the need for testing and testable design of digital circuits
- Illustrate methods and algorithms for testing digital combinatorial networks and test pattern generation
- Exemplify methods for testing sequential circuits and memory testing
- Inferring testing methods using Boundary scan, Built-in self test and other advanced topics in digital circuit design.

Modules	RBT Level
Module 1	
Faults in digital circuits: Failures and Faults, Modeling of faults, Temporary Faults. (Text 1) **Logic Simulation:** Applications, Problems in simulation based design verification, types of simulation, The unknown logic values, compiled simulation, event-driven simulation, Delay models, Element evaluation, Hazard detection, Gate-level event-driven Simulation. (Text 2)	L1,L2
Module 2	
Test generation for Combinational Logic circuits: Fault Diagnosis of digital circuits, Test generation techniques for combinational circuits, Detection of multiple faults in Combinational logic circuits. (Text 1) **Testable Combinational logic circuit design:** The Read-Muller expansion technique, Three level OR-AND-OR design, Automatic synthesis of testable logic.(Text 1)	L1,L2,L3
Module 3	
Testable Combinational logic circuit design: Testable design of multilevel combinational circuits, Synthesis of random pattern testable combinational circuits, Path delay fault testable combinational logic design, Testable PLA design. (Text 1) **Test generation for Sequential circuits:** Testing of sequential circuits as Iterative combinational circuits, state table verification, Test generation based on Circuit Structure, Functional Fault models, test Generation based on Functional Fault models. (Text 1)	L1,L2,L3
Module 4	
Design of testable sequential circuits: Controllability and observability, Ad-Hoc design rules for improving testability, design of	L1,L2,L3

diagnosable sequential circuits, the scan-path technique for testable sequential circuit design, Level Sensitive Scan Design(LSSD), Random Access Scan Technique, Partial scan, testable sequential circuit design using Nonscan Techniques, Cross check, Boundary Scan. (Text 1)	
Module 5	
Built-In Self Test: Test pattern generation for BIST, Output response analysis, Circular BIST, BIST Architectures. (Text 1) **Testable Memory Design:** RAM Fault Models, Test algorithms for RAMs, Detection of pattern-sensitive faults, BIST techniques for RAM chips, Test generation and BIST for embedded RAMs. (Text1)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Analyze the need for fault modeling and testing of digital circuits
- Generate fault lists for digital circuits and compress the tests for efficiency
- Create tests for digital memories and analyze failures in them
- Apply boundary scan technique to validate the performance of digital circuits
- Design built-in self tests for complex digital circuits

Question paper pattern:

- The question paper will have 10 questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Lala Parag K., Digital Circuit Testing and Testability, New York, Academic Press, 1997.
2. Abramovici M, Breuer M A and Friedman A D, "Digital Systems Testing and Testable Design", Wiley, 1994.

Reference Books:

1. Vishwani D Agarwal, "Essential of Electronic Testing for Digital, Memory and Mixed Signal Circuits", Springer, 2002.
2. Wang, Wu and Wen, "VLSI Test Principles and Architectures", Morgan Kaufmann, 2006.

Advances in VLSI Design [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16EVE23	IA Marks	20
Number of Lecture Hours/Week	04	Exam marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable the students to:

- Learn circuit-oriented approach towards digital design
- Illustrate the impact of interconnect wiring on the functionality and performance of a digital gate.
- Infer different approaches to digital timing and clocking circuits
- Understand the impact of clock skew on the behaviour of digital synchronous circuits
- Explain the role of peripheral circuitry such as the decoders, sense amplifiers, drivers and control circuitry in the design of reliable and fast memories

Modules	**RBT Level**
Module 1	
Implementation Strategies For Digital ICS: Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Standard Cell, Compiled Cells, Macrocells, Megacells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Pre-wired Arrays, Perspective-The Implementation Platform of the Future.	L1,L2,L3
Module 2	
Coping With Interconnect: Introduction, Capacitive Parasitics, Capacitance and Reliability-Cross Talk, Capacitance and Performance in CMOS, Resistive Parasitics, Resistance and Reliability-Ohmic Voltage Drop, Electromigration, Resistance and Performance-RC Delay, Inductive Parasitics, Inductance and Reliability-Voltage Drop, Inductance and Performance-Transmission Line Effects, Advanced Interconnect Techniques, Reduced-Swing Circuits, Current-Mode Transmission Techniques, Perspective: Networks-on-a-Chip.	L1,L2,L3
Module 3	
Timing Issues In Digital Circuits: Introduction, Timing Classification of Digital Systems, Synchronous Interconnect, Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect, Synchronous Design — An In-depth Perspective, Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques, Latch-Based Clocking, Self-Timed Circuit Design, Self-Timed Logic - An Asynchronous	L1,L2,L3

Technique, Completion-Signal Generation, Self-Timed Signaling, Practical Examples of Self-Timed Logic, Synchronizers and Arbiters, Synchronizers-Concept and Implementation, Arbiters, Clock Synthesis and Synchronization Using a Phase-Locked Loop, Basic Concept, Building Blocks of a PLL.	
Module 4	
Designing Memory and Array Structures: Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read-Only Memories, Nonvolatile Read-Write Memories, Read-Write Memories (RAM), Contents-Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers, Timing and Control.	L1,L2,L3
Module 5	
Designing Memory and Array Structures: Memory Reliability and Yield, Signal-to-Noise Ratio, Memory yield, Power Dissipation in Memories, Sources of Power Dissipation in Memories, Partitioning of the memory, Addressing the Active Power Dissipation, Data-retention dissipation, Case Studies in Memory Design: The Programmable Logic Array (PLA), A 4 Mbit SRAM, A 1 Gbit NAND Flash Memory, Perspective: Semiconductor Memory Trends and Evolutions.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Apply design automation for complex circuits using the different implementation methodology like custom versus semi-custom, hardwired versus fixed, regular array versus ad-hoc.
- Use the approaches to minimize the impact of interconnect parasitics on performance, power dissipation and circuit reliability
- Impose the ordering of the switching events to meet the desired timing constraints using synchronous, clocked approach.
- Infer the reliability of the memory

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Jan M Rabey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits-A Design Perspective", PHI, 2nd Edition.

Reference Books:

1. M. Smith, "Application Specific Integrated circuits", Addison Wesley, 1997
2. H. Veendrick, "MOS IC's: From Basics to ASICs, Wiley-VCH, 1992.
3. Anantha P. Chandrakasan , Robert W. Brodersen, "Low Power Digital CMOS Design", Kluwer Academic Publisher, 1995.

<table>
<tr><td colspan="4"><u>Real Time Operating System</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>16EVE24</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
</table>

Course Objectives: This course will enable the students to:

- Introduce the fundamental concepts of Real Time Operating Systems and the real time embedded system
- Apply concepts relating to operating systems such as Scheduling techniques, Thread Safe Reentrant Functions, Dynamic priority policies.
- Describe concepts related to Multi resource services like blocking, Deadlock, live lock & soft real-time services.
- Discuss Memory management concepts, Embedded system components, Debugging components and file system components.
- Study programs for multithreaded applications using suitable data structures.

Modules	RBT Level
Module 1	
Real-Time Systems and Resources: Brief history of Real Time Systems, A brief history of Embedded Systems. System Resources, Resource Analysis, Real-Time Service Utility, Scheduler concepts, Real-Time OS, State transition diagram and tables, Thread Safe Reentrant Functions. (Text 1: Selected sections from Chap. 1, 2)	L1,L2,L3
Module 2	
Processing with Real Time Scheduling: Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies with timing diagrams and problems and issues, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies, Alternative to RM policy. (Text 1: Chap. 2,3,7)	L1,L2,L3
Module 3	
Memory and I/O: Worst case execution time, Intermediate I/O, Shared Memory, ECC Memory, Flash file systems. Multi-resource Services, Blocking, Deadlock and live lock, Critical sections to protect shared resources, Missed deadline, QoS, Reliability and Availability, Similarities and differences, Reliable software, Available software. (Text 1: Selected topics from Chap. 4,5,6,7,11)	L1,L2,L3
Module 4	
Firmware Components: The 3 firmware components, RTOS system software mechanisms, Software application components. Debugging	L1,L2,L3

Components, Exceptions, assert, Checking return codes, Single-step debugging, kernel scheduler traces, Test access ports, Trace Ports, External test equipment. (Text 1: Selected topics from Chap. 8,9)	
Module 5	
Process and Threads: Process and thread creations, Simple Programs, Programs related to semaphores, message queue, shared buffer applications involving inter task/thread communication using multiple threads. (Text 2: Chap. 11)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Develop programs for real time services, firmware and RTOS, using the fundamentals of Real Time Embedded System, real time service utilities, debugging methodologies and optimization techniques.
- Select the appropriate system resources (CPU, I/O, Memory, Cache, ECC Memory, Microcontroller/FPGA/ASIC to improve the system performance.
- Apply priority based static and dynamic real time scheduling techniques for the given specifications.
- Analyze deadlock conditions, shared memory problem, critical section problem, missed deadlines, availability, reliability and QoS.
- Develop programs for multithreaded applications using suitable techniques and data structure

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Sam Siewert, "Real-Time Embedded Systems and Components", Cengage Learning India Edition, 2007.
2. Dr. K.V.K.K Prasad, Embedded/Real Time Systems, Concepts, Design and Programming, Black Book, Dream Tech Press, New edition, 2010.

Reference Books:

1. James W S Liu, "Real Time System", Pearson education, 2008.
2. Dream Tech Software Team, "Programming for Embedded Systems", John Wiley, India Pvt. Ltd., 2008.

System Verilog [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16EVE251	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Understand digital system verification using object oriented methods
- Learn the System Verilog language for digital system verification.
- Create/build test benches for the basic design/methodology.
- Use constrained random tests for verification
- Understand concepts of functional coverage

Modules	**RBT Level**
Module 1	
Verification Guidelines: The verification process, basic test bench functionality, directed testing, methodology basics, constrained random stimulus, randomization, functional coverage, test bench components. **Data Types:** Built in Data types, fixed and dynamic arrays, Queues, associative arrays, linked lists, array methods, choosing a storage type, creating new types with type def, creating user defined structures, type conversion, Enumerated types, constants and strings, Expression width.	L1, L2
Module 2	
Procedural Statements and Routines: Procedural statements, Tasks, Functions and void functions, Task and function overview, Routine arguments, returning from a routine, Local data storage, time values. **Converting the test bench and design:** Separating the test bench and design, The interface construct, Stimulus timing, Interface driving and sampling, System Verilog assertions.	L1,L2,L3
Module 3	
Randomization: Introduction, Randomization in System Verilog, Constraint details, Solution probabilities, Valid constraints, In-line constraints, Random number functions, Common randomization problems, Iterative and array constraints, Random control.	L1,L2,L3
Module 4	
Threads and Interprocess Communication: Working with threads, Disabling threads, Interprocess	L1,L2,L3

communication, Events, semaphores, Mailboxes, Building a test bench with threads and Interprocess Communication.	
Module 5	
Functional Coverage: Coverage types, Coverage strategies, Simple coverage example, Anatomy of Cover group and Triggering a Cover group, Data sampling, Cross coverage, Generic Cover groups, Coverage options, Analyzing coverage data, measuring coverage statistics during simulation.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Write test benches for moderately complex digital circuits
- Use System Verilog language
- Appreciate functional coverage
- Apply constrained random tests benches using System Verilog
- Analyze a verification case and apply System Verilog to verify the design

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Chris Spear, 'System Verilog for Verification – A guide to learning the Test bench language features', Springer Publications, 2nd Edition, 2010.

Reference Book:

Stuart Sutherland, Simon Davidmann, Peter Flake, "System Verilog for Design-A guide to using system verilog for Hardware design and modeling", Springer Pulications, 2nd Edition, 2006.

VLSI Design for Signal Processing [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16EVE252	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Learn several high-level architectural transformations that can be used to design families of architectures for a given algorithm.
- Deal with high-level algorithm transformations such as strength reduction, look-ahead and relaxed look-ahead.

Modules	**RBT Level**
Module 1	
Introduction to DSP Systems: Typical DSP Algorithms, DSP Application Demands and Scaled CMOS Technologies, Representations of DSP Algorithms. **Iteration Bounds:** Data flow graph Representations, loop bound and Iteration bound.	L1, L2
Module 2	
Iteration Bounds: Algorithms for Computing Iteration Bound, Iteration Bound of multi rate data flow graphs. **Pipelining and Parallel Processing:** pipelining of FIR Digital Filters, parallel processing, Pipelining and parallel processing for low power.	L1,L2,L3
Module 3	
Retiming: Definition and Properties, Solving Systems of Inequalities, Retiming Techniques, **Unfolding**: An Algorithm for Unfolding, Properties of Unfolding, Critical path, Unfolding and Retiming, Application of Unfolding. **Systolic Architecture Design:** systolic array design Methodology, FIR systolic array.	L1,L2,L3
Module 4	
Systolic Architecture Design: Selection of Scheduling Vector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design for space representation containing Delays. **Fast convolution**: Cook-Toom Algorithm, Winograd Algorithm, Iterated convolution, cyclic convolution Design of fast convolution Algorithm by Inspection.	L1,L2,L3
Module 5	
Pipelined and Parallel Recursive and Adaptive Filter: Pipeline Interleaving in Digital Filter, first order IIR digital Filter, Higher order IIR digital Filter, parallel processing for IIR filter, Combined pipelining and parallel processing for IIR Filter, Low power IIR Filter Design Using Pipelining and parallel processing, pipelined adaptive	L1,L2,L3

digital filter.

Course Outcomes: After studying this course, students will be able to:

- Illustrate the use of various DSP algorithms and addresses their representation using block diagrams, signal flow graphs and data-flow graphs
- Use pipelining and parallel processing in design of high-speed /low-power applications
- Apply unfolding in the design of parallel architecture
- Evaluate the use of look-ahead techniques in parallel and pipelined IIR Digital filters.
- Develop an algorithm or architecture or circuit design for DSP applications

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Keshab K.Parthi, "VLSI Digital Signal Processing systems, Design and implementation ", Wiley 1999.

Reference Books:

1. Mohammed Isamail and Terri Fiez, "Analog VLSI Signal and Information Processing ", Mc Graw-Hill,1994.
2. S.Y. Kung, H.J. White House, T. Kailath, " VLSI and Modern Signal Processing ", Prentice Hall, 1985.
3. Jose E. France, Yannis Tsividis, " Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing ", Prentice Hall, 1994.
4. Lars Wanhammar, “DSP Integrated Circuits”, Academic Press Series in Engineering, 1st Edition.

Micro Electro Mechanical Systems [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16ELD253	IA Marks	20
Number of Lecture Hours/Week	04	Exam marks	80
Total Number of Lecture Hours	40 (08 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Know an overview of microsystems, their fabrication and application areas.
- Teach working principles of several MEMS devices.
- Develop mathematical and analytical models of MEMS devices
- Know methods to fabricate MEMS devices
- Expose the students to various application areas where MEMS devices can be used.

Modules	**RBT Level**
Module 1	
Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.	L1, L2
Module 2	
Working Principles of Microsystems: Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. **Engineering Science for Microsystems Design and Fabrication:** Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.	L1, L2
Module 3	
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.	L1,L2,L3
Module 4	
Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	L1,L2,L3

Module 5	
Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro-manufacturing. **Microsystem Design:** Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.	L1,L2,L3
Course Outcomes: After studying this course, students will be able to: • Appreciate the technologies related to Micro Electro Mechanical Systems. • Understand design and fabrication processes involved with MEMS devices. • Analyse the MEMS devices and develop suitable mathematical models • Know various application areas for MEMS devices	
Question paper pattern: • The question paper will have 10 full questions carrying equal marks. • Each full question consists of 16 marks with a maximum of four sub questions. • There will be 2 full questions from each module covering all the topics of the module • The students will have to answer 5 full questions, selecting one full question from each module.	
Text Book: Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2^{nd} Ed, Wiley.	
Reference Books: 1. Hans H. Gatzen, Volker Saile, Jurg Leuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015. **2.** Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Micro electromechanical Systems (MEMS), Cenage Learning.	

SoC Design [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	16EVE254	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Describe the ARM processor architecture and user-level assembly language programming
- Appreciate what a high-level language (in this case, C) really needs and how those needs are met by the ARM instruction set.
- raises the issues involved in debugging systems which use embedded processor cores and in the production testing of board-level systems.
- Learn the concept of memory hierarchy, discussing the principles of memory management and caches.

Modules	RBT Level
Module 1	
ARM Organization and Implementation:3-stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface. **The ARM Instruction Set :**Introduction, Exceptions, Conditional execution, Branch and Branch with Link (B, BL),Branch, Branch with Link and eXchange (BX, BLX),Software Interrupt (SWI),Data processing instructions, Multiply instructions, Count leading zeros (CLZ - architecture v5T only), Single word and unsigned byte data transfer instruction, Half-word and signed byte data transfer instructions ,Multiple register transfer instructions, Swap memory and register instructions (SWP), Status register to general register transfer instructions , General register to status register transfer instructions, Coprocessor instructions, Coprocessor data operations, Coprocessor data transfers, Coprocessor register transfers, Breakpoint instruction (BRK - architecture v5T only), Unused instruction space, Memory faults, ARM architecture variants.	L1,L2
Module 2	
Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment. **Architectural Support for System Development:** The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA), The ARM reference peripheral specification, Hardware system prototyping tools, The ARMulator, The JTAG boundary scan test architecture, The ARM debug architecture, Embedded Trace,	L1,L2

Signal processing support.	
Module 3	
ARM Processor Cores: ARM7TDMI, ARM8,ARM9TDMI, ARM10TDMI ,Discussion ,Example and exercises. **Memory Hierarchy:** Memory size and speed, On-chip memory, Caches, Cache design - an example, Memory management, Examples and exercises.	L1,L2
Module 4	
Architectural Support for Operating Systems: An introduction to operating systems, The ARM system control coprocessor, CP15 protection unit registers, ARM protection unit,CP15 MMU registers, ARM MMU architecture, Synchronization, Context switching, Input/ Output, Example and exercises. **ARM CPU Cores:** The ARM710T, ARM720T and ARM740T, The ARM810,The Strong ARM SA-110,The ARM920T and ARM940T,The ARM946E-S and ARM966E-S,The ARM1020E,Discussion,Example and exercises.	L1,L2
Module 5	
Embedded ARM Applications: The VLSI Ruby II Advanced Communication Processor, The VLSI ISDN Subscriber Processor, The One C™ VWS22100 GSM chip, The Ericsson-VLSI Bluetooth Baseband Controller, The ARM7500 and ARM7500FE, The ARM7100 364,The SA-1100 368,Examples and exercises. **The AMULET Asynchronous ARM Processors:** Self-timed design 375,AMULET1 377,AMULET2 381,AMULET2e 384,AMULET3 387,The DRACO telecommunications controller 390, A self-timed future? 396,Example and exercises.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Apply the 3- and 5-stage pipeline ARM processor cores and analyse the implementation issues.
- Use the concepts and methodologies employed in designing a System-on-chip (SoC) based around a microprocessor core and in designing the microprocessor core itself.
- Understand how SoCs and microprocessors are designed and used, and why a modern processor is designed the way that it is.
- Use integrated ARM CPU cores (including StrongARM) that incorporate full support for memory management.
- Analyze the requirements of a modern operating system and use the ARM architecture to address the same.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Steve Furber, “ARM System-On-Chip Architecture”, Addison Wesley, 2nd edition.

References Books:

1. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.
2. Sudeep Pasricha and Nikil Dutt, "On-Chip Communication Architectures: System on Chip Interconnect”, Morgan Kaufmann, Publishers © 2008.
3. Michael Keating, Pierre Bricaud, “Reuse Methodology Manual for System on Chip designs”, Kluwer Accademic Publishers, 2nd edition, 2008.

<table>
<tr><td colspan="4"><u>VLSI and ES Lab-2</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II</td></tr>
<tr><td>Laboratory Code</td><td>16EVEL26</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>01Hr Tutorial (Instructions) + 02 Hours Laboratory</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 02</td></tr>
<tr><td colspan="4">Course objectives: This laboratory course enables students to:
• Learn the CAD tool and the flow of the Full Custom IC design cycle.
• Learn running DRC, LVS and Parasitic Extraction of the various designs.
• Create various components like inverter, differential amplifier and use the same in the design of operational amplifier, R-2R based DAC and ADC.
• Understand the suitability of different techniques of IPC and task switching in a multithreaded application.
• Study and implement different types of data structures required to implement inter task communication.
• Implement Inter task communication using an appropriate data structure.</td></tr>
<tr><td colspan="3">Part – A: Experiments to be done using CADENCE/SYNOPSIS/MENTOR GRAPHICS/TANNER Tool</td><td>RBT Level</td></tr>
<tr><td colspan="3">1. Design an Inverter with given specifications*, completing the design flow mentioned below:
a. Draw the schematic and verify the following
i) DC Analysis
ii) Transient Analysis
b. Draw the Layout and verify the DRC, ERC
c. Check for XX
d. Extract RC and back annotate the same and verify the Design
e. Verify & Optimize for Time, Power and Area to the given constraint***
(Following specification may be used to design an Inverter in gpdk 180nm technology with minimum area:
i. Maximum output rise time=100ps
ii. Maximum output fall time=100ps
iii. $P_{avg} \leq 15\mu w$
iv. Load capacitance= 50fF
v. Input rise time=200ps
vi. Input fall time=200ps
Choose maximum frequency based on the power)</td><td>L3</td></tr>
<tr><td colspan="3">Design the following circuits with given specifications*, completing the design flow mentioned below:
a. Draw the schematic and verify the following
i) DC Analysis
ii) AC Analysis
iii) Transient Analysis</td><td>L3</td></tr>
</table>

b. Draw the Layout and verify the DRC, ERC, LVS c. Check for XX d. Extract RC and back annotate the same and verify the Design. 2. i) A Single Stage differential amplifier ii) Common source amplifier 3. Design an op-amp with given specification* using given differential amplifier Common source amplifier in library** 4. Design a 4 bit R-2R based DAC for the given specification**	
5. Design an Integrator and Differentiator using OPAMP (First Order)	
6. Design and characterize a basic Sigma delta ADC from the available designs.	
7. Design a simple NAND/NOR gate using any one of the tools given above. (Any other experiments may be added in supportive of the course) * Appropriate specification should be given. ** Applicable Library should be added & information should be given to the Designer. *** An appropriate constraint should be given	
Part – B: Experiments to be done using Linux	
1. Develop and test programs to (a) create child process and display it's id and (b) Execute child process function using switch structure	
2. Develop and test program for a multithreaded application, where communication is through a buffer for the conversion of lowercase text to uppercase text, using semaphore concept.	
3. Develop and test program for a multithreaded application, where communication is through shared memory for the conversion of lowercase text to uppercase text.	
4. Develop program for inter-thread communication using message queue. Data is to be input from the keyboard for the chosen application.	
5. Create 'n' number of child threads. Each thread prints the message "I'm in thread number …" and sleeps for 50 ms and then quits. The main thread waits for complete execution of all the child threads and then quits. Compile and execute in Linux.	
6. Implement the multi-thread application satisfying the following : i. Two child threads are created with normal priority. ii. Thread 1 receives and prints its priority and sleeps for 50ms and then quits. iii. Thread 2 prints the priority of the thread 1 and rises its priority to above normal and retrieves the new priority of thread 1, prints it and then quits. iv. The main thread waits for the child thread to complete its job and	L3

quits.	
7. Implement the usage of anonymous pipe with 512 bytes for data sharing between parent and child processes using handle inheritance mechanism	

Course outcomes: This laboratory course enable the students to:

- Design Analog, digital and mixed mode circuits
- Learn the various issues in Mixed signal designs basically data converters.
- Acquire hands-on skills of using CAD tools in VLSI design.
- Appreciate the design process in VLSI through a mini-project on the design of a CMOS sub-system.
- Select a suitable task switching technique in a multithreaded application.
- Implement different techniques of message passing and Inter task communication.
- Implement different data structures such as pipes, queues and buffers in multithreaded programming.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination, one experiment from Part-A and One experiment from Part-B is to be set.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the Procedure part to be made zero.

Reference Book: (for some of the Part-B programs)

Dreamtech Software Team, “Programming for Embedded Systems”, John Wiley, India Pvt. Ltd., 2008.

M.Tech-VLSI & ES-2016-FOURTH SEMESTER SYLLABUS

Synthesis and Optimization of Digital Circuits [As per Choice Based credit System (CBCS) Scheme SEMESTER – IV			
Subject Code	16ELD41	IA Marks	20
Number of Lecture Hours/Week	04	Exam marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable students:

- Understand the need for optimization and dimensions of optimization for digital circuits.
- Understand basic optimization techniques used in circuits design
- Understand advanced tools and techniques in digital systems design including Hardware Modeling and Compilation Techniques.
- Explain details of Logic-Level synthesis and optimization techniques for combinational and sequential circuits.
- Explain the concept of scheduling and resource binding for optimization.

Modules	**RBT Level**
Module 1	
Introduction to Synthesis and optimization: Design of Microelectronics circuits, Computer aided Synthesis and Optimization. **Hardware Modeling**: HDLs for Synthesis, Abstract models, Compilation and Behavioral Optimization. (Text1: Topics from Chap. 1,3)	L1, L2, L3
Module 2	
Graph theory for CAD for VLSI: Graphs, Combinatorial Optimization, Graph Optimization problems and Algorithms, Boolean Algebra and Applications. **Architectural Synthesis and Optimization:** Fundamental Architectural Synthesis problems, Area and Performance Estimation, Strategies for Architectural Optimization, Data path Synthesis, Control Path Synthesis.(Text1: Topics From Chap. 2,4)	L1, L2, L3
Module 3	
Two level Combinational Logic Optimization: Introduction, Logic Optimizations, Operations on Two level Logic Covers, Algorithms for Logic Minimization, Symbolic Minimization and Encoding Problems. **Multiple Level Combinational Logic Optimization**: Introduction, Models and Transformations for Combinational Networks, The Algebraic Model, The Boolean Model. (Text1: Chap. 7, 8)	L1, L2, L3
Module 4	
Sequential Logic Optimization: Introduction, Sequential Logic Optimization using State based Models, Sequential Logic Optimization using Network Models, Implicit FSM Traversal Methods, Testability concerns for	L1, L2, L3

Synchronous Circuits. (Text 1: Chap. 9)	
Module 5	
Scheduling Algorithms: Introduction, A Model for Scheduling problems, Scheduling with Resource Constraints, Scheduling without Resource Constraints, Scheduling Algorithms for Extended Sequencing Models, Scheduling Pipelined Circuits. **Resource Sharing and Binding:** Sharing and Binding for Resource dominated circuits, Sharing and Binding for General Circuits, Concurrent Binding and Scheduling, Resource sharing and Binding for Non – Scheduled Sequencing Graphs. (Text1: Chap. 5,6)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Understand the process of synthesis and optimization in a top down approach for digital circuits models using HDLs.
- Understand the terminologies of graph theory and its algorithms to optimize a Boolean equation.
- Apply different two level and multilevel optimization algorithms for combinational circuits
- Apply the different sequential circuit optimization methods using state models and network models.
- Apply different scheduling algorithms with resource binding and without resource binding for pipelined sequential circuits and extended sequencing models.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Giovanni De Micheli, “Synthesis and Optimization of Digital Circuits”, Tata McGraw-Hill, 2003.

Reference Book:

Edwars M.D., Automatic Logic synthesis Techniques for Digital Systems, Macmillan New Electronic Series, 1992.

CMOS RF Circuit Design [As per Choice Based credit System (CBCS) Scheme SEMESTER – IV			
Subject Code	16EVE421	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Learn basic concepts in RF and microwave design emphasising the effects of nonlinearity and noise.
- Appreciate communication system, multiple access and wireless standards necessary for RF circuit design.
- Deal with transceiver architecture, various receiver and transmitter designs, their merits and demerits
- Understand the design of RF building blocks such as Low Noise Amplifiers and Mixers

Modules	**RBT Level**
Module 1	
Introduction to RF Design and Wireless Technology: **Basic concepts in RF design(I):** General considerations, Effects of Nonlinearity, Noise, Sensitivity and dynamic range	L1,L2,L3
Module 2	
Basic concepts in RF design (II): Passive impedance transformation, scattering parameters, analysis of nonlinear dynamic systems	L1,L2,L3
Module 3	
Communication Concepts: General concepts, analog modulation, digital modulation, spectral re-growth, Mobile RF communications, Multiple access techniques, Wireless standards	L1,L2,L3
Module 4	
Transceiver Architecture (I): General considerations, Receiver architecture,	L1,L2,L3
Module 5	
Transceiver Architecture (II): Transmitter architectures **Low Noise Amplifiers:** LNA topologies: common-source stage with inductive load, common-source stage with resistive feedback. **Mixers:** General considerations, passive down conversion mixers.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

1. Analyse the effect of nonlinearity and noise in RF and microwave design.
2. Exemplify the approaches taken in actual RF products.
3. Minimize the number of off-chip components required to design mixers and Low-Noise Amplifiers.
4. Explain various receivers and transmitter topologies with their merits and

drawbacks.

5. Demonstrate how the system requirements define the parameters of the circuits and how the performance of each circuit impacts that of the overall transceiver.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

B. Razavi, "**RF Microelectronics**", PHI, second edition.

Reference Books:

1. R. Jacob Baker, H.W. Li, D.E. Boyce "**CMOS Circuit Design, layout and Simulation**", PHI 1998.
2. Thomas H. Lee "**Design of CMOS RF Integrated Circuits**" Cambridge University press 1998.
3. Y.P. Tsividis, "**Mixed Analog and Digital Devices and Technology**", TMH 1996

Advances in Image Processing [As per Choice Based credit System (CBCS) Scheme SEMESTER – IV			
Subject Code	16ECS422	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Acquire fundamental knowledge in understanding the representation of the digital image and its properties
- Equip with some pre-processing techniques required to enhance the image for further analysis purpose.
- Select the region of interest in the image using segmentation techniques.
- Represent the image based on its shape and edge information.
- Describe the objects present in the image based on its properties and structure.

Modules	**RBT Level**
Module 1	
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.	L1
Module 2	
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.	L1, L2
Module 3	
Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.	L1, L2, L3
Module 4	
Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.	L1, L2, L3
Module 5	
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds.	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Understand the representation of the digital image and its properties
- Apply pre-processing techniques required to enhance the image for its further analysis.

- Use segmentation techniques to select the region of interest in the image for analysis
- Represent the image based on its shape and edge information.
- Describe the objects present in the image based on its properties and structure.
- Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", Cengage Learning, 2013, ISBN: 978-81-315-1883-0

Reference Books:

1. Geoff Doughertry, Digital Image Processing for Medical Applications, Cambridge university Press, 2010
2. S.Jayaraman, S Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, 2011

High Speed VLSI Design [As per Choice Based credit System (CBCS) Scheme SEMESTER – IV			
Subject Code	16EVE423	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Learn sources of process – driven performance variation in quarter-micron CMOS and apply the rules of thumb.
- Comprehend non-clocked static circuit families, used to implement combinatorial logic.
- Interpret the design styles used for clocked and non-clocked systems.
- Explore the design parameters such as on-chip device length tolerance, supply rail inconsistency and temperature variations.

Modules	**RBT Level**
Module 1	
Process Variability: Introduction**,** Front-end -of-line variability considerations, charge loss mechanisms, back-end-of- line variability considerations.	L1, L2
Module 2	
Non-Clocked logic styles: Introduction, static CMOS structures, DC VS logic, Non-clocked pass-gate families. **Clocked logic styles**: Introduction, single-rail domino logic styles. Dual-rail domino structures, latched domino structures, clocked-pass gate logic.	L1, L2,L3
Module 3	
Circuit Design margin and design variability: Introduction, process induced variation, design induced variations, and application induced variations', Noise. **Latching Strategies:** Introduction, basic latch design, latching single ended logic, latching differential logic, race-free latched for pre-charge logic.	L1, L2,L3
Module 4	
Interface Techniques: Introduction, signaling standard, chip-chip communication networks, ESD protection, Driver design techniques, receiver design techniques.	L1, L2,L3
Module 5	
Clocking styles: Introduction, clock jitter and skew, clock	L1, L2,L3

generation and clock distribution.

Course Outcomes: After studying this course, students will be able to:

1. Accomplish their goal in achieving the trade offs in performance, power, area, reliability and cost by the selection of design styles.
2. Analyse strengths and weakness of non-clocked static circuit families in terms of characteristics.
3. Differentiate the styles used for clocked and non-clocked circuit families.
4. Interpret the performance considerations to enable high speed communication; by choosing the input and output convention compatible with signal levels required for the design.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Kerry Bernstein & et. Al., "**High Speed CMOS Design Styles"**, Kluwer, 1999.

Reference Books:

1. Howard Johnson & Martin Graham, **"High Speed Digital Design"** A Handbook of Black Magic, Prentice Hall PTR, 1993.
2. William S. Dally & John W. Poulton, **"Digital Systems Engineering"**, Cambridge University Press, 1998.
3. Masakazu Shoji, **"High Speed Digital Circuits"**, Addison Wesley Publishing Company, 1996.

Reconfigurable Computing

[As per Choice Based credit System (CBCS) Scheme
SEMESTER – IV

Subject Code	16ELD424	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 03

Course Objectives: The aim of this course is to enable the students to

- Acquire fundamental knowledge and understanding of principles and practice in reconfigurable architecture.
- Understand the FPGA design principles, and logic synthesis.
- Integrate hardware and software technologies for reconfiguration computing focusing on partial reconfiguration design.
- Focus on different domains of applications on reconfigurable computing.

Modules	RBT Level
Module 1	
Introduction : History, Reconfigurable Vs Processor based system, RC Architecture. **Reconfigurable Logic Devices**: Field Programmable Gate Array, Coarse Grained Reconfigurable Arrays. **Reconfigurable Computing System**: Parallel Processing on Reconfigurable Computers, A survey of Reconfigurable Computing System. (Text 1)	LI, L2
Module 2	
Languages and Compilation: Design Cycle, Languages, HDL, High Level Compilation, Low level Design flow, Debugging Reconfigurable Computing Applications. (Text 1)	L1,L2
Module 3	
Implementation: Integration, FPGA Design flow, Logic Synthesis. **High Level Synthesis for Reconfigurable Devices:** Modelling, Temporal Partitioning Algorithms. (Text 2)	L1, L2, L3
Module 4	
Partial Reconfiguration Design: Partial Reconfiguration Design, Bitstream Manipulation with JBits, The modular Design flow, The Early Access Design Flow, Creating Partially Reconfigurable Designs, Partial Reconfiguration using Hansel-C Designs, Platform Design. (Text 2)	L1,L2
Module 5	
Signal Processing Applications: Reconfigurable computing for DSP, DSP application building blocks, Examples: Beamforming, Software Radio, Image and video processing, Local Neighbourhood functions, Convolution. (Text 1) **System on a Programmable Chip:** Introduction to SoPC, Adaptive Multiprocessing on Chip. (Text 2)	L1, L2, L3

Course Outcomes:: After studying this course, students will be able to:

- Simulate and synthesize the reconfigurable computing architectures.
- Use the reconfigurable architectures for the design of a digital system.

- Design of digital systems for a variety of applications on signal processing and system on chip configurations.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. M. Gokhale and P. Graham, “Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays”, Springer, 2005.

2. C. Bobda, “Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications”, Springer, 2007.

Reference Books:

1. D. Pellerin and S. Thibault, “Practical FPGA Programming in C”, Prentice-Hall, 2005.

2. W. Wolf, “FPGA Based System Design”, Prentice-Hall, 2004.

3. R. Cofer and B. Harding, “Rapid System Prototyping with FPGAs: Accelerating the Design Process”, Newnes, 2005.

SCHEME OF TEACHING AND EXAMINATION
MASTER OF BUSINESS ADMINISTRATION

I SEMESTER

Subject Code	Title of the Subject	Category	Teaching hours / week			Duration of Exam (Hours)	Marks for		Total Marks	Credits
			Lecture	Practical / Field Work / Assignment *	Total		IA	Exam		
16MBA11	Management & Organizational Behaviour	Core Course	3	2	5	3	20	80	100	4
16MBA12	Managerial Economics	Core Course	3	2	5	3	20	80	100	4
16MBA13	Accounting for Managers	Core Course	3	2	5	3	20	80	100	4
16MBA14	Quantitative Methods	Core Course	3	2	5	3	20	80	100	4
16MBA15	Marketing Management	Core Course	3	2	5	3	20	80	100	4
16MBA16	Managerial Communications	Core Course	3	2	5	3	20	80	100	4
	Total		**18**	**12**	**30**		**120**	**480**	**600**	**24**

*** Practical /Field Work / Assignment is a part of contact hours for the faculty and must be considered in the workload.**

II SEMESTER

Subject Code	Title of the Subject	Category	Teaching hours / week			Duration of Exam (Hours)	Marks for		Total Marks	Credits
			Lecture	Practical / Field Work / Assignment *	Total		IA	Exam		
16MBA21	Human Resource Management	Core Course	3	2	5	3	20	80	100	4
16MBA22	Financial Management	Core Course	3	2	5	3	20	80	100	4
16MBA23	Research Methods	Core Course	3	2	5	3	20	80	100	4
16MBA24	Business Law and Policy	Core Course	3	2	5	3	20	80	100	4
16MBA25	Strategic Management	Core Course	3	2	5	3	20	80	100	4
16MBA26	Entrepreneurship Development	Core Course	3	2	5	3	20	80	100	4
	Total		**18**	**12**	**30**		**120**	**480**	**600**	**24**

*** Practical /Field Work / Assignment is a part of contact hours for the faculty and must be considered in the workload.**

III SEMESTER
(Core Specialisation)

Subject Code			Category	Teaching hours / week			Duration of Exam (Hours)	Marks for		Total Marks	Credits
Marketing	**Finance**	**Human Resource**		**Lecture**	**Practical / Field Work / Assignment ****	**Total**		**IA**	**Exam**		
16MBAMM301	16MBAFM301	16MBAHR301	Foundation Course	3	2	5	3	20	80	100	3
16MBAMM302	16MBAFM302	16MBAHR302	Foundation Elective	3	2	5	3	20	80	100	3
16MBAMM303	16MBAFM303	16MBAHR303	Elective	3	2	5	3	20	80	100	3
16MBAMM304	16MBAFM304	16MBAHR304	Foundation Course	3	2	5	3	20	80	100	3
16MBAMM305	16MBAFM305	16MBAHR305	Foundation Elective	3	2	5	3	20	80	100	3
16MBAMM306	16MBAFM306	16MBAHR306	Elective	3	2	5	3	20	80	100	3
16MBAIN307			Internship *	0	8	8	-	50	50	100	4
			Industrial Visit	0	0	0	0	0	00	00	0
				18	**12**	**30**		**120**	**480**	**700**	**22**

*** Internship will be carried out by students after second semester during vacation and the report submitted by the students will be assessed internally during the third semester. Total number of teaching hours per week is excluding internship workload.**

**** Practical /Field Work / Assignment is a part of contact hours for the faculty and must be considered in the workload.**
Industrial visit is a mandatory activity with zero credits

III SEMESTER
(Core Specialisation Subjects)

Marketing Specialisation		Finance Specialisation		Human Resource Specialisation	
Subject Code	**Title of the Subject**	**Subject Code**	**Title of the Subject**	**Subject Code**	**Title of the Subject**
16MBAMM301	Consumer Behavior	16MBAFM301	Principles & Practices of Banking	16MBAHR301	Industrial Relations & Legislations
16MBAMM302	Retail Management	16MBAFM302	Investment Banking & Financial Services	16MBAHR302	Recruitment & Selection
16MBAMM303	Services Marketing	16MBAFM303	Investment Management	16MBAHR303	Compensation & Benefits
16MBAMM304	Marketing Research	16MBAFM304	Advanced Financial Management	16MBAHR304	Learning & Development
16MBAMM305	Business Marketing	16MBAFM305	Cost Management	16MBAHR305	Knowledge Management
16MBAMM306	Supply Chain Management	16MBAFM306	Strategic Credit Management	16MBAHR306	Conflict & Negotiation Management

III SEMESTER (Dual Specialisation)

Subject Code			Category	Teaching hours / week			Duration of Exam (Hours)	Marks for		Total Marks	Credits
Marketing &Finance	**Finance &HR**	**HR & Marketing**		**Lecture**	**Practical / Field Work / Assignment ****	**Total**		**IA**	**Exam**		
16MBAMM301	16MBAFM301	16MBAHR301	Foundation Course	3	2	5	3	20	80	100	3
16MBAMM302	16MBAFM302	16MBAHR302	Foundation Elective	3	2	5	3	20	80	100	3
16MBAMM303	16MBAFM303	16MBAHR303	Elective	3	2	5	3	20	80	100	3
16MBAFM301	16MBAHR301	16MBAMM301	Foundation Course	3	2	5	3	20	80	100	3
16MBAFM302	16MBAHR302	16MBAMM302	Foundation Elective	3	2	5	3	20	80	100	3
16MBAFM303	16MBAHR303	16MBAMM303	Elective	3	2	5	3	20	80	100	3
16MBAIN307			Internship *	0	8	8	---	50	50	100	4
			Industrial Visit	0	0	0	0	00	00	00	0
				18	**12**	**30**		**120**	**480**	**700**	**22**

*** Internship will be carried out by students after second semester during vacation and the report submitted by the students will be assessed internally during the third semester. Total number of teaching hours per week is excluding internship workload.**

**** Practical /Field Work / Assignment is a part of contact hours for the faculty and must be considered in the workload.**
Industrial visit is a mandatory activity with zero credits

IV SEMESTER
(Core Specialisation)

Subject Code			Category	Teaching hours / week			Duration of Exam (Hours)	Marks for		Total Marks	Credits
Marketing	Finance	Human Resource		Lecture	Practical / Field Work / Assignment **	Total		IA	Exam		
16MBAMM401	16MBAFM401	16MBAHR401	Foundation Course	3	2	5	3	20	80	100	3
16MBAMM402	16MBAFM402	16MBAHR402	Foundation Elective	3	2	5	3	20	80	100	3
16MBAMM403	16MBAFM403	16MBAHR403	Elective	3	2	5	3	20	80	100	3
16MBAMM404	16MBAFM404	16MBAHR404	Foundation Course	3	2	5	3	20	80	100	3
16MBAMM405	16MBAFM405	16MBAHR405	Foundation Elective	3	2	5	3	20	80	100	3
16MBAMM406	16MBAFM406	16MBAHR406	Elective	3	2	5	3	20	80	100	3
16MBAPR407			Project Work *	0	8	8	---	50	150	200	12
										800	30

* Project work will be carried out after third semester and shall be evaluated during fourth semester. The internal assessment will be made for 50 marks. In the examination, the total marks of 150 shall be allotted as follows: 50 marks each for report evaluation by internal and external examiners respectively and remaining 50 marks for the viva voce examination, jointly assessed by internal and external examiners.

**** Practical /Field Work / Assignment is a part of contact hours for the faculty and must be considered in the workload.**

IV SEMESTER
(Core Specialisation Subjects)

Marketing Specialisation			Financial Specialisation			Human Resource Specialisation	
Subject Code	**Title of the Subject**		**Subject Code**	**Title of the Subject**		**Subject Code**	**Title of the Subject**
16MBAMM401	Sales Management		16MBAFM401	Mergers, Acquisitions & Corporate Restructuring		16MBAHR401	Public relations
16MBAMM402	Integrated Marketing Communication		16MBAFM402	Risk Management and Insurance		16MBAHR402	Workplace Ethics & Value Systems
16MBAMM403	E-Marketing		16MBAFM403	Tax Management		16MBAHR403	International Human Resource Management
16MBAMM404	Strategic Brand Management		16MBAFM404	International Financial Management		16MBAHR404	Organisation Change and Development
16MBAMM405	Rural Marketing		16MBAFM405	Financial Derivatives		16MBAHR405	Strategic Talent Management
16MBAMM406	International Marketing Management		16MBAFM406	Corporate Valuation		16MBAHR406	Personal Growth & Interpersonal Effectiveness

IV SEMESTER
(Dual Specialisation)

Subject Code			Category	Teaching hours / week			Duration of Exam (Hours)	Marks for		Total Marks	Credits
Marketing &Finance	**Finance &HR**	**HR & Marketing**		**Lecture**	**Practical / Field Work / Assignment ****	**Total**		**IA**	**Exam**		
16MBAMM401	16MBAFM401	16MBAHR401	Foundation Course	3	2	5	3	20	80	100	3
16MBAMM402	16MBAFM402	16MBAHR402	Foundation Elective	3	2	5	3	20	80	100	3
16MBAMM403	16MBAFM403	16MBAHR403	Elective	3	2	5	3	20	80	100	3
16MBAFM401	16MBAHR401	16MBAMM401	Foundation Course	3	2	5	3	20	80	100	3
16MBAFM402	16MBAHR402	16MBAMM402	Foundation Elective	3	2	5	3	20	80	100	3
16MBAFM403	16MBAHR403	16MBAMM403	Elective	3	2	5	3	20	80	100	3
16MBAPR407			Project Work *	0	8	8	---	50	150	200	12
										800	30

- Project work will be carried out after third semester and shall be evaluated during fourth semester. The internal assessment will be made for 50 marks. In the examination, the total marks of 150 shall be allotted as follows: 50 marks each for report evaluation by internal and external examiners respectively and remaining 50 marks for the viva voce examination, jointly assessed by internal and external examiners.

**** Practical /Field Work / Assignment is a part of contact hours for the faculty and must be considered in the workload.**

IV SEMESTER
(Dual Specialisation Subjects)

Marketing & Finance Specialisation			Marketing & Human Resources Specialisation			Finance & Human Resource Specialisation	
Subject Code	**Title of the Subject**		**Subject Code**	**Title of the Subject**		**Subject Code**	**Title of the Subject**
16MBAMM401	Sales Management		16MBAMM401	Sales Management		16MBAFM401	Mergers, Acquisitions & Corporate Restructuring
16MBAMM402	Integrated Marketing Communication		16MBAMM402	Integrated Marketing Communication		16MBAFM402	Risk Management and Insurance
16MBAMM403	E-Marketing		16MBAMM403	E-Marketing		16MBAFM403	Tax Management
16MBAFM401	Mergers, Acquisitions & Corporate Restructuring		16MBAHR401	Public relations		16MBAHR401	Public relations
16MBAFM402	Risk Management and Insurance		16MBAHR402	Workplace Ethics & Value Systems		16MBAHR402	Workplace Ethics & Value Systems
16MBAFM403	Tax Management		16MBAHR403	International Human Resource Management		16MBAHR403	International Human Resource Management

Plan of action (proposed)

1. Implementation of CBCS for MBA Programme will be effective from next academic year, i.e., 2016-17
2. Review of Scheme of Teaching and Examinations being finalized
3. Award of Credits for various components of MBA Programme
4. Allotment of marks for the subjects/papers, seminar and summer project.
   80:20 patterns of marks for external examination and internal (IA) marks respectively is to be adopted for all the subjects, except Internship, for which the pattern will be 50:50 basis for internal and external assessments respectively.

   Question paper for theory examination shall consist of Part A and B as under:
   - Part A shall consist of 5 questions subdivided into a, b, c in 3+7+10 mixed pattern
   - Part B shall be a *compulsory* question on Case study/ Practical problem for 20 marks (may contain a maximum of 4 sub-questions).

   IA Pattern: 20 marks in each subject, comprising of 10 marks for tests and 10 marks for assignments/seminars/practical exercises/quiz/oral exams

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B.E: CIVIL ENGINEERING

III SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT31	Engineering Mathematics –III*	Maths	04		03	60	40	100	4
2	17CV32	Strength of Materials	Civil Engg.	04		03	60	40	100	4
3	17CV33	Fluid Mechanics	Civil Engg.	04		03	60	40	100	4
4	17CV34	Basic Surveying	Civil Engg.	04		03	60	40	100	4
5	17CV35	Engineering Geology	Civil Engg.	04		03	60	40	100	3
6	17CV36	Building Materials and Construction	Civil Engg.	03		03	60	40	100	4
7	17CVL37	Building Materials Testing Laboratory	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CVL38	Basic Surveying Practice	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
TOTAL				Theory: 24hours Practical: 06 hours		25	510	340	850	28

1. Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2. Audit Course:
(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – I, which is 03 contact hours per week.

1	17MATDIP31	Additional Mathematics –I	Maths	03		03	60	–	60	–

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
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B.E: CIVIL ENGINEERING

IV SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT41	Engineering Mathematics –IV*	Maths	04		03	60	40	100	4
2	17CV42	Analysis of Determinate Structures	Civil Engg.	04		03	60	40	100	3
3	17CV43	Applied Hydraulics	Civil Engg.	04		03	60	40	100	4
4	17CV44	Concrete Technology	Civil Engg.	04		03	60	40	100	4
5	17CV45	Basic Geotechnical Engineering	Civil Engg.	04		03	60	40	100	4
6	17CV46	Advanced Surveying	Civil Engg.	03		03	60	40	100	4
7	17CVL47	Fluid Mechanics Laboratory	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CVL48	Engineering Geology Laboratory	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
			TOTAL	**Theory: 24hours Practical: 06 hours**		**25**	**510**	**340**	**850**	**28**

1. Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2.Audit Course:
(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – II, which is 03 contact hours per week.

1	17MATDIP41	Additional Mathematics –II	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

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B.E: CIVIL ENGINEERING

V SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CV51	Design of RC Structural Elements	Civil Engg.	04		03	60	40	100	4
2	17CV52	Analysis of Indeterminate Structures	Civil Engg.	04		03	60	40	100	4
3	17CV53	Applied Geotechnical Engineering	Civil Engg.	04		03	60	40	100	4
4	17CV54	Computer Aided Building Planning and Drawing	Civil Engg.	04		03	60	40	100	4
5	17CV55X	Professional Elective-1	Civil Engg.	03		03	60	40	100	3
6	17CV56X	Open Elective-1	Civil Engg.	03		03	60	40	100	3
7	17CVL57	Geotechnical Engineering Laboratory	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CVL58	Concrete and Highway Materials Laboratory	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
			TOTAL	Theory: 22hours Practical: 06 hours		24	480	320	800	26

Professional Elective-1			Open Elective – 1*** (List offered by Civil Engg Board only)	
17CV551	Air pollution and Control		17CV561	Traffic Engineering
17CV552	Railways, Harbours, tunneling and Airports		17CV562	Sustainability Concepts in Engineering
17CV553	Masonry Structures		17CV563	Remote Sensing and GIS
17CV554	Theory of Elasticity		17CV563	Occupational Health and Safety
			17CV563	NCC

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).
Selection of an open elective is not allowed, if:
- The candidate has no pre – requisite knowledge.
- The candidate has studied similar content course during previous semesters.
- The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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B.E: CIVIL ENGINEERING

VI SEMESTER

SL. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CV61	Construction Management and Entrepreneurship	Civil Engg.	04		03	60	40	100	4
2	17CV62	Design of Steel Structural Elements	Civil Engg.	04		03	60	40	100	4
3	17CV63	Highway Engineering	Civil Engg.	04		03	60	40	100	4
4	17CV64	Water Supply and Treatment Engineering	Civil Engg.	04		03	60	40	100	4
5	17CV65X	Professional Elective-2	Civil Engg.	03		03	60	40	100	3
6	17CV66X	Open Elective-2	Civil Engg.	03		03	60	40	100	3
7	17CVL67	Software Application Laboratory	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CVL68	Extensive Survey Project /Camp	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
			TOTAL	**Theory:22hours Practical: 06 hours**		**24**	**480**	**320**	**800**	**26**

Professional Elective-2			Open Elective – 2*** (List offered by Civil Engg Board only)	
17CV651	Solid Waste Management		17CV661	Water Resource Management
17CV652	Matrix Method of Structural Analysis		17CV662	Environmental Protection and Management
17CV653	Alternative Building Materials		17CV663	Numerical Methods and Applications
17CV654	Ground Improvement Techniques		17CV664	Finite Element Analysis

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).
Selection of an open elective is not allowed, if:
· The candidate has no pre – requisite knowledge.
· The candidate has studied similar content course during previous semesters.
· The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).
Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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VII SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CV71	Municipal and Industrial Waste Water Engineering	Civil Engg.	04		03	60	40	100	4
2	17CV72	Design of RCC and Steel Structures	Civil Engg.	04		03	60	40	100	4
3	17CV73	Hydrology and Irrigation Engineering	Civil Engg.	04		03	60	40	100	4
4	17CV74X	Professional Elective-3	Civil Engg.	03		03	60	40	100	3
5	17CV75X	Professional Elective-4	Civil Engg.	03		03	60	40	100	3
6	17CVL76	Environmental Engineering Laboratory	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
7	17CVL77	Computer Aided Detailing of Structures	Civil Engg.	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CVP78	Project Work Phase–I + Project work Seminar	Civil Engg.		03	--	--	100	100	2
TOTAL				**Theory:18 hours Practical and Project: 09 hours**		**21**	**420**	**380**	**800**	**24**

Professional Elective-3		**Professional Elective-4**	
17CV741	Design of Bridges	17CV751	Urban Transportation and Planning
17CV742	Ground Water & Hydraulics	17CV752	Prefabricated Structures
17CV743	Design Concept of Building Services	17CV753	Rehabilitation and Retrofitting of Structures
17CV744	Structural Dynamics	17CV754	Reinforced Earth Structures

1. **Project Phase – I and Project Seminar:** Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and Seminar presentation skill.

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B.E: CIVIL ENGINEERING

VIII SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CV81	Quantity Surveying and Contracts Management	Civil Engg.	4	-	3	60	40	100	4
2	17CV82	Design of Pre Stressed Concrete Elements	Civil Engg.	4	-	3	60	40	100	4
3	17CV83X	Professional Elective-5	Civil Engg.	3	-	3	60	40	100	3
4	17CV84	Internship/ Professional Practice	Civil Engg.	Industry Oriented		3	50	50	100	2
5	17CVP85	Project Work-II	Civil Engg.	-	6	3	100	100	200	6
6	17CVS86	Seminar on current trends in Engineering and Technology	Civil Engg.	-	4	-	-	100	100	1
TOTAL				**Theory: 11 hours Project and Seminar: 10 hours**		**15**	**330**	**370**	**700**	**20**

Professional Elective -5	
17CV831	Earthquake Engineering
17CV832	Hydraulic Structures
17CV833	Pavement Design
17CV834	Advanced Foundation Design

1. Internship/ Professional Practice: 4 Weeks internship to be completed between the (VI and VII semester vacation) and/or (VII and VIII semester vacation) period

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B.E: Computer Science and Engineering

III SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT31	Engineering Mathematics - III	Maths	04		03	60	40	100	4
2	17CS32	Analog and Digital Electronics	CS/IS	04		03	60	40	100	4
3	17CS33	Data Structures and Applications	CS/IS	04		03	60	40	100	4
4	17CS34	Computer Organization	CS/IS	04		03	60	40	100	4
5	17CS35	Unix and Shell Programming	CS/IS	03		03	60	40	100	3
6	17CS36	Discrete Mathematical Structures	CS/IS	04		03	60	40	100	4
7	17CSL37	Analog and Digital Electronics Laboratory	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CSL38	Data Structures Laboratory	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
TOTAL				Theory: 24hours Practical: 06 hours		25	510	340	850	28

1.Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2. Audit Course:

(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – I, which is 03 contact hours per week.

1	17MATDIP31	Additional Mathematics –I	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

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B.E: Computer Science and Engineering

IV SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT41	Engineering Mathematics - IV	Maths	04		03	60	40	100	4
2	17CS42	Object Oriented Concepts	CS/IS	03		03	60	40	100	3
3	17CS43	Design and Analysis of Algorithms	CS/IS	04		03	60	40	100	4
4	17CS44	Microprocessors and Microcontrollers	CS/IS	04		03	60	40	100	4
5	17CS45	Software Engineering	CS/IS	04		03	60	40	100	4
6	17CS46	Data Communication	CS/IS	04		03	60	40	100	4
7	17CSL47	Design and Analysis of Algorithm Laboratory	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CSL48	Microprocessors Laboratory	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
			TOTAL	**Theory: 24hours** **Practical: 06 hours**		**25**	**510**	**340**	**850**	**28**

1. Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2.Audit Course:
(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – II, which is 03 contact hours per week.

1	17MATDIP41	Additional Mathematics - II	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

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V SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CS51	Management and Entrepreneurship for IT Industry	CS/IS	04		03	60	40	100	4
2	17CS52	Computer Networks	CS/IS	04		03	60	40	100	4
3	17CS53	Database Management System	CS/IS	04		03	60	40	100	4
4	17CS54	Automata theory and Computability	CS/IS	04		03	60	40	100	4
5	17CS55x	Professional Elective-1	CS/IS	03		03	60	40	100	3
6	17CS56x	Open Elective-1	CS/IS	03		03	60	40	100	3
7	17CSL57	Computer Network Laboratory	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CSL58	DBMS Laboratory with mini project	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
			TOTAL	Theory: 22hours Practical: 06 hours		24	480	320	800	26

Professional Elective-1			Open Elective – 1*** (List offered by CSE Board only)	
17CS551	Object Oriented Modeling and Design		17CS561	Programming in JAVA *(Not for CSE/ISE students)*
17CS552	Introduction to Software Testing		17CS562	Artificial Intelligence
17CS553	Advanced JAVA and J2EE		17CS563	Embedded Systems
17CS554	Advanced Algorithms		17CS564	Dot Net framework for application development;
			17CS565	Cloud Computing *(Not for CSE/ISE students)*

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).
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· The candidate has studied similar content course during previous semesters.
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Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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VI SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CS61	Cryptography, Network Security and Cyber Law	CS/IS	04		03	60	40	100	4
2	17CS62	Computer Graphics and Visualization	CS/IS	04		03	60	40	100	4
3	17CS63	System Software and Compiler Design	CS/IS	04		03	60	40	100	4
4	17CS64	Operating Systems	CS/IS	04		03	60	40	100	4
5	17CS65x	Professional Elective-2	CS/IS	03		03	60	40	100	3
6	17CS66x	Open Elective-2	CS/IS	03		03	60	40	100	3
7	17CSL67	System Software and Operating System Laboratory	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CSL68	Computer Graphics Laboratory with mini project	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
			TOTAL	**Theory:22hours** **Practical: 06 hours**		**24**	**480**	**320**	**800**	**26**

Professional Elective-2			**Open Elective – 2*** (List offered by CSE Board only)**	
17CS651	Data Mining and Data Warehousing		17CS661	Mobile Application Development
17CS652	Software Architecture and Design Patterns		17CS662	Big Data Analytics *(Not for CSE/ISE students)*
17CS653	Operations research		17CS663	Wireless Networks and Mobile computing
17CS654	Distributed Computing system		17CS664	Python Application Programming
			17CS665	Service Oriented Architecture
			17CS666	Multicore Architecture and Programming

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· The candidate has no pre – requisite knowledge.
· The candidate has studied similar content course during previous semesters.
· The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).
Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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VII SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CS71	Web Technology and its applications	CS/IS	04		03	60	40	100	4
2	17CS72	Advanced Computer Architectures	CS/IS	04		03	60	40	100	4
3	17CS73	Machine Learning	CS/IS	04		03	60	40	100	4
4	17CS74x	Professional Elective 3	CS/IS	03		03	60	40	100	3
5	17CS75x	Professional Elective 4	CS/IS	03		03	60	40	100	3
6	17CSL76	Machine Learning Laboratory	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
7	17CSL77	Web Technology Laboratory with mini project	CS/IS	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17CSP78	Project Work Phase-I + Project work Seminar	CS/IS		03	--	--	100	100	2
TOTAL				**Theory:18 hours Practical and Project: 09 hours**		**21**	**420**	**380**	**800**	**24**

Professional Elective-3		Professional Elective-4	
17CS741	Natural Language Processing	17CS751	Soft and Evolutionary Computing
17CS742	Cloud Computing and its Applications	17CS752	Computer Vision and Robotics
17CS743	Information and Network Security	17CS753	Digital Image Processing
17CS744	Unix System Programming	17CS754	Storage Area Networks

1. **Project Phase – I and Project Seminar:** Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and Seminar presentation skill.

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VIII SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17CS81	Internet of Things and Applications	CS/IS	4	-	3	60	40	100	4
2	17CS82	Big Data Analytics	CS/IS	4	-	3	60	40	100	4
3	17CS83X	Professional Elective-5	CS/IS	3	-	3	60	40	100	3
4	17CS84	Internship/ Professional Practice	CS/IS	Industry Oriented		3	50	50	100	2
5	17CSP85	Project Work-II	CS/IS	-	6	3	100	100	200	6
6	17CSS86	Seminar	CS/IS	-	4	-	-	100	100	1
TOTAL				**Theory: 11 hours Project and Seminar: 10 hours**		**15**	**330**	**370**	**700**	**20**

Professional Elective -5	
17CS831	High Performance Computing
17CS832	User Interface Design
17CS833	Network management
17CS834	System Modeling and Simulation

1. Internship/ Professional Practice: 4 Weeks internship to be completed between the (VI and VII semester vacation) and/or (VII and VIII semester vacation) period.

SCHEME OF TEACHING AND EXAMINATION

B.E. Electronics & Communication Engineering / Telecommunication Engineering

(Common to Electronics & Communication and Telecommunication Engineering)

III SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT31	Engineering Mathematics - III*	Maths	04		03	60	40	100	4
2	17EC32	Electronic Instrumentation	EC	03		03	60	40	100	3
3	17EC33	Analog Electronics	EC	04		03	60	40	100	4
4	17EC34	Digital Electronics	EC	04		03	60	40	100	4
5	17EC35	Network Analysis	EC	04		03	60	40	100	4
6	17EC36	Engineering Electromagnetics	EC	04		03	60	40	100	4
7	17ECL37	Analog Electronics Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17ECL38	Digital Electronics Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
TOTAL				Theory: 24hours Practical: 06 hours		25	510	340	850	28

1.Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters

2. Audit Course:

(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – I, which is 03 contact hours per week

1	17MATDIP31	Additional Mathematics - I	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

B.E Electronics & Communication Engineering / Telecommunication Engineering
(Common to Electronics & Communication and Telecommunication Engineering)

IV SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT41	Engineering Mathematics –IV*	Maths	04		03	60	40	100	4
2	17EC42	Signals and Systems	EC	04		03	60	40	100	4
3	17EC43	Control Systems	EC	04		03	60	40	100	4
4	17EC44	Principles of Communication Systems	EC	04		03	60	40	100	4
5	17EC45	Linear Integrated Circuits	EC	04		03	60	40	100	4
6	17EC46	Microprocessor	EC	03		03	60	40	100	3
7	17ECL47	Microprocessor Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17ECL48	Linear IC's and Communication Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
		TOTAL		Theory : 24hours Practical: 06 hours		25	510	340	850	28

1. Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters

2.Audit Course:

(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – II, which is 03 contact hours per week

1	17MATDIP41	Additional Mathematics –II	Maths	03		03	60	--	[illegible]	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

B.E.: Electronics & Communication Engineering

V SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17ES51	Management and Entrepreneurship Development	EC	04		03	60	40	100	4
2	17EC52	Digital Signal Processing	EC	04		03	60	40	100	4
3	17EC53	Verilog HDL	EC	04		03	60	40	100	4
4	17EC54	Information Theory & Coding	EC	04		03	60	40	100	4
5	17EC55X	Professional Elective-1	EC	03		03	60	40	100	3
6	17EC56X	Open Elective-1	EC	03		03	60	40	100	3
7	17ECL57	DSP Lab	EC	01 Hour Instruction 02 Hour Practical		03	60	40	100	2
8	17ECL58	HDL Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
TOTAL				Theory: 22hours Practical: 66 hours		24	480	320	800	26

Professional Elective-1		Open Elective – 1*** (List offered by EC/TC Board only)	
17EC551	Nanoelectronics	17EC561	Automotive Electronics
17EC552	Switching & Finite Automata Theory	17EC562	Object Oriented Programming Using C++
17EC553	Operating System	17EC563	8051 Microcontroller
17EC554	Electrical Engineering Materials		
17EC555	MSP430 Microcontroller		

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives)

Selection of an open elective is not allowed, if

The candidate has no pre – requisite knowledge

The candidate has studied similar content course during previous semesters

The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s)

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser

VI SEMESTER

B.E.: Electronics & Communication Engineering

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17EC61	Digital Communication	EC	04		03	60	40	100	4
2	17EC62	ARM Microcontroller & Embedded Systems	EC	04		03	60	40	100	4
3	17EC63	VLSI Design	EC	04		03	60	40	100	4
4	17EC64	Computer Communication Networks	EC	04		03	60	40	100	4
5	17EC65X	Professional Elective-2	EC	03		03	60	40	100	3
6	17EC66X	Open Elective-2	EC	03		03	60	40	100	3
7	17ECL67	Embedded Controller Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17ECL68	Computer Networks Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
TOTAL				Theory: 22hours Practical: 06 hours		24	480	320	800	26

Professional Elective-2	
17EC651	Cellular Mobile Communication
17EC652	Adaptive Signal Processing
17EC653	Artificial Neural Networks
17EC654	Digital Switching Systems
17EC655	Microelectronics

Open Elective – 2*** (List offered by EC/TC Board only)	
17EC661	Data Structures Using C++
17EC662	Power Electronics *(not for EEE students)*
17EC663	Digital System Design using Verilog

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives)

Selection of an open elective is not allowed, if:

The candidate has no pre – requisite knowledge.

The candidate has studied similar content course during previous semesters.

The candidate has studied similar content course during previous semesters.

The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

B.E.: Electronics & Communication Engineering

VII SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17EC71	Microwave and Antennas	EC	04		03	60	40	100	4
2	17EC72	Digital Image Processing	EC	04		03	60	40	100	4
3	17EC73	Power Electronics	EC	04		03	60	40	100	4
4	17EC74X	Professional Elective-3	EC	03		03	60	40	100	3
5	17EC75X	Professional Elective-4	EC	03		03	60	40	100	3
6	17ECL76	Advanced Communication Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
7	17ECL77	VLSI Lab	EC	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17ECP78	Project Work Phase–I + Project work Seminar	EC		03		-	100	100	2
TOTAL				Theory:18 hours Practical and Project: 09 hours		21	420	380	800	24

Professional Elective-3		Professional Elective-4	
17EC741	Multimedia Communication	17EC751	DSP Algorithms and Architecture
17EC742	Biomedical Signal Processing	17EC752	IOT and Wireless Sensor Networks
17EC743	Real Time Systems	17EC753	Pattern Recognition
17EC744	Cryptography	17EC754	Advanced Computer Architecture
17EC745	CAD for VLSI	17EC755	Satellite Communication

I **Project Phase – I and Project Seminar:** Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and Seminar presentation skill.

VIII SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17EC81	Wireless Cellular and LTE 4G Broadband	EC	4	-	3	60	40	100	4
2	17EC82	Fiber Optics & Networks	EC	4	-	3	60	40	100	4
3	17EC83X	Professional Elective-5	EC	3	-	3	60	40	100	3
4	17EC84	Internship/Professional Practice	EC	Industry Oriented		3	50	50	100	2
5	17ECP85	Project Work	EC	-	6	3	100	100	200	6
6	17ECS86	Seminar	EC		4		-	100	100	1
		TOTAL		**Theory: 11 hours Project and Seminar: 10 hours**		15	330	370	700	20

Professional Elective -5	
17EC831	Micro Electro Mechanical Systems
17EC832	Speech Processing
17EC833	Radar Engineering
17EC834	Machine learning
17EC835	Network and Cyber Security

1. Internship/ Professional Practice: 4 Weeks internship to be completed between the (VI and VII semester vacation) and/or (VII and VIII semester vacation) period.

VISVESVAR[redacted]A TECHNOLOGICAL UNIVERSITY, BE[redacted]GAVI
Scheme of Teaching and Examination 2017-2018
Choice Based Credit System (CBCS)

B.E: ELECTRICAL AND ELECTRONICS ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

III SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT31	Engineering Mathematics-III (Core)	Mathematics	04		03	60	40	100	4
2	17EE32	Electric Circuit Analysis (Core)	EEE	04		03	60	40	100	4
3	17EE33	Transformers and Generators (Core)	EEE	04		03	60	40	100	4
4	17EE34	Analog Electronic Circuits (Core)	EEE	04		03	60	40	100	4
5	17EE35	Digital System Design (Core)	EEE	04		03	60	40	100	4
6	17EE36	Electrical and Electronic Measurements (Foundation course)	EEE	03		03	60	40	100	3
7	17EEL37	Electrical Machines Laboratory -1	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17EEL38	Electronics Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
TOTAL				Theory: 24hours Practical: 06 hours		25	510	340	850	28

1. **Kannada/Constitution of India, Professional Ethics and Human Rights:** 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2. **Audit Course:**
(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – I, which is 03 contact hours per week.

1	17MATDIP31	Additional Mathematics - I	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2017-2018
Choice Based Credit System (CBCS)

B.E: ELECTRICAL AND ELECTRONICS ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

IV SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT41	Engineering Mathematics-IV (Core)	Mathematics	04		03	60	40	100	4
2	17EE42	Power Generation and Economics (Core)	EEE	04		03	60	40	100	4
3	17EE43	Transmission and Distribution (Core)	EEE	04		03	60	40	100	4
4	17EE44	Electric Motors (Core)	EEE	04		03	60	40	100	4
5	17EE45	Electromagnetic Field Theory (Core)	EEE	04		03	60	40	100	4
6	17EE46	Operational Amplifiers and Linear ICs (Foundation course)	EEE	03		03	60	40	100	3
7	17EEL47	Electrical Machines Laboratory -2	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17EEL48	Op- amp and Linear ICs Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
			TOTAL	Theory: 24hours Practical: 06 hours		25	510	340	850	28

1. **Kannada/Constitution of India, Professional Ethics and Human Rights:** 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2.Audit Course:

(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – II, which is 03 contact hours per week.

1	17MATDIP41	Additional Mathematics –II	Maths	03		03	60	–	60	–

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

Scheme of Teaching and Examination 2017-2018

Choice Based Credit System (CBCS)

B.E: ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

V SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17EE51	Management and Entrepreneurship	EEE	04		03	60	40	100	4
2	17EE52	Microcontroller(Core)	EEE	04		03	60	40	100	4
3	17EE53	Power Electronics(Core)	EEE	04		03	60	40	100	4
4	17EE54	Signals and Systems(Core)	EEE	04		03	60	40	100	4
5	17EE55X	Professional Elective – I	EEE	03		03	60	40	100	3
6	17EE56Y	Open Elective - I	EEE	03		03	60	40	100	3
7	17EEL57	Microcontroller Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17EEL58	Power Electronics Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
			TOTAL	**Theory: 22hours Practical: 06 hours**		**24**	**480**	**320**	**800**	**26**

Professional Elective-1		**Open Elective – 1*** (List offered by EEE Board only)**	
17EE551	Introduction to Nuclear Power	17EE561	Electronic Communication systems
17EE552	Electrical Engineering Materials	17EE562	Programmable Logic controllers
17EE553	Estimating and Costing	17EE563	Renewable Energy Systems
17EE554	Special Electrical Machines	17EE564	Business Communication

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).

Selection of an open elective is not allowed, if:

- The candidate has no pre – requisite knowledge.
- The candidate has studied similar content course during previous semesters.
- The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2017-2018
Choice Based Credit System (CBCS)
B.E: ELECTRICAL AND ELECTRONICS ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

VI SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17EE61	Control Systems(Core)	EEE	04		03	60	40	100	4
2	17EE62	Power System Analysis – 1(Core)	EEE	04		03	60	40	100	4
3	17EE63	Digital Signal Processing(Core)	EEE	04		03	60	40	100	4
4	17EE64	Electrical Machine Design(Core)	EEE	04		03	60	40	100	4
5	17EE65X	Professional Elective – II	EEE	03		03	60	40	100	3
6	17EE66Y	Open Elective - II	EEE	03		03	60	40	100	3
7	17EEL67	Control System Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17EEL68	Digital Signal Processing Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
			TOTAL	Theory:22hours Practical: 06 hours		Core Course	480	320	800	26

Professional Elective-2			Open Elective – 2*** (List offered by EEE Board only)	
17EE651	Computer Aided Electrical Drawing		17EE661	Artificial Neural Networks and Fuzzy logic
17EE652	Advanced Power Electronics		17EE662	Sensors and Transducers
17EE653	Energy Audit and Demand side Management		17EE663	Batteries and Fuel Cells for Commercial, Military and Space Applications
17EE654	Solar and Wind Energy		17EE664	Industrial Servo Control Systems

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).
Selection of an open elective is not allowed, if:

- The candidate has no pre – requisite knowledge.
- The candidate has studied similar content course during previous semesters.
- The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied as Professional elective(s).
- A similar course, under any category, is prescribed in the higher semesters.

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2017-2018
Choice Based Credit System (CBCS)

B.E: ELECTRICAL AND ELECTRONICS ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

VII SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17EE71	Power System Analysis – 2(Core)	EEE	04		03	60	40	100	4
2	17EE72	Power System Protection(Core)	EEE	04		03	60	40	100	4
3	17EE73	High Voltage Engineering(Core)	EEE	04		03	60	40	100	4
4	17EE74X	Professional Elective – III	EEE	03		03	60	40	100	3
5	17EE75Y	Professional Elective – IV	EEE	03		03	60	40	100	3
6	17EEL76	Power system Simulation Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
7	17EEL77	Rely and High Voltage Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17EEP78	Project Work Phase–I + Project work Seminar	EEE		03	--	--	100	100	2
TOTAL				Theory:18 hours Practical and Project: 09 hours		21	420	380	800	24

Professional Elective-3		Professional Elective-4	
17EE741	Advanced Control Systems	17EE751	FACTs and HVDC Transmission
17EE742	Utilization of Electrical Power	17EE752	Testing and Commissioning of Power System Apparatus
17EE743	Carbon Capture and Storage	17EE753	Spacecraft Power Technologies
17EE744	Power System Planning	17EE754	Industrial Heating

1. **Project Phase – I and Project Seminar:** Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and Seminar presentation skill.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2017-2018
Choice Based Credit System (CBCS)

B.E: ELECTRICAL AND ELECTRONICS ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

VIII SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17EE81	Power System Operation and Control (Core)	EEE	4	-	3	60	40	100	4
2	17EE82	Industrial Drives and Applications(Core)	EEE	4	-	3	60	40	100	4
3	17EE83X	Professional Elective-5	EEE	3	-	3	60	40	100	3
4	17EE84	Internship/ Professional Practice (Core)	EEE	Industry Oriented		3	50	50	100	2
5	17EEP85	Project Work-II(Core)	EEE	-	6	3	100	100	200	6
6	17EES86	Seminar (Core)	EEE	-	4	-	-	100	100	1
TOTAL				Theory: 11 hours Project and Seminar: 10 hours		15	330	370	700	20

Professional Elective -5	
17EE831	Smart Grid
17EE832	Operation and Maintenance of Solar Electric Systems
17EE833	Integration of Distributed Generation
17EE834	Power System in Emergencies

1. Internship/ Professional Practice: 4 Weeks internship to be completed between the (VI and VII semester vacation) and/or (VII and VIII semester vacation) period.

B.E. Mechanical Engineering
III SEMESTER

Sl. No	Subject Code	Title	Teaching Department	Teaching Hours /Week			Examination				Credits
				Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17MAT31	Engineering Mathematics – III	Maths	04			03	60	40	100	4
2	17ME32	Materials Science	ME	04			03	60	40	100	4
3	17ME33	Basic Thermodynamics	ME	03	02		03	60	40	100	4
4	17ME34	Mechanics of Materials	ME	03	02		03	60	40	100	4
5	17ME35A/ 17ME35B	Metal Casting and Welding Machine Tools and Operations	ME ME	04			03	60	40	100	4
6	17ME36 A/ 17ME36B	Computer Aided Machine Drawing	ME	01		4	03	60	40	100	3
		Mechanical Measurements and Metrology	ME	03							
7	17MEL37A/ 17MEL37B	Materials Testing Lab/ Mechanical Measurements and Metrology Lab	ME ME	1		2	03	60	40	100	2
8	17MEL38A/ 17MEL38B	Foundry and Forging Lab Machine Shop/	ME ME	1		2	03	60	40	100	2
9	17KL/CPH3 9/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	1			01	30	20	50	1
	TOTAL			22/24	04	08/04		510	340	850	28

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B.E. Mechanical Engineering
IV SEMESTER

Sl. No	Subject Code	Title	Teaching Department	Teaching Hours /Week			Examination				Credit s
				Lectu re	Tutoria l	Practica l	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17MAT41	Engineering Mathematics – III	Maths	04			03	60	40	100	04
2	17ME42	Kinematics of Machinery	ME	03	02		03	60	40	100	04
3	17ME43	Applied Thermodynamics	ME	03	02		03	60	40	100	04
4	17ME44	Fluid mechanics	ME	03	02		03	60	40	100	04
5	17ME45A/ 17ME45B	Metal Casting and Welding	ME	04			03	60	40	100	04
		Machine Tools and Operations	ME								
6	17ME46 A/ 17ME46B	Computer Aided Machine Drawing	ME	01		4	03	60	40	100	03
		Mechanical Measurements and Metrology	ME	03							
7	17MEL47A/ 17MEL47B	Materials Testing Lab/	ME	1		2	03	60	40	100	02
		Mechanical Measurements and Metrology Lab	ME								
8	17MEL48A/ 17MEL48B	Foundry and Forging Lab	ME	1		2	03	60	40	100	02
		Machine Shop/	ME								
9	17KL/CPH39 /49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	1			01	30	20	50	1
		TOTAL		21/23	06	08/04		510	340	850	28

KINEMATICS OF MACHINES
B.E, IV Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME42	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03
Credits – 04			

Course Objectives:

1. **Familiarize with mechanisms and motion analysis of mechanisms.**
2. **Understand methods of mechanism motion analysis and their characteristics.**
3. **Analyse motion of planar mechanisms, gears, gear trains and cams.**

B.E. Mechanical Engineering

V SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17ME51	Management and Engineering Economics	3	2	0	03	60	40	100	4
2	17ME52	Dynamics of Machinery	3	2	0	03	60	40	100	4
3	17ME53	Turbo Machines	3	2	0	03	60	40	100	4
4	17ME54	Design of Machine Elements - I	3	2	0	03	60	40	100	4
5	17ME55X	Professional Elective-I	3	0	0	03	60	40	100	3
6	17ME56X	Open Elective-I	3	0	0	03	60	40	100	3
7	17MEL57	Fluid Mechanics & Machinery Lab	1	0	2	03	60	40	100	2
8	17MEL58	Energy Lab	1	0	2	03	60	40	100	2
TOTAL			20	08	04		480	320	60	40

Professional Elective-I		Open Elective-I	
17ME551	Refrigeration and Air-conditioning	17ME561	Optimization Techniques
17ME552	Theory of Elasticity	17ME562	Energy and Environment
17ME553	Human Resource Management	17ME563	Automation and Robotics
17ME554	Non Traditional Machining	17ME564	Project Management

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study

2. Professional Elective: Elective relevant to chosen specialization/ branch

3. Open Elective: Electives from other technical and/or emerging subject areas.

B.E. Mechanical Engineering

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17ME61	Finite Element Analysis	3	2	0	03	60	40	100	4
2	17ME62	Computer integrated Manufacturing	4	0	0	03	60	40	100	4
3	17ME63	Heat Transfer	3	2	0	03	60	40	100	4
4	17ME64	Design of Machine Elements -II	3	2	0	03	60	40	100	4
5	17ME65X	Professional Elective-II	3	0	0	03	60	40	100	3
6	17ME66X	Open Elective-II	3	0	0	03	60	40	100	3
7	17MEL67	Heat Transfer Lab	1	0	2	03	60	40	100	2
8	17MEL68	Modeling and Analysis Lab(FEA)	1	0	2	03	60	40	100	2
		TOTAL	21	6	04		480	320	800	26

Professional Elective-II		Open Elective-II	
17ME651	Computational Fluid Dynamics	17ME661	Energy Auditing
17ME652	Mechanics of Composite Materials	17ME662	Industrial Safety
17ME653	Metal Forming	17ME663	Maintenance Engineering
17ME654	Tool Design	17ME664	Total Quality Management
17ME655	Automobile Engineering		

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch

3. Open Elective: Electives from other technical and/or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
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B.E. Mechanical Engineering

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME71	Energy Engineering	3	2	0	03	80	20	100	4
2	15ME72	Fluid Power Systems	4	0	0	03	80	20	100	4
3	15ME73	Control Engineering	3	2	0	03	80	20	100	4
4	15ME74X	Professional Elective - III	3	0	0	03	80	20	100	3
5	15ME75X	Professional Elective-IV	3	0	0	03	80	20	100	3
6	15MEL76	Design Lab	1	0	2	03	80	20	100	2
7	15MEL77	CIM Lab	1	0	2	03	80	20	100	2
8	15MEP78	Project Phase – I	-	-	-	-	-	100	100	2
		TOTAL	**18**	**4**	**04**		**560**	**240**	**800**	**24**

Professional Elective-III		Professional Elective-IV	
15ME741	Design of Thermal Equipments	15ME751	Automotive Electronics
15ME742	Tribology	15ME752	Fracture Mechanics
15ME743	Financial Management	15ME753	Human Resource Management
15ME744	Design for Manufacturing	15ME754	Mechatronics
15ME745	Smart Materials & MEMS	15ME755	Advanced Vibrations

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Mechanical Engineering

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME81	Operations Research	3	2	0	03	80	20	100	4
2	15ME82	Additive Manufacturing	4	0	0	03	80	20	100	4
3	15ME83X	Professional Elective - V	3	0	0	03	80	20	100	3
4	15ME84	Internship / Professional Practice	Industry Oriented			03	50	50	100	2
5	15ME85	Project Phase – II	-	6	-	03	100	100	200	6
6	15MES86	Seminar	-	4	-	-	-	100	100	1
		TOTAL	**10**	**12**	**-**		**390**	**310**	**700**	**20**

Professional Elective-V	
15ME831	Cryogenics
15ME832	Experimental Stress Analysis
15ME833	Theory of Plasticity
15ME834	Green Manufacturing
15ME835	Product life cycle management

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **Internship / Professional Practice:** To be carried out between 6^{th}& 7^{th} semester vacation or 7^{th}& 8^{th} semester vacation.

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Programme: CIVIL ENGINEERING

III SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week: Theory Lecture (L)	Tutorial (T)	Practical/ Drawing (P)	Examination: Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
1	BSC	18MAT31	Transform Calculus, Fourier Series and Numerical Techniques	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18CV32	Strength of Materials	Civil Engg.	3	2	--	03	40	60	100	4
3	PCC	18CV33	Fluid Mechanics	Civil Engg.	3	0	--	03	40	60	100	3
4	PCC	18CV34	Building Materials and Construction	Civil Engg.	3	0	--	03	40	60	100	3
5	PCC	18CV35	Basic Surveying	Civil Engg.	3	0	--	03	40	60	100	3
6	PCC	18CV36	Engineering Geology	Geology	3	0	--	03	40	60	100	3
7	PCC	18CVL37	Computer Aided Building Planning & Drawing	Civil Engg.	--	2	2	03	40	60	100	2
8	PCC	18CVL38	Building Materials Testing Laboratory	Civil Engg.	--	2	2	03	40	60	100	2
9	HSMC	18KVK39	Vyavaharika Kannada (Kannada for communication)/ **OR**	HSMC	--	2	--	--	100	--	100	1
		18KAK39	Aadalitha Kannada (Kannada for Administration) **OR**									
		18CPC39	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
TOTAL					**17 OR 18**	**08 OR 10**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP31	Additional Mathematics - I	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for

SEE. (b)These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.
Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs
Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.
AICTE Activity Points to be earned by students admitted to BE/B. Tech/B. Plan day college programme (For more details refer to Chapter 6,AICTE Activity Point Programme, Model Internship Guidelines): Over and above the academic grades, every Day College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card. The activities can be can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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Programme: CIVIL ENGINEERING

IV SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18MAT41	Complex Analysis, Probability And Statistical Methods	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18CV42	Analysis of Determinate Structures	Civil Engg.	3	2	--	03	40	60	100	4
3	PCC	18CV43	Applied Hydraulics	Civil Engg.	3	0	--	03	40	60	100	3
4	PCC	18CV44	Concrete Technology	Civil Engg.	3	0	--	03	40	60	100	3
5	PCC	18CV45	Advanced Surveying	Civil Engg.	3	0	--	03	40	60	100	3
6	PCC	18CV46	Water Supply & Treatment Engineering	Civil Engg.	3	0	--	03	40	60	100	3
7	PCC	18CVL47	Engineering Geology Laboratory	Geology	--	2	2	03	40	60	100	2
8	PCC	18CVL48	Fluid Mechanics and Hydraulic Machines Laboratory	Civil Engg.	--	2	2	03	40	60	100	2
9	HSMC	18KVK39/49	Vyavaharika Kannada (Kannada for Communication)/	HSMC	--	2	--	--	100	--	100	1
		OR										
		18KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPC39/49	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	**17 OR 18**	**08 OR 10**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39/49Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39/49Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP41	Additional Mathematics - II	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

(b)These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.
Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs
Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.
AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HSMC	18CV51	Construction Management & Entrepreneurship	Civil Engg.	2	2	--	03	40	60	100	3
2	PCC	18CV52	Analysis of Indeterminate Structures	Civil Engg.	3	2	--	03	40	60	100	4
3	PCC	18CV53	Design of RC Structural Elements	Civil Engg.	3	2	--	03	40	60	100	4
4	PCC	18CV54	Basic Geotechnical Engineering	Civil Engg.	3	--	--	03	40	60	100	3
5	PCC	18CV55	Municipal Wastewater Engineering	Civil Engg.	3	--	--	03	40	60	100	3
6	PCC	18CV56	Highway Engineering	Civil Engg.	3	--	--	03	40	60	100	3
7	PCC	18CVL57	Surveying Practice	Civil Engg.	--	2	2	03	40	60	100	2
8	PCC	18CVL58	Concrete and Highway Materials Laboratory	Civil Engg.	--	2	2	03	40	60	100	2
9	HSMC	18CIV59	Environmental Studies	Civil/Environmental [Paper setting Board: Civil Engineering]	1	--	--	02	40	60	100	1
				TOTAL	**18**	**10**	**04**	**26**	**360**	**540**	**900**	**25**

Note: PCC: Professional Core, HSMC: Humanity and Social Science.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VI SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture L	Tutorial T	Practical/ Drawing P	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18CV61	Design of Steel Structural Elements	Civil Engg.	3	2	--	03	40	60	100	4
2	PCC	18CV62	Applied Geotechnical Engineering	Civil Engg.	3	2	--	03	40	60	100	4
3	PCC	18CV63	Hydrology and Irrigation Engineering	Civil Engg.	3	2	--	03	40	60	100	4
4	PEC	18CV64X	Professional Elective -1	Civil Engg.	3	--	--	03	40	60	100	3
5	OEC	18CV65X	Open Elective -A	Civil Engg.	3	--	--	03	40	60	100	3
6	PCC	18CVL66	Software Application Laboratory	Civil Engg.	--	2	2	03	40	60	100	2
7	PCC	18CVL67	Environmental Engineering Laboratory	Civil Engg.	--	2	2	03	40	60	100	2
8	EP	18CVEP68	Extensive Survey project	Civil Engg.	--	2	2	03	40	60	100	2
9	Internship	--	Internship	To be carried out during the vacation/s of VI and VII semesters and /or VII and VIII semesters.								
				TOTAL	**15**	**12**	**06**	**24**	**320**	**480**	**800**	**24**

Note: PCC: Professional core, PEC: Professional Elective, OE: Open Elective, MP: Mini-project.

Professional Elective -1

Course code under18CV64X	
18CV641	Matrix Method of Structural Analysis
18CV642	Solid Waste Management
18CV643	Alternate Building Materials
18CV644	Ground Improvement Techniques
18CV645	Railway, Harbours, Tunnelling & Airports

Open Elective -A

Course code under18CV65X	
18CV651	Remote Sensing & GIS
18CV652	Traffic Engineering
18CV653	Occupational Health & Safety

18CV654	Sustainability Concepts in Civil Engineering
Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX65X). Selection of an open elective shall not be allowed if, • The candidate has studied the same course during the previous semesters of the programme. • The syllabus content of open elective is similar to that of the Departmental core courses or professional electives. • A similar course, under any category, is prescribed in the higher semesters of the programme. Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.	
Internship: All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.	
AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.	

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VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18CV71	Quality Surveying and Contract Management	Civil Engg.	3	--	--	03	40	60	100	3
2	PCC	18CV72	Design of RCC and Steel Structures	Civil Engg.	3	--	--	03	40	60	100	3
3	PEC	18CV73X	Professional Elective - 2	Civil Engg.	3	--	--	03	40	60	100	3
4	PEC	18CV74X	Professional Elective - 3	Civil Engg.	3	--	--	03	40	60	100	3
5	OEC	18CV75X	Open Elective -B	Civil Engg.	3	--	--	03	40	60	100	3
6	PCC	18CVL76	Computer Aided Detailing of Structures	Civil Engg.	--	2	2	03	40	60	100	2
7	PCC	18CVL77	Geotechnical Engineering Laboratory	Civil Engg.	--	2	2	03	40	60	100	2
8	Project	18CVP78	Project Work Phase - 1		--	--	2	--	100	--	100	1
9	Internship	--	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	**15**	**04**	**06**	**21**	**380**	**420**	**00**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective - 2

Course code under 18CV73X	**Course Title**
18CV731	Theory of Elasticity
18CV732	Air Pollution and Control
18CV733	Pavement Materials & Construction
18CV734	Ground Water Hydraulics
18CV735	Masonry Structures

Professional Electives - 3

Course code under 18CV74X	**Course Title**
18CV741	Earthquake Engineering
18CV742	Design Concepts of Building Services
18CV743	Reinforced Earth Structures

18CV744	Design of Hydraulic Structures
18CV745	Urban Transport Planning
Open Elective -B	
Course code under 18CV75X	**Course Title**
18CV751	Finite Element Method
18CV752	Numerical Methods and Applications
18CV753	Environmental Protection and Management

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX75X).

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

CIE procedure for Project Work Phase - 1:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Internship: All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
					L	T	P					
1	PCC	18CV81	Design of Pre-stressed Concrete	Civil Engg.	3	--	--	03	40	60	100	3
2	PEC	18CV82X	Professional Elective - 4	Civil Engg.	3	--	--	03	40	60	100	3
3	Project	18CVP83	Project Work Phase - 2	Civil Engg.	--	--	16	03	40	60	100	8
4	Seminar	18CVS84	Technical Seminar	Civil Engg.	--	--	2	03	100	--	100	1
5	Internship	18CVI85	Internship	Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.)				03	40	60	100	3
				TOTAL	**06**	**--**	**18**	**15**	**260**	**240**	**500**	**18**

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4

Course code under 18CV82X	Course Title
18CV821	Bridge Engineering
18CV822	Prefabricated Structures
18CV823	Advanced Foundation Engineering
18CV824	Rehabilitation & Retrofitting
18CV825	Pavement Design

Project Work

CIE procedure for Project Work Phase - 2:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:

(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department. **(ii) Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to. **Internship:** Those, who have not pursued /completed the internship, shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.
AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card. Activity points of the students who have earned the prescribed AICTE activity Points shall be sent the University along with the CIE marks of 8th semester. In case of students who have not satisfied the AICTE activity Points at the end of eighth semester, the column under activity Points shall be marked NSAP (Not Satisfied Activity Points).

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
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(Effective from the academic year 2018 – 19)

III SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week: Theory Lecture (L)	Tutorial (T)	Practical/ Drawing (P)	Examination: Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
1	BSC	18MAT31	Transform Calculus, Fourier Series And Numerical Techniques	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18CS32	Data Structures and Applications	CS / IS	3	2	--	03	40	60	100	4
3	PCC	18CS33	Analog and Digital Electronics	CS / IS	3	0	--	03	40	60	100	3
4	PCC	18CS34	Computer Organization	CS / IS	3	0	--	03	40	60	100	3
5	PCC	18CS35	Software Engineering	CS / IS	3	0	--	03	40	60	100	3
6	PCC	18CS36	Discrete Mathematical Structures	CS / IS	3	0	--	03	40	60	100	3
7	PCC	18CSL37	Analog and Digital Electronics Laboratory	CS / IS	--	2	2	03	40	60	100	2
8	PCC	18CSL38	Data Structures Laboratory	CS / IS	--	2	2	03	40	60	100	2
9	HSMC	18KVK39	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK39	Aadalitha Kannada (Kannada for Administration)									
		OR	**OR**									
		18CPC39	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	**17 OR 18**	**08 OR 10**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course

18KVK39 Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and **18KAK39** Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP31	Additional Mathematics - I	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

(b) These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE Activity Points to be earned by students admitted to BE/B.Tech/B. Plan day college programme (For more details refer to Chapter 6,AICTE Activity Point Programme, Model Internship Guidelines): Over and above the academic grades, every Day College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card. The activities can be can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
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IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18MAT41	Complex Analysis, Probability and Statistical Methods	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18CS42	Design and Analysis of Algorithms	CS / IS	3	2	--	03	40	60	100	4
3	PCC	18CS43	Operating Systems	CS / IS	3	0	--	03	40	60	100	3
4	PCC	18SC44	Microcontroller and Embedded Systems	CS / IS	3	0	--	03	40	60	100	3
5	PCC	18CS45	Object Oriented Concepts	CS / IS	3	0	--	03	40	60	100	3
6	PCC	18CS46	Data Communication	CS / IS	3	0	--	03	40	60	100	3
7	PCC	18CSL47	Design and Analysis of Algorithm Laboratory	CS / IS	--	2	2	03	40	60	100	2
8	PCC	18CSL48	Microcontroller and Embedded Systems Laboratory	CS / IS	--	2	2	03	40	60	100	2
9	HSMC	18KVK49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK49	Aadalitha Kannada (Kannada for Administration)									
		OR	**OR**									
		18CPC39	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	**17 OR 18**	**08 OR 10**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course

18KVK49 Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and **18KAK49** Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP41	Additional Mathematics - II	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

(b) These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HSMC	18CS51	Management, Entrepreneurship for IT idustry	HSMC	2	2	--	03	40	60	100	3
2	PCC	18CS52	Computer Networks and Security	CS / IS	3	2	--	03	40	60	100	4
3	PCC	18CS53	Database Management System	CS / IS	3	2	--	03	40	60	100	4
4	PCC	18CS54	Automata theory and Computability	CS / IS	3	--	--	03	40	60	100	3
5	PCC	18CS55	Application Development using Python	CS / IS	3	--	--	03	40	60	100	3
6	PCC	18CS56	Unix Programming	CS / IS	3	--	--	03	40	60	100	3
7	PCC	18CSL57	Computer Network Laboratory	CS / IS	--	2	2	03	40	60	100	2
8	PCC	18CSL58	DBMS Laboratory with mini project	CS / IS	--	2	2	03	40	60	100	2
9	HSMC	18CIV59	Environmental Studies	Civil/ Environmental [Paper setting: Civil Engineering Board]	1	--	--	02	40	60	100	1
				TOTAL	**18**	**10**	**04**	**26**	**360**	**540**	**900**	**25**

Note: PCC: Professional Core, HSMC: Humanity and Social Science.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
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VI SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18CS61	System Software and Compilers	CS / IS	3	2	--	03	40	60	100	4
2	PCC	18CS62	Computer Graphics and Visualization	CS / IS	3	2	--	03	40	60	100	4
3	PCC	18CS63	Web Technology and its applications	CS / IS	3	2	--	03	40	60	100	4
4	PEC	18CS64X	Professional Elective -1	CS / IS	3	--	--	03	40	60	100	3
5	OEC	18CS65X	Open Elective –A	CS / IS	3	--	--	03	40	60	100	3
6	PCC	18CSL66	System Software Laboratory	CS / IS	--	2	2	03	40	60	100	2
7	PCC	18CSL67	Computer Graphics Laboratory with mini project	CS / IS	--	2	2	03	40	60	100	2
8	MP	18CSMP68	Mobile Application Development	CS / IS	--	--	2	03	40	60	100	2
9	INT	--	Internship	(To be carried out during the intervening vacations of VI and VII semesters)				--	--	--	--	--
				TOTAL	**15**	**10**	**06**	**24**	**320**	**480**	**800**	**24**

Note: PCC: Professional core, PEC: Professional Elective, OE: Open Elective, MP: Mini-project, INT: Internship.

Professional Elective -1	
Course code under18XX64X	**Course Title**
18CS641	Data Mining and Data Warehousing
18CS642	Object Oriented Modelling and Design
18CS643	Cloud Computing and its Applications
18CS644	Advanced JAVA and J2EE
18CS645	System Modelling and Simulation
Open Elective –A (Not for CSE / ISE Programs)	
18CS651	Mobile Application Development
18CS652	Introduction to Data Structures and Algorithms
18CS653	Programming in JAVA
18CS654	Introduction to Operating System

Students can select any one of the open electives offered by any Department (Please refer to the list of open electives under 18CS65X).
Selection of an open elective is not allowed provided,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Adviser/Mentor.

Mini-project work: Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.
CIE procedure for Mini-project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the Mini-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
SEE for Mini-project:
(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.
Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not takeup/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18CS71	Artificial Intelligence and Machine Learning	CS / IS	4	--	--	03	40	60	100	4
2	PCC	18CS72	Big Data Analytics	CS / IS	4	--	--	03	40	60	100	4
3	PEC	18CS73X	Professional Elective – 2	CS / IS	3	--	--	03	40	60	100	3
4	PEC	18CS74X	Professional Elective – 3	CS / IS	3	--	--	03	40	60	100	3
5	OEC	18CS75X	Open Elective –B	CS / IS	3	--	--	03	40	60	100	3
6	PCC	18CSL76	Artificial Intelligence and Machine Learning Laboratory	CS / IS	--	--	2	03	40	60	100	2
7	Project	18CSP77	Project Work Phase – 1	CS / IS	--	--	2	--	100	--	100	1
8	INT	--	Internship	(If not completed during the vacation of VI and VII semesters, it has to be carried out during the intervening vacations of VII and VIII semesters								
				TOTAL	**17**	--	**04**	**18**	**340**	**360**	**700**	**20**

Note: PCC: Professional core, PEC: Professional Elective, OEC: Open Elective, INT: Internship.

Professional Elective - 2	
Course code under 18CS73X	**Course Title**
18CS731	Software Architecture and Design Patterns
18CS732	High Performance Computing
18CS733	Advanced Computer Architecture
18CS734	User Interface Design
Professional Electives – 3	
Course code under 18CS74X	**Course Title**
18CS741	Digital Image Processing
18CS742	Network management
18CS743	Natural Language Processing
18CS744	Cryptography
18CS745	Robotic Process Automation Design & Development
Open Elective –B (Not for CSE / ISE Programs)	
18CS751	Introduction to Big Data Analytics
18CS752	Python Application Programming
18CS753	Introduction to Artificial Intelligence
18CS754	Introduction to Dot Net framework for Application Development

Students can select any one of the open electives offered by any Department (Please refer to the list of open electives under 18CS75X).
Selection of an open elective is not allowed provided,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Adviser/Mentor.

Project work: Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

CIE procedure for Project Work Phase - 1:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not takeup/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
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VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18CS81	Internet of Things	CS / IS	3	--	--	03	40	60	100	3
2	PEC	18CS82X	Professional Elective – 4	CS / IS	3	--	--	03	40	60	100	3
3	Project	18CSP83	Project Work Phase – 2	CS / IS	--	--	2	03	40	60	100	8
4	Seminar	18CSS84	Technical Seminar	CS / IS	--	--	2	03	100	--	100	1
5	INT	18CSI85	Internship	(Completed during the intervening vacations of VI and VII semesters and /or VII and VIII semesters.)				03	40	60	100	3
				TOTAL	**06**	--	**04**	**15**	**260**	**240**	**500**	**18**

Note: PCC: Professional Core, PEC: Professional Elective, OEC: Open Elective, INT: Internship.

Professional Electives – 4

Course code under 18CS82X	Course Title
18CS821	Mobile Computing
18CS822	Storage Area Networks
18CS823	NoSQL Database
18CS824	Multicore Architecture and Programming

Project Work CIE procedure for Project Work Phase - 2:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
SEE for Project Work Phase - 2:
(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.
Internship: Those, who have not pursued /completed the internship shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card. Activity points of the students who have earned the prescribed AICTE activity Points shall be sent the University along with the CIE marks of 8th semester. In case of students who have not satisfied the AICTE activity Points at the end of eighth semester, the column under activity Points shall be marked NSAP (Not Satisfied Activity Points).

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III SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week: Theory Lecture (L)	Tutorial (T)	Practical/ Drawing (P)	Examination: Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
1	BSC	18MAT31	Transform Calculus, Fourier Series and Numerical Techniques	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18EC32	Network Theory		3	2	--	03	40	60	100	4
3	PCC	18EC33	Electronic Devices		3	0	--	03	40	60	100	3
4	PCC	18EC34	Digital System Design		3	0	--	03	40	60	100	3
5	PCC	18EC35	Computer Organization & Architecture		3	0	--	03	40	60	100	3
6	PCC	18EC36	Power Electronics & Instrumentation		3	0	--	03	40	60	100	3
7	PCC	18ECL37	Electronic Devices & Instrumentation Laboratory		--	2	2	03	40	60	100	2
8	PCC	18ECL38	Digital System DesignLaboratory		--	2	2	03	40	60	100	2
9	HSMC	18KVK39/49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPC39/49	Constitution of India, Professional Ethics and Cyber Law		1	--	--	03	40	60		
					Examination is by objective type questions							
				TOTAL	17 OR 18	10 OR 08	04	24 OR 27	420 OR 360	480 OR 540	900	24

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39Vyavaharika Kannada (Kannada for communication) is for non-kannada speaking, reading and writing students and 18KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NC MC	18MATDIP31	Additional Mathematics - I	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech programs,shall attend the classes during therespective semesters to complete all the formalities of the course and appear for the University examination.In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.
(b)These Courses shall not beconsidered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE Activity Points to be earned by students admitted to BE/B.Tech/B.Plan day college programme (For more details refer to Chapter 6,AICTE Activity Point Programme, Model Internship Guidelines):
Over and above the academic grades, every Day College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card.
The activities can be can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.
In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

IVSEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18MAT41	Complex Analysis, Probability and Statistical Methods	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18EC42	Analog Circuits		3	2	--	03	40	60	100	4
3	PCC	18EC43	Control Systems		3	0	--	03	40	60	100	3
4	PCC	18EC44	Engineering Statistics & Linear Algebra		3	0	--	03	40	60	100	3
5	PCC	18EC45	Signals & Systems		3	0	--	03	40	60	100	3
6	PCC	18EC46	Microcontroller		3	0	--	03	40	60	100	3
7	PCC	18ECL47	Microcontroller Laboratory		--	2	2	03	40	60	100	2
8	PCC	18ECL48	Analog Circuits Laboratory		--	2	2	03	40	60	100	2
9	HSMC	18KVK39/49	Vyavaharika Kannada (Kannada for communication)	HSMC	--	2	--	--	100	--	100	1
		18KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPC39/49	Constitution of India, Professional Ethics and Cyber Law		1	--	--	03	40	60		
					Examination is by objective type questions							
				TOTAL	**17 OR 18**	**10 OR 08**	**04**	**24 OR 27**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39/49 Vyavaharika Kannada (Kannada for communication) is for non-kannada speaking, reading and writing students and 18KAK39/49 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP41	Additional Mathematics – II	Mathematics	02	01	--	03	40	60	100	0

((a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the student have to Fulfill the requirements during subsequent semester/s to appear for SEE.

(b) These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
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Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
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V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture (L)	Tutorial (T)	Practical/ Drawing (P)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	HSMC	18ES51	Technological Innovation Management And Entrepreneurship		3	0	--	03	40	60	100	3
2	PCC	18EC52	Digital Signal Processing		3	2	--	03	40	60	100	4
3	PCC	18EC53	Principles of Communication Systems		3	2	--	03	40	60	100	4
4	PCC	18EC54	Information Theory & Coding		3	--	--	03	40	60	100	3
5	PCC	18EC55	Electromagnetic Waves		3	--	--	03	40	60	100	3
6	PCC	18EC56	Verilog HDL		3	--	--	03	40	60	100	3
7	PCC	18ECL57	Digital Signal Processing Laboratory		--	2	2	03	40	60	100	2
8	PCC	18ECL58	HDL Laboratory		--	2	2	03	40	60	100	2
9	HSMC	18CIV59	Environmental Studies	Civil/ Environmental [Paper setting: Civil Engineering Board]	1	--	--	02	40	60	100	1
				TOTAL	**19**	**08**	**4**	**26**	**360**	**540**	**900**	**25**

Note: PCC:Professional Core, HSMC: Humanity and Social Science.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
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Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
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VI SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18EC61	Digital Communication		3	2	--	03	40	60	100	4
2	PCC	18EC62	Embedded Systems		3	2	--	03	40	60	100	4
3	PCC	18EC63	Microwave & Antennas		3	2	--	03	40	60	100	4
4	PEC	18XX64X	Professional Elective -1		3	--	--	03	40	60	100	3
5	OEC	18XX65X	Open Elective –A		3	--	--	03	40	60	100	3
6	PCC	18ECL66	Embedded Systems Laboratory		--	2	2	03	40	60	100	2
7	PCC	18ECL67	Communication Laboratory		--	2	2	03	40	60	100	2
8	MP	18ECMP68	Mini-project		--	--	2	03	40	60	100	2
9	Internship	--	Internship	To be carried out during the vacation/s of VI and VII semesters and /or VII and VIII semesters.								
				TOTAL	**15**	**10**	**6**	**24**	**320**	**480**	**800**	**24**

Note: PCC: Professional core, PEC: Professional Elective, OE: Open Elective, MP: Mini-project.

Professional Elective -1

Course code under 18XX64X	Course Title
18EC641	Operating System
18EC642	Artificial Neural Networks
18EC643	Object Oriented Programming using C++
18EC644	Digital System Design using Verilog
18EC645	Nanoelectronics

Open Elective –A

(i) 18EC651 Signal Processing (ii)18EC652 Sensors &Signal Conditioning

Students can select any one of the open electives offered by other Departments except those that are offered by the parent Department (Please refer to the list of open electives under 18XX65X).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Mini-project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the Mini-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college.
The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Mini-project:
(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18EC71	Computer Networks		3	--	--	03	40	60	100	3
2	PCC	18EC72	VLSI Design		3	--	--	03	40	60	100	3
3	PEC	18XX73X	Professional Elective - 2		3	--	--	03	40	60	100	3
4	PEC	18XX74X	Professional Elective - 3		3	--	--	03	40	60	100	3
5	OEC	18XX75X	Open Elective -B		3	--	--	03	40	60	100	3
6	PCC	18ECL76	Computer Networks Lab		--	2	2	03	40	60	100	2
7	PCC	18ECL77	VLSI Laboratory		--	2	2	03	40	60	100	2
8	Project	18ECP78	Project Work Phase - 1		--	--	2	--	100	--	100	1
9	Internship	--	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	**15**	4	**6**	**21**	**380**	**420**	**800**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective - 2

Course code under 18XX73X	Course Title
18EC731	Real Time System
18EC732	Satellite Communication
18EC733	Digital Image Processing
18EC734	Data Structures using C++
18EC735	DSP Algorithms &Architecture

Professional Electives - 3

Course code under 18XX74X	Course Title
18EC741	IOT & Wireless Sensor Networks
18EC742	Automotive Electronics
18EC743	Multimedia Communication
18EC744	Cryptography
18EC745	Machine Learning

Open Elective –B

(i) 18EC751 Communication Theory (ii) 18EC752 Neural Networks

Students can select any one of the open electives offered by other Departments except those that are offered by the parent Department (Please refer to the list of open electives under 18XX75X).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

CIE procedure for Project Work Phase - 1:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.
The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18EC81	Wireless and Cellular Communication		3	--	--	03	40	60	100	3
2	PEC	18XX82X	Professional Elective - 4		3	--	--	03	40	60	100	3
3	Project	18ECP83	Project Work Phase - 2		--	--	2	03	40	60	100	8
4	Seminar	18ECS84	Technical Seminar		--	--	2	03	100	--	100	1
5	Internship	18ECI85	Internship	Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.)				03	40	60	100	3
				TOTAL	**06**	--	**4**	**15**	**260**	**240**	**500**	**18**

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4	
Course code under 18XX82X	**Course Title**
18EC821	Network Security
18EC822	Micro Electro Mechanical Systems
18EC823	Radar Engineering
18EC824	Optical Communication Networks
18EC825	Biomedical Signal Processing

Project Work

CIE procedure for Project Work Phase - 2:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:

(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

(ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Internship: Those, who have not pursued /completed the internship shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

Activity points of the students who have earned the prescribed AICTE activity Points shall be sent the University along with the CIE marks of 8th semester. In case of students who have not satisfied the AICTE activity Points at the end of eighth semester, the column under activity Points shall be marked NSAP (Not Satisfied Activity Points).

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III SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18MAT31	Transform Calculus, Fourier Series and Numerical Techniques (Common to all Branches)	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18EE32	Electric Circuit Analysis	EEE	3	2	--	03	40	60	100	4
3	PCC	18EE33	Transformers and Generators	EEE	3	0	--	03	40	60	100	3
4	PCC	18 EE 34	Analog Electronic Circuits	EEE	2	2	--	03	40	60	100	3
5	PCC	18 EE 35	Digital System Design	EEE	3	0	--	03	40	60	100	3
6	PCC	18 EE 36	Electrical and Electronic Measurements	EEE	3	0	--	03	40	60	100	3
7	PCC	18 EE L37	Electrical Machines Laboratory -1	EEE	--	2	2	03	40	60	100	2
8	PCC	18 EE L38	Electronics Laboratory	EEE	--	2	2	03	40	60	100	2
9	HSMC	18KVK39/49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPC39	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	**16 OR 17**	**10 OR 12**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP31	Additional Mathematics - I	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech. programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

(b)These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE Activity Points to be earned by students admitted to BE/B. Tech/B. Plan day college programme (For more details refer to Chapter
6,AICTE Activity Point Programme, Model Internship Guidelines):

Over and above the academic grades, every Day College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card.

The activities can be can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.

In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points.

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IVSEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18MAT41	Complex analysis, probability and statistical methods	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18 EE42	Power Generation and Economics	EEE	3	0	--	03	40	60	100	3
3	PCC	18 EE43	Transmission and Distribution	EEE	3	2	--	03	40	60	100	4
4	PCC	18 EE44	Electric Motors	EEE	3	0	--	03	40	60	100	3
5	PCC	18 EE45	Electromagnetic Field Theory	EEE	2	2	--	03	40	60	100	3
6	PCC	18 EE46	Operational Amplifiers and Linear ICs	EEE	3	0	--	03	40	60	100	3
7	PCC	18 EEL47	Electrical Machines Laboratory -2	EEE	--	2	2	03	40	60	100	2
8	PCC	18 EEL48	Op- amp and Linear ICs Laboratory	EEE	--	2	2	03	40	60	100	2
9	HSMC	18KVK39/49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPC49	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	16 OR 17	10 OR 12	04	24 OR 26	420 OR 360	480 OR 540	900	24

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39/49Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39/49 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP41	Additional Mathematics - II	Mathematics	02	01	--	03	40	60	100	0

((a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination .In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

(b)These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18 EE51	Management and Entrepreneurship	EEE	3	0	--	03	40	60	100	3
2	PCC	18 EE52	Microcontroller	EEE	3	2	--	03	40	60	100	4
3	PCC	18 EE53	Power Electronics	EEE	3	2	--	03	40	60	100	4
4	PCC	18 EE54	Signals and Systems	EEE	3	--	--	03	40	60	100	3
5	PCC	18 EE55	Electrical Machine Design	EEE	3	--	--	03	40	60	100	3
6	PCC	18 EE56	High Voltage Engineering	EEE	3	--	--	03	40	60	100	3
7	PCC	18 EEL57	Microcontroller Laboratory	EEE	--	2	2	03	40	60	100	2
8	PCC	18 EEL58	Power Electronics Laboratory	EEE	--	2	2	03	40	60	100	2
9	HSMC	18CIV59	Environmental Studies	Civil/ Environmental [Paper setting: Civil Engineering Board]	1	--	--	02	40	60	100	1
				TOTAL	**18**	**10**	**04**	**26**	**360**	**540**	**900**	**25**

Note: PCC: Professional Core, HSMC: Humanity and Social Science.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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Scheme of Teaching and Examination 2018 – 19
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VI SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18 EE61	Control Systems	EEE	3	2	--	03	40	60	100	4
2	PCC	18 EE62	Power System Analysis – 1	EEE	3	2	--	03	40	60	100	4
3	PCC	18 EE63	Digital Signal Processing	EEE	3	2	--	03	40	60	100	4
4	PEC	18 EE64X	Professional Elective -1	EEE	3	--	--	03	40	60	100	3
5	OEC	18 EE65X	Open Elective -A	EEE	3	--	--	03	40	60	100	3
6	PCC	18 EEL66	Control System Laboratory	EEE	--	2	2	03	40	60	100	2
7	PCC	18 EEL67	Digital Signal Processing Laboratory	EEE	--	2	2	03	40	60	100	2
8	MP	18 EEMP68	Mini-project		--	--	2	03	40	60	100	2
9	Internship	--	Internship	To be carried out during the vacation/s of VI and VII semesters and /or VII and VIII semesters.								
				TOTAL	**15**	**10**	**06**	**24**	**320**	**480**	**800**	**24**

Note: PCC: Professional core, PEC: Professional Elective, OE: Open Elective, MP: Mini-project.

Professional Elective -1

Course code under18XX64X	Course Title
18 EE641	Introduction to Nuclear Power
18 EE642	Electrical Engineering Materials
18 EE643	Computer Aided Electrical Drawing
18 EE644	Embedded System
18 EE645	Object Oriented Programming using C++

Open Elective -A

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX65X).
Selection of an open elective shall not be allowed if,
- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Mini-project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini-project can be assigned to an individual student or to a group having not more than 4 students.
CIE procedure for Mini-project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the Mini-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college.
The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
SEE for Mini-project:
(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.
Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18 EE71	Power System Analysis – 2	EEE	2	2	--	03	40	60	100	3
2	PCC	18 EE72	Power System Protection	EEE	3	--	--	03	40	60	100	3
3	PEC	18 EE73X	Professional Elective - 2	EEE	3	--	--	03	40	60	100	3
4	PEC	18 EE74X	Professional Elective - 3	EEE	3	--	--	03	40	60	100	3
5	OEC	18 EE75X	Open Elective -B	EEE	3	--	--	03	40	60	100	3
6	PCC	18 EEL76	PSS laboratory	EEE	--	2	2	03	40	60	100	2
7	PCC	18 EEL77	Relay & HV lab	EEE	--	2	2	03	40	60	100	2
8	Project	18 EEP78	Project Work Phase - 1	EEE	--	--	2	--	100	--	100	1
9	Internship	--	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	**14**	**06**	**06**	**21**	**380**	**420**	**800**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective - 2

Course code under 18XX73X	Course Title
18EE731	Solar and Wind Energy
18EE732	Sensors and Transducers
18 EE733	Integrated of Distribution Generation.
18 EE734	Advanced Control Systems
18 EE735	Reactive Power Control in Electric Power Systems

Professional Electives - 3

Course code under 18 EE74X	Course Title
18 EE741	Industrial Drives and Application
18 EE742	Utilization of Electrical Power
18 EE743	PLC and SCADA
18 EE744	Smart Grid
18 EE745	Artificial Neural Network With Applications to Power Systems

Open Elective -B

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX75X).

Selection of an open elective shall not be allowed if,

The candidate has studied the same course during the previous semesters of the programme.

The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.

A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

CIE procedure for Project Work Phase - 1:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.
The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report(covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18EE81	Power System Operation and Control	EEE	3	--	--	03	40	60	100	3
2	PEC	18EE82X	Professional Elective - 4	EEE	3	--	--	03	40	60	100	3
3	Project	18EEP83	Project Work Phase - 2		--	--	2	03	40	60	100	8
4	Seminar	18EES84	Technical Seminar		--	--	2	03	100	--	100	1
5	Internship	18EEI85	Internship	Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.)				03	40	60	100	3
				TOTAL	**06**	--	**04**	**15**	**260**	**240**	**500**	**18**

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4

Course code under 18XX82X	Course Title
18EE821	FACTs and HVDC Transmission
18EE822	Electrical Estimation and Costing
18EE823	Electric Vehicles Technologies
18EE824	Power System Planning
18EE825	Electrical Power Quality

Project Work

CIE procedure for Project Work Phase - 2:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:

(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Internship: Those, who have not pursued /completed the internship, shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

Activity points of the students who have earned the prescribed AICTE activity Points shall be sent the University along with the CIE marks of 8th semester. In case of students who have not satisfied the AICTE activity Points at the end of eighth semester, the column under activity Points shall be marked NSAP (Not Satisfied Activity Points).

B.E ELECTRICAL AND ELECTRONICS ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

OPEN ELECTIVE - A

Course Code	18EE65X	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl No	**Board and the Department offering the Electives**	**Course Sl No**	**Course code under 18EE65X**	**Course Title**
	Electrical and Electronics Engineering	1	18EE651	Industrial Servo Control Systems
		2	18EE652	PLC and SCADA
		3	18EE653	Renewable Energy Systems
		4	18EE654	Testing and Commissioning of Electrical Equipment

B.E ELECTRICAL AND ELECTRONICS ENGINEERING **Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
SEMESTER - VII

OPEN ELECTIVE - B

Course Code	18EE75X	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl No	**Board and the Department offering the Electives**	**Course Sl No**	**Course code under 18EE75X**	**Course Title**
	Electrical and Electronics Engineering	1	18EE751	Industrial Motors and Control
		2	18EE752	Sensors and Transducers
		3	18EE753	Electric Vehicles
		4	18EE754	Energy Conservation and Audit

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III SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18MAT31	Mathematics	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18ME32	Mechanics of Materials		3	2	--	03	40	60	100	4
3	PCC	18ME33	Basic Thermodynamics		3	0	--	03	40	60	100	3
4	PCC	18ME34	Material Science		3	0	--	03	40	60	100	3
5	PCC	18ME35A or	Metal cutting and forming		3	0	--	03	40	60	100	3
		18ME35B	Metal Casting and Welding									
6	PCC	18ME36A or	Computer Aided Machine Drawing/		1	4	--	03	40	60	100	3
		18ME36B	Mechanical Measurements and Metrology		3	0						
7	PCC	18MEL37A or	Material Testing lab		--	2	2	03	40	60	100	2
		18MEL37B	Mechanical Measurements and Metrology lab									
8	PCC	18MEL38A	Workshop and Machine Shop Practice (Consists of Fitting, and Machining)		--	2	2	03	40	60	100	2
		18MEL38B	Foundry,Forging and Welding lab									
9	HSMC	18KVK39/49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPC39	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	**17 OR 19**	**10 OR 14**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39 Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP31	Additional Mathematics - I	Mathematics	02	01	--	03	40	60	100	0

a) The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

b) These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

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IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18MAT41	Mathematics	Mathematics	2	2	--	03	40	60	100	3
2	PCC	18ME42	Applied Thermodynamics		3	2	--	03	40	60	100	4
3	PCC	18ME43	Fluid Mechanics		3	0	--	03	40	60	100	3
4	PCC	18ME44	Kinematics of Machines		3	0	--	03	40	60	100	3
5	PCC	18ME45A	Metal cutting and forming		3	0	--	03	40	60	100	3
		18ME45B	Metal Casting and Welding									
6	PCC	18ME46A or	Computer Aided Machine Drawing/		1	4	--	03	40	60	100	3
		18ME46B	Mechanical Measurements and Metrology		3	0						
7	PCC	18MEL47A or	Material Testing lab		--	2	2	03	40	60	100	2
		18MEL47B	Mechanical Measurements and Metrology lab									
8	PCC	18MEL48A	Workshop and Machine Shop Practice (Consists of Fitting, and Machining)		--	2	2	03	40	60	100	2
		18MEL48B	Foundry, Forging and Welding lab									
9	HSMC	18KVK49/49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK49/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPH49	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
TOTAL					**17 OR 19**	**10 OR 14**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

18KVK39 Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP31	Additional Mathematics - I	Mathematics	02	01	--	03	40	60	100	0

(a) The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the student have to fulfill the requirements during subsequent semester/s to appear for SEE.
(b) These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

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V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18ME51	Management and Economics		2	2	--	03	40	60	100	3
2	PCC	18ME52	Design of Machine Elements I		3	2	--	03	40	60	100	4
3	PCC	18ME53	Dynamics of Machines		3	2	--	03	40	60	100	4
4	PCC	18ME54	Turbo Machines		3	--	--	03	40	60	100	3
5	PCC	18ME55	Fluid Power Engineering		3	--	--	03	40	60	100	3
6	PCC	18ME56	Operations Management		3	--	--	03	40	60	100	3
7	PCC	18MEL57	Fluid Mechanics/Machines lab		--	2	2	03	40	60	100	2
8	PCC	18MEL58	Energy Conversion Lab		--	2	2	03	40	60	100	2
9	HSMC	18CIV59	Environmental Studies	Civil/ Environmental [Paper setting: Civil Engineering Board]	1	--	--	02	40	60	100	1
				TOTAL	**18**	**10**	**04**	**26**	**360**	**540**	**900**	**25**

Note: PCC: Professional Core, HSMC: Humanity and Social Science.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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VI SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18ME61	Finite Element Methods		3	2	--	03	40	60	100	4
2	PCC	18ME62	Design of Machine Elements II		3	2	--	03	40	60	100	4
3	PCC	18ME63	Heat Transfer		3	2	--	03	40	60	100	4
4	PEC	18ME64X	Professional Elective -1		3	--	--	03	40	60	100	3
5	OEC	18ME65X	Open Elective -A		3	--	--	03	40	60	100	3
6	PCC	18MEL66	Computer Aided Modelling and Analysis Lab		--	2	2	03	40	60	100	2
7	PCC	18MEL67	Heat Transfer Lab		--	2	2	03	40	60	100	2
8	MP	18MEMP68	Mini-project		--	--	2	03	40	60	100	2
9	Internship	--	Internship	To be carried out during the vacation/s of VI and VII semesters and /or VII and VIII semesters.								
				TOTAL	**15**	**10**	**06**	**24**	**320**	**480**	**800**	**24**

Note: PCC: Professional core, PEC: Professional Elective, OE: Open Elective, MP: Mini-project.

Professional Elective -1

Course code under 18XX64X	Course Title	Course code under 18XX64X	Course Title
18ME641	**Non-Traditional Machining**	18ME644	**Vibrations and Noise Engineering**
18ME642	**Refrigeration and Air conditioning**	18ME645	**Composite Materials Technology**
18ME643	**Theory of Elasticity**	18ME646	**Entrepreneurship Development**

Open Elective -A

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX65X).

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Mini-project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the Mini-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college.
The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Mini-project:
(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.
Internship: All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18ME71	Control Engineering		3	--	--	03	40	60	100	3
2	PCC	18ME72	Computer Aided Design and Manufacturing		3	--	--	03	40	60	100	3
3	PEC	18ME73X	Professional Elective - 2		3	--	--	03	40	60	100	3
4	PEC	18ME74X	Professional Elective - 3		3	--	--	03	40	60	100	3
5	OEC	18ME75X	Open Elective -B		3	--	--	03	40	60	100	3
6	PCC	18MEL76	Computer Integrated Manufacturing Lab		--	2	2	03	40	60	100	2
	PCC	18MEL77	Design Lab		--	2	2	03	40	60	100	2
7	Project	18MEP78	Project Work Phase - 1		--	--	2	--	100	--	100	1
8	Internship	--	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	**15**	**04**	**06**	**18**	**340**	**360**	**700**	**20**

Professional Elective - 2

Course code under 18XX73X	Course Title	Course code under 18XX73X	Course Title
18ME731	**Design for Manufacture**	18ME734	**Total Quality Management**
18ME732	**Automation and Robotics**	18ME735	**Operations Research**
18ME733	**Computational Fluid Dynamics**		

Professional Electives - 3

Course code under 18XX74X	Course Title	Course code under 18XX74X	Course Title
18ME741	**Additive Manufacturing**	18ME744	**Mechatronics**
18ME742	**Emerging Sustainable Building Cooling Technologies**	18ME745	**Project Management**
18ME743	**Theory of Plasticity**		

Open Elective -B

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX75X).

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or6.

CIE procedure for Project Work Phase - 1:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Internship: All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the Internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18ME81	**Energy Engineering**		3	--	--	03	40	60	100	3
2	PEC	18ME82X	**Professional Elective - 4**		3	--	--	03	40	60	100	3
3	Project	18MEP83	**Project Work Phase - 2**		--	--	2	03	40	60	100	8
4	Seminar	18MES84	**Technical Seminar**		--	--	2	03	100	--	100	1
5	Internship	18XXI85	Internship	Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.)				03	40	60	100	3
				TOTAL	**06**	**--**	**04**	**15**	**260**	**240**	**500**	**18**

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4			
Course code under 18XX82X	**Course Title**	**Course code under 18XX82X**	**Course Title**
18ME821	**CNC Machine Tools**	18ME824	**Automobile Engineering**
18ME822	**Tribology**	18ME825	**Tool Design**
18ME823	**Non-Destructive Testing and Evaluation**	18ME826	**Fracture Mechanics**

Project Work

CIE procedure for Project Work Phase - 2:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:

(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

(ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.

Internship: Those, who have not pursued /completed the internship, shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

Activity points of the students who have earned the prescribed AICTE activity Points shall be sent the University along with the CIE marks of 8th semester. In case of students who have not satisfied the AICTE activity Points at the end of eighth semester, the column under activity Points shall be marked NSAP (Not Satisfied Activity Points).

B.E. Mechanical Engineering
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

OPEN ELECTIVE - A

Course Code	18ME65X	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl. No.	Board and the Department offering the Electives		Course Sl. No.	Course code under 18XX65X	Course Title
1	ME	Mechanical Engineering	1	18ME651	**Non-Conventional Energy Sources**
			2	18ME652	**World Class Manufacturing**
			3	18ME653	**Supply Chain Management**
			4	18ME654	**Advanced Materials Technology**

B.E Mechanical Engineering
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

OPEN ELECTIVE - B

Course Code	18ME75X	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl NO	Board and the Department offering the Electives		Course Sl No	Course code under 18XX75X	Course Title
2	ME	Mechanical Engineering	1	18ME751	**Energy and Environment**
			2	18ME752	**Automotive Engineering**
			3	18ME753	**Industrial Safety**
			4	18ME754	**Optimization Techniques**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech COMPUTER NETWORK ENGINEERING (SCN)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	CourseTitle	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18SCN11	MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE	04	--	03	40	60	100	4
2	PCC	18SCN12	Advances in Computer Networks	04	--	03	40	60	100	4
3	PCC	18SCN13	Information and Network Security	04	--	03	40	60	100	4
4	PCC	18SCN14	Internet of Things	04	--	03	40	60	100	4
5	PEC	18SCN15X	Professional Elective -1	04	--	03	40	60	100	4
6	PCC	18SCNL16	Computer Networks And Iot Laboratory	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1

Course Code under 18SCN15X	Course title
18SCN151	Wireless Networks & Mobile Computing
18SCN152	Multi Core Architecture and Programming
18SCN153	Social Network Analysis
18SCN154	Cloud Security

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted forthe same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech COMPUTER NETWORK ENGINEERING (SCN)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18SCN21	Multimedia Communications	04	--	03	40	60	100	4
2	PCC	18SCN22	Network Programming	04	--	03	40	60	100	4
3	PCC	18SCN23	Wireless Ad hoc Networks	04	--	03	40	60	100	4
4	PEC	18SCN24X	Professional elective 2	04	--	03	40	60	100	4
5	PEC	18SCN25X	Professional elective 3	04	--	03	40	60	100	4
6	PCC	18SCNL26	Mini Project	--	04	03	40	60	100	2
7	PCC	18SCN27	Technical Seminar	--	02	--	100	--	100	2
			TOTAL	**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 2		Professional Elective 3	
Course Code under 18SCN24X	**Course title**	**Course Code under 18SCN25X**	**Course title**
18SCN241	Advances in Storage Area Network	18SCN251	Wireless Sensor Networks
18SCN242	Switching & Statistical Multiplexing In Telecommunications	18SCN252	Managing Big Data
18SCN243	Ethernet Technology	18SCN253	Network Management
18SCN244	Mobile Application Development	18SCN254	Advances In Operating Systems

Note:

1. Technical Seminar:CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester.Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech COMPUTER NETWORK ENGINEERING (SCN)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18SCN31	Cloud Computing	04	--	03	40	60	100	4
2	PEC	18SCN32X	Professional elective4	04	--	03	40	60	100	4
3	PEC	18SCN33X	Professional elective 5	04	--	03	40	60	100	4
4	Project	18SCN34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	Intenship	18SCNI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 4		Professional elective 5	
Course Code under 18SCN32X	**Course title**	**Course Code under 18SCN33X**	**Course title**
18SCN321	Computer Systems Performance Analysis	18SCN331	Analysis of Computer Networks
18SCN322	Network Routing Algorithm	18SCN332	Protocol Engineering
18SCN323	Information Security Policies in Industry	18SCN333	Web Engineering
18SCN324	Machine Learning Techniques	18SCN334	Web Mining

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfying the internship requirements.

Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech COMPUTER NETWORK ENGINEERING (SCN)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	18SCN41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Visvesvaraya Technological University, Belagavi
Tentative Scheme of Teaching and Evaluation
PG Programmes
(w. e. f. Academic year 2018-19)
(Common to Design Engineering/Machine Design/ Engineering Analysis and Design)

28-07-2018

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018 - 19
M.Tech (MMD, MDE & MEA)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Field work/Assignment	Durationinhours	CIE Marks	SEE Marks	TotalMarks	
1	PCC	**18MDE11**	**Mathematical Methods in Engineering**	04	--	03	40	60	100	4
2	PCC	**18MDE12**	**Advanced Theory of Vibrations**	04	--	03	40	60	100	4
3	PCC	**18MDE13**	**Continuum Mechanics**	04	--	03	40	60	100	4
4	PCC	**18MDE14**	**Dynamics and Mechanism Design**	04	--	03	40	60	100	4
5	PEC	**18MDE15**	**Fracture Mechanics**	04	--	03	40	60	100	4
6	PCC	**18MDEL16**	**Design Laboratory 1**	-	04	03	40	60	100	2
7	PCC	**18RMI17**	**Research Methodology and IPR**	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018 - 19
M.Tech (MMD, MDE & MEA)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/Fieldwork/Assignment	Duration inhours	CIE Marks	SEE Marks	Total Marks	
1	PCC	**18MEA21**	**Finite Element Methods**	04	--	03	40	60	100	4
2	PCC	**18MDE22**	**Advanced Machine design**	04	--	03	40	60	100	4
3	PCC	**18MDE23**	**Tribology and Bearing Design**	04	--	03	40	60	100	4
4	PEC	**18XXX24X**	**Professional elective 1**	04	--	03	40	60	100	4
5	PEC	**18XXX25X**	**Professional elective 2**	04	--	03	40	60	100	4
6	PCC	**18MDEL26**	**Design Laboratory 2**	--	04	03	40	60	100	2
7	PCC	**18MDE27**	**Technical Seminar**	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		Professional Elective 2	
Course Code under 18XXX24X	**Course title**	**Course Code under 18XXX25X**	**Course title**
18MDE241	**Material Handling Equipment Design**	**18CAE251**	**Design Optimization**
18MEA242	**Computer Applications in Design**	**18MEA252**	**Automobile System Design**
18MDE243	**Rotor Dynamics**	**18MEA253**	**Computational Fluid Dynamics**

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018 - 19
M.Tech (MMD, MDE & MEA)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
					Practical/	uration in hours	E Marks	SEE Marks	Total Marks	
1	PCC	**18MDE31**	**Design for manufacture and assembly**	04	--	03	40	60	100	4
2	PEC	**18XXX32X**	**Professional elective 3**	04	--	03	40	60	100	4
3	PEC	**18XXX33X**	**Professional elective 4**	04	--	03	40	60	100	4
4	Project	**18MDE34**	**Evaluation of Project phase -1**	--	02	--	100	--	100	2
5	Intenship	**18MDEI35**	**Internship**	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				**12**	**02**	**12**	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		Professional elective 4	
Course Code under 18XXX32X	**Course title**	**Course Code under 18XXX32X**	**Course title**
18CAE321	**Experimental Mechanics**	**18CAE331**	**Smart materials and Structures**
18MDE322	**Mechatronics System Design**	**18MDE332**	**Composite Materials Technology**
18MEA323	**Robust Design**	**18MDE333**	**Acoustics and Noise Control Engineering**

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.
SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent university examinations after satisfying the internship requirements.
Internship SEE (University examination) shall be as per the university norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAG AVI
Schem e of Teaching and Examination – 2018 - 19
M.Tech. (MMD, MDE & MEA)
Outcome Based E ducation(OBE) and Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/Fieldwork/Assignment	Duration inhours	CIE Marks	SEE MarksVivavoce	Total Marks	
1	Project	**18MDE41**	**Project work phase -2**	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:
1. Project Phase-2:

CIE marks shall be awarded by a comm ittee comprising of HoD as Chairman, guide/co-guide, if any, and a senior faculty of the department. The CIE marks awarded for project work phase-2 shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examin ation (SEE), after satisfying the plagiarism check, shall be as per the un iversity norms.

I SEMESTER

ADVANCED THEORY OF VIBRATIONS

(Common toMDE, MEA, MMD, CAE)

Course Code	**18MDE12**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To understand the theoreticalprinciplesof vibration,andvibrationanalysistechniquesfor thepracticalsolutionof vibration problems.
CL02	To understand theimportanceofvibrations in design ofmachineparts subject to vibrations.
CL03	To understand the concepts of Transient and Non-linear vibrations.
CL04	To understand concepts of vibration measurements and its applications.
CL05	To understand the principles of Transient and Non linear vibrations.

Course Content:

Module 1:ReviewofMechanicalVibrations:Basicconcepts;freevibrationofsingledegreeoffreedomsystemswithandwithoutdamping,forced vibration ofsingleDOF-systems, Natural frequency. VibrationControl:Introduction,Vibrationisolationtheory,Vibrationisolationandmotionisolationforharmonicexcitation,practical aspects ofvibration analysis, vibration isolation, Dynamicvibration absorbers, and Vibration dampers **12 Hours**

Module 2: VibrationMeasurementandapplications: Introduction,Transducers,Vibrationpickups,Frequencymeasuringinstruments,Vibration exciters, Signal analysis.

Modal analysis &Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Conditionmonitoring anddiagnosis.

10 Hours

Module 3:TransientVibrationofsingleDegree-offreedomsystems:Impulseexcitation,arbitraryexcitation,Laplacetransformformulation,Pulse excitation and risetime, Shock responsespectrum, Shock isolation. RandomVibrations:Randomphenomena,Timeaveragingandexpectedvalue,Frequencyresponsefunction,Probabilitydistribution, Correlation, Powerspectrum and powerspectral density,Fouriertransforms and response.

10 Hours

Module 4:NonLinearVibrations:Introduction,Sourcesofnonlinearity,Qualitativeanalysisofnonlinear systems.Phaseplane,Conservativesystems,Stabilityofequilibrium,Methodofisoclines,Perturbationmethod,Methodofiteration, Self-excited oscillations.

10 Hours

Module 5: Continuous Systems: Vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.

08 Hours

CourseOutcomes:

Upon completion of this course, students will be able to:

C01	Apply Newtons equation of motion and energy methods to model basic vibrating mechanical system, model undamped and damped mechanical systems and structures for free and harmonically forced vibrations.
C02	Model single-and multi-degree of freedom for free and forced vibrations and determine response to vibration, natural frequencies and modes of vibration.
C03	Apply the fundamentals of vibration to its measurement and analysis.
C04	Solverealisticvibrationproblems in mechanicalengineeringdesign that involves application ofmost ofthe coursesyllabus.

TextBooks

1. S. S. Rao, “ MechanicalVibrations” , Pearson Education, 4th edition.
2. S. Graham Kelly,“ Fundamentals ofMechanicalVibration” -McGraw-Hill, 2000
3. Theoryof Vibration with Application, -William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition PearsonEducation.

ReferenceBooks

1. S. Graham Kelly,“ Mechanical Vibrations” , Schaum’ s Outlines, TataMcGraw Hill, 2007.
2. C Sujatha,“ Vibrations and Acoustics – Measurements and signalanalysis” , Tata McGraw Hill, 2010.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

CONTINUUM MECHANICS
(Common to MDE, MEA, MMD)

Course Code	**18MDE13**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To expose the students to the field of Continuum Mechanics.
CL02	To understand elastic behavior of materials (hyper elasticity, linear elasticity) and plasticity (basic concepts of small strain and large strain plasticity).
CL03	Introduce student to basic notion and rules of tensor calculus as well as basic idea and laws of continuum mechanics.
CL04	To learn the fundamentals of analysis of stresses, deformation and strain, generalised Hooke's law, two dimensional problems, and viscoelastic equations.

Course Content:

Module 1:Analysis of Stress: Definition and Notation for forces and stresses. Body force, surface force, components of stresses, equations of equilibrium, specification of stress at a point. Principal stresses, maximum and minimum shear stress, Mohr's diagram in three dimensions. Boundary conditions. Stress components on an arbitrary plane, stress invariants, octahedral stresses, decomposition of state of stress, deviator and spherical stress tensors, stress transformation.

10 Hours

Module 2:Deformation and Strain: Deformation, strain Displacement relations, strain components, The state of strain at a point, , Principal strain, strain invariants, Strain transformation, Compatibility equations, Cubical dilatation, spherical and deviator strains, plane strain, Mohr's circle, and compatibility equation

Relations and the General Equations of Elasticity: Generalized Hooke's; law in terms of engineering constants. Formulation of elasticity Problems.

10 Hours

Module 3: Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation of simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems.

Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal theorem.

10 Hours

Module 4: Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis, strain components in polar co-ordinates, Rotating disk and cylinder, Concentrated force on semi-infinite plane, Stress concentration around a circular hole in an infinite plate.

Thermal Stresses: Introduction, Thermo-elastic stress -strain relations, thin circular disc, long circular cylinder. **10 Hours**

Module 5: Torsion of Prismatic Bars: Introduction, Torsion of circular cross section bars, Torsion of elliptical cross section bars, Soap film analogy, Membrane analogy, Torsion of thin walled open tubes.

Elastic Stability: Axial compression of prismatic bars, Elastic stability, buckling load for column with constant cross section.

Viscoelasticity: Linear Viscoelastic behavior. Simple viscoelastic models-generalized models, linear differential operator equation. Creep and Relaxation- creep function, relaxation function, hereditary integrals. Complex modulii and compliances. (Note: No numericals)

10 Hours

Course Outcomes:

At the end of the course, students should be able to:

	Treat general stresses and deformations in continuous materials.
	Formulate and solve specific technical problems of displacement, strain and stress.
	Perform experiments with stresses and deformations.
	Model and analyse the stresses and deformations of simple geometries under an arbitrary load in solids.

C01
C02
C03
C04

Text Books:

1 Timoshenko and Goodier, "Theory of Elasticity"-'Tata McGraw Hill, New Delhi,3rd edition , 1970

2. L S Srinath “Advanced Mechanics of Solids”- Tata McGraw Hill, New Delhi, 3rd edition, 2010

3 G. Thomas Mase, Ronald E. Smelser, George. E. Mase, Continuum Mechanics for Engineers, 3rd Edition, CRC Press,Boca Raton, 2010

References:

1. Batra, R. C., Elements of Continuum Mechanics, Reston, 2006.
2. George E. Mase, Schaum's Outline of Continuum Mechanics, McGraw-Hill, 1970
3. Dill, Ellis Harold, Continuum Mechanics: Elasticity, Plasticity, Viscoelasticity, CRC Press , 2006.
4. Sadhu Singh," Theory of Elasticity"- Khanna publisher, 4th edition, 2013

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

DYNAMICS AND MECHANISM DESIGN

(Common to MDE, MEA, MMD)

Course Code	**18MDE14**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To provide a theoretical and practical foundation for analysis and design of articulated mechanical systems for desired applications.
CL02	evelop skills to analyze the displacement, velocity, and acceleration of mechanisms.
CL03	Improve understanding of the synthesis of mechanismsfor given tasks
CL04	To includedynamics considerations in thedesignofmechanisms forengineeringapplications.

Course Content:

Module 1:GeometryofMotion: Introduction,analysisandsynthesis,Mechanismterminology,planar,Sphericalan dspatialmechanisms,mobility, Grashoffslaw,Equivalentmechanisms,uniquemechanisms.
Kinematicanalysisofplanemechanisms: Auxiliarypointmethodusing rotated velocityvector, Hall - Ault auxiliarypoint method, Goodman's indirect method. Numerical examples.

08 Hours

Module 2:GeneralizedPrinciplesofDynamics: Fundamentallawsofmotion,generalizedcoordinates,configurati onspace,constraints, v irtual work,principleofvirtualwork,energy andmomentum, workandkineticenergy,andstability,kineticenergyofasystem, angular momentum,generalizedmomentum.

Lagrange'sEquation: Lagrange'sequationfromD'Alembert'sprinciples,examples, Hamiltonsequations,Hamiltonsprinciple,Lagrange'sequationfromHamiltonsprinciple,Derivationof Hamiltonsequations,numerical examples. **12 Hours**

Module 3: SynthesisofLinkages: Type,number,anddimensionalsynthesis, function generation,pathgenerationandbodyguidance,precisionpositions,structuralerror,Chebychevspacing.T wopositionsynthesisof slider crankmechanisms, crank-rocker mechanismswithoptimumtransmissionangle.

MotionGeneration: Polesandrelative poles, Location ofpoles andrelativepoles, polode, curvature,Inflection circle,numerical examples.

10 Hours

Module 4:GraphicalMethodsofDimensionalSynthesis: Twopositionsynthesisofcrankandrockermechanisms,t hreepositionsynthesis,four positionsynthesis(pointprecisionreduction),Overlaymethod,Couplercurvesynthesis,Cognatelinkages.
Ana1yticalMethodsof DimensionalSynthesis: Freudenstein'sequationforfourbarmechanismandslidercrankmechanism,exa

mples,Bloch'smethodof synthesis, analytical synthesis usingcomplexalgebra.

12 Hours

Module 5:

SystemDynamics: Gyroscopicactioninmachines,Euler'sequationofmotion,PhasePlanerepresentation,PhaseplaneAnalysis, Response ofLinear Systemstotransientdisturbances.

Spatial Mechanisms: Introduction, Positionanalysis problem, Velocity and acceleration analysis, Eulerian angles, numerical examples. **08 Hours**

Course Outcomes:

At the end of the course, students will be able to:

C01	Apply the tools of analytical dynamics with the main goal of developing mathematical models that describe the dynamics of systems of rigid bodies.
C02	Formulate equations of motion for complicated mechanical systems /linkages and hods for solving these equations.
C03	Understand multi body dynamics in mechanical engineering design.

Text Books:

1. K.J.Waldron&G.L.Kinzel , "Kinematics, Dynamics and Design of Machinery", Wiley India, 2007.
2. Greenwood , "Classical Dynamics", Prentice Hall of India, 1988.

References Books:

1. J E Shigley, "Theory of Machines and Mechanism" -McGraw-Hill, 1995
2. A.G.Ambekar , "Mechanism and Machine Theory", PHI, 2007.
3. Ghosh and Mallick , "Theory of Mechanism and Mechanism", East West press 2007.
4. David H. Myszka , "Machines and Mechanisms", Pearson Education, 2005.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

FRACTURE MECHANICS
(Common to MDE, MEA, MMD)

Course Code	**18MDE15**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To understand the design principle of materials and structures using fracture mechanics approaches.
CL02	To introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design.
CL03	To develop the ability in students to compute the stress intensity factor, strain energy release rateand the stress and strain fields around a crack tip for linear and non linear materials.
CL04	To prepare the students for broader applications of fracture mechanics in material testing,evaluation,characterization, and material selection.

Course Content:

Module 1: Fracture mechanics principles: Introduction and historical review, sources of micro and macro cracks. stress concentration due to elliptical hole, strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, numerical problems. The Airy stress function, complex stress function, solution to crack problems, effect of finite size, special cases, elliptical cracks, numerical problems.

10 Hours

Module 2: Plasticity effects, Irwin plastic zone correction, and Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, plastic constraint factor. The thickness effect, and numerical problems.

Determination of stress intensity factors and plane strain fracture toughness: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors.

Plane strain fracture toughness test; standard test, and specimen size requirements.

10 Hours

Module 3: The energy release rate, and criteria for crack growth. The crack resistance (R curve), compliance, J integral, tearing modulus and stability.

Elastic Plastic Fracture Mechanics (EPFM): Fracture beyond general yield. The crack-tip opening displacement, the use of CTOD criteria, and experimental determination of CTOD. Parameters affecting the critical CTOD, use of J integral, and limitation of J integral.

10 Hours

Module 4: Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.**

10 Hours

Module 5: Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, mixed mode (combined) loading and design criteria.

10 Hours

Course Outcomes:

At the end of the course students will:

C01	Develop basic fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
C02	Be able to select appropriate materials for engineering structures to insure damage tolerance.
C03	Learn to employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.

C04	Understand the relationship between crack tip opening displacement, SIF and ERR and application of such parameters for ductile and brittle materials.
C05	Understanding of experimental techniques to determine the critical values of parameters at crack tip.
C06	Understand and appreciate of the status of academic research in field of fracture mechanics.

Text Books:

1. David Broek, "Elementary Engineering Fracture Mechanics", Springer Netherlands,2011
2. Anderson , "Fracture Mechanics-Fundamental and Application", T.L CRC press1998.

Reference Books:

1. Karen Hellan , "Introduction to fracture mechanics", McGraw Hill, 2nd Edition
2. S.A. Meguid , "Engineering fracture mechanics" Elsevier Applied Science, 1989
3. Jayatilaka, "Fracture of Engineering Brittle Materials", Applied Science Publishers, 1979
4. Rolfe and Barsom , "Fracture and Fatigue Control in Structures" , Prentice Hall, 1977
5. Knott , "Fundamentals of fracture mechanisms", Butterworths, 1973

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

DESIGN LABORATORY-I
(Common to MDE, MEA, MMD)

Course Code	**18MDEL16**	**CIE Marks**	**40**
Number of Practical Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam Hours**	**03**

Note:
1. These are independent laboratory exercises.
2. Student must submit a comprehensive report on the problems solved and give a presentation on the same for Internal Evaluation.
3. Any one of the experiments done from the following list has to be set in the examination for conduction and evaluation.

Experiment #1
Experimental and Numerical Analysis of Tensile Test
Part A: Experimental study of Tensile Test
Part B: Numerical Analysis of Tensile Test.

Experiment #2
Experimental and Numerical Analysis of Flexural Test

Part A: Experimental study of Flexural Test
Part B: Numerical Analysis of Flexural Test.

Experiment #3
Numerically Calculation and MATLAB Simulation
Part A: Invariants, Principal stresses and strains with directions
Part A: Maximum shear stresses and strains and planes, Von-Mises stress
Part C: Calculate and Plot Stresses in Thick-Walled Cylinder

Experiment #4
Stress analysis of rectangular plate with circular hole under i. Uniform Tension and ii. shear Part A: Matlab simulation for Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate
Part B: Modeling of plate geometry under chosen load conditions and study the effect of plate geometry.
Part C: Numerical Analysis using FEA package.

Experiment #5
Single edge notched beam in four point bending.
Part A: Modeling of single edge notched beam in four point bending.
Part B: Numerical Studies using FEA.
Part C: Correlation Studies.

Experimental #6
Torsion of Prismatic bar with Rectangular cross-section.
Part A: Elastic solutions, MATLAB Simulation
Part B: Finite Element Analysis of any chosen geometry. Part C: Correlation studies.

Experiment #7
Contact Stress Analysis of Circular Disc under diametrical compression
Part A: 3-D Modeling of Circular Discs with valid literature background, supported with experimental results on contact stress.
Part B: Numerical Analysis using any FEA package.
Part C: 2D Photo Elastic Investigation.

Experiment #8
Vibration Characteristics of a Spring Mass Damper System.
Part A: Analytical Solutions.
Part B: MATLAB Simulation. Part C: Correlation Studies.

II Semester

FINITE ELEMENT METHOD

(Common to MDE, MEA, MMD, CAE)

Course Code	**18MEA21**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To present the Finite element method (FEM) as a numerical method for engineering analysis of continua and structures.
CL02	To present Finite element formulation using variational and weighted residual approaches.
CL03	To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems.
CL04	Learn to model complex geometry problems and technique of solutions.

Course Content:

Module 1: Introduction to finite element method: basic steps in finite element method to solve mechanical engineering problems (solid, fluid and heat transfer). Functional approach and Galerkin approach. Displacement approach: admissible functions. Convergence criteria: conforming and nonconforming elements, C0, C1 and Cn continuity elements. Basic equations, element characteristic equations, assembly procedure, boundary and constraint conditions.

10 Hours.

Module 2: Solid Mechanics: One-dimensional finite element formulations and analysis – bars- uniform, varying and stepped cross section. Basic (Linear) and higher order elements formulations for axial, torsional and temperature loads with problems.

Beams- basic (linear) element formulation-for uniform, varying and stepped cross section-for different loading and boundary conditions, numericals.

Trusses, Plane frames and Space frame – basic (Linear) elements formulations for different boundary conditions -axial, bending, torsional, and temperature loads, numericals.

10 Hours.

Module 3: Two dimensional finite element formulations for solid mechanics problems: triangular membrane (tria 3, tria 6, tria 10) element, fournoded quadrilateral membrane (quad 4, quad 8) element formulations for in-plane loading with simple problems.

Triangular and quadrilateral axi-symmetric basic and higher order elements formulation for axi-symmetric loading with simple numericals.

Three dimensional finite element formulations for solid mechanics problems: finite element formulation of tetrahedral element (tet 4, tet 10), hexahedral element (hexa 8, hexa 20), for different loading conditions. Serendipity and Lagrange family elements.

10 Hours.

Module 4: Finite element formulations for structural mechanics problems: Basics of plates and shell theories: classical thin plate theory, shear deformation theory and thick plate theory. Finite element formulations for triangular and quadrilateral plate elements. Finite element formulation of flat, curved, cylindrical and conical shell elements.

10 Hours.

Module 5: Dynamic analysis: finite element formulation for point/lumped mass and distributed masses system, finite element formulation of one dimensional dynamic analysis: bar, truss, frame and beam element. Finite element formulation of two dimensional dynamic analysis: triangular membrane and axi-symmetric element, quadrilateral membrane and axi-symmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.

10 Hours.

Course Outcomes:
At the end of this course, students should be able to:

C01	Understand the concepts of Variational methods and Weighted residual methods.
C02	Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3D element.
C03	Develop element characteristic equations and generate global stiffness equations.
C04	Apply suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
C05	Identify how the finite element method expands beyond the structural domain, for problems involving dynamics and heat transfer.

Text Books:

1. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.
2. Lakshminarayana H. V., Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

Reference Books:

1. Rao S. S, Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006
2. P.Seshu, Textbook of Finite Element Analysis, PHI, 2004.
3. J.N.Reddy, Introduction to Finite Element Method, mcgraw -Hill, 2006.
4. Bathe K. J, Finite Element Procedures, Prentice-Hall, 2006..
5. Cook R. D., Finite Element Modeling for Stress Analysis, Wiley,1995.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

ADVANCED MACHINE DESIGN

(Common toMDE, MEA, MMD, CAE)

Course Code	**18MDE22**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To identify failure modes and evolve design by analysis methodology.
CL02	To understand the theories of failure relating to different ductile and brittle materials.
CL03	To understand the concept of fatigue testing of materials including criteria for fatigue design and different fatigue life models.
CL04	To understand the concepts of the stress life behavior, strain life behavior and factors influencing stress life behavior and strain life behavior.
CL05	To understand the concept of crack nucleation, crack growth and fracture of materials using fundamentals of linear elastic fracture mechanics.
CL06	To gain the knowledge of various cumulative damage theories and different cycle counting methods relating to fatigue from variable amplitude loading.
CL07	To understand the different surface failure mechanisms with stress distribution of various contact surfaces.
CL08	To learn fundamental approaches to failure prevention for static and repeated loading.

Course Content:

Module 1:
Introduction: Roleoffailurepreventionanalysisinmechanicaldesign,Modesofmechanicalfailure,Reviewoffailuretheoriesfor ductile and brittlematerials includingMohr’ s theoryand modified Mohr’ stheory.Numerical examples.
FatigueofMaterials:Introductory concepts,Highcycleandlowcyclefatigue,Fatiguedesignmodels,Fatiguedesignmethods,Fatigue designcriteria,Fatiguetesting,Testmethodsandstandardtestspecimens,Fatigue fracture surfacesandmacroscopic features,Fatiguemechanisms and microscopic features.

10 Hours

Module 2: Stress-Life(S-N)Approach:S-Ncurves,Statisticalnatureoffatiguetestdata,GeneralS-Nbehavior,Meanstresseffects,Different factorsinfluencing S-N behaviour,S-Ncurve representationandapproximations,Constantlifediagrams,Fatiguelifeestimationusing S- N approach.
Strain-Life(ε-N)approach:Monotonic stress-strainbehavior

,Straincontrolledtestmethods,Cyclicstress-strainbehavior,Strainbased approachtolife estimation,Determinationofstrainlife fatigue properties,Meanstresseffects,Effectofsurface finish,Life estimationby ε-N approach.

10 Hours

Module

3:LEFMApproach:LEFMconcepts,Cracktipplasticzone,Fracturetoughness,Fatiguecrackgrowth,Meanstresseffects,Crackgrowth lifeestimation.

Notchesandtheireffects:Concentrationsandgradientsinstressandstrain,S-Napproachfornotchedmembranes,mean StresseffectsandHaighdiagrams,Numerical examples.

10 Hours

Module 4:

FatiguefromVariableAmplitudeLoading: Spectrumloadsandcumulativedamage,Damagequantificationandtheconceptsofdamage fractionandaccumulation,Cumulativedamagetheories,Loadinteractionandsequence effects,Cyclecounting methods,Lifeestimation usingstress lifeapproach. Numerical examples.

Notchstrainanalysis: Strain– lifeapproach,Neuber' srule,Glinka' srule,applicationsof fracturemechanics to crack growth at notches. Numerical examples. **10 Hours**

Module

5:SurfaceFailure: Introduction,Surfacegeometry,Matingsurface,Friction,Adhesivewear,Abrasivewear,Corrosionwear.

Surface fatigue: spherical contact, Cylindrical contact, General contact, Dynamiccontact stresses, Surfacefatiguestrength, Surface fatigue failure modes, Design to avoid Surface failures. **10 Hours**

CourseOutcomes:

Upon completion of this course, students will be able to:

C01	Apply stateofthe art design methodologynamelydesign byanalysisand damagetolerant design to mechanical components.
C02	Distinguish different design criteria and their procedure to carry out the design of mechanical components.
C03	Design machine components which are subjected to fluctuating loads.
C04	Design machine components using techniques like stress life approach, Strain life approach and Fracture mechanics approach.
C05	Define the various statistical aspects of fatigue using different probability distribution plots.
C06	Explain the contact stresses and implementation of Hertz contact phenomenon to the real field problem.
C07	Explain surface failure mechanisms.

TextBooks:

1. RalphI. Stephens,Ali Fatemi, Robert, Henryo. Fuchs, " MetalFatiguein engineering" , John WileyNew York, Second edition. 2001.
2. FailureofMaterials in Mechanical Design, Jack.A. Collins,John Wiley,New York 1992.

3. RobertL.Norton , “ Machine Design” , Pearson EducationIndia, 2000.

ReferenceBooks:

1. S.Suresh , “ FatigueofMaterials” , Cambridge UniversityPress, -1998
2. Julie.A.Benantine, “ Fundamentals ofMetalFatigue Analysis” , PrenticeHall,1990
3. Fatigue andFracture, ASM Hand Book, Vol 19,2002.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

TRIBOLOGY AND BEARING DESIGN
(Common to MDE, MEA, MMD)

Course Code	**18MDE23**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To understand the fundamental principles of lubrication for reduction of friction and wear.
CL02	To understand the principles for selecting compatible materials for minimizing friction and wear in machinery.
CL03	To understand the principles of hydrodynamic and hydrostatic lubrication and their design and applications.
CL04	To Understand the principles of bearing selection and bearing arrangement in machines.
CL05	To learn the computations required for selecting and designing bearings in machines.
CL06	To understand the fundamental principles of high contact stresses (Hertz stresses), fatigue-failure, and Elasto- hydrodynamic (EHD) lubrication in rolling bearings and gears.
CL07	To understand the factors influencing the design and selection of Porous and Magnetic bearings.

Course Content:

Module 1: Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Effect of pressure
and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary

parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems. **8 Hours Module 2: Hydrodynamic Lubrication:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold's equation in two dimensions

with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression

for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems

Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.

12 Hours

Module 3:Hydrostatic Bearings: Hydrostatic thrust bearings , hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and

hydrostatic journal bearings.

EHL Contacts: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.

10 Hours

Module 4:Antifriction bearings: Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings.

Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings,Equations for porous bearings and working principal, Fretting phenomenon and its stages.

10 Hours

Module 5: Magnetic Bearings: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

10 Hours

Course Outcomes:

Upon completion of this course, students will be able to:

C01	Design or choose efficient tribological systems such as rolling element bearings, hydrodynamic bearings, and dry sliding bearings, for the needs of a specific application.
C02	Select compatible materials for minimizing friction and wear in machinery.
C03	Explain the concepts advanced bearings like magnetic bearings, porous bearings and gas lubricated bearings.

Text Books:

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press

Company, 2000.

Reference Books:

1. Dudley D.Fulier " Theory and practice of Lubrication for Engineers", New York Company.1998
2. Moore "Principles and applications of Tribology", Pergamon press, 1975.
3. Oscar Pinkus, BenoSternlicht, ‘‘Theory of hydrodynamic lubrication’’, McGraw-Hill, 1961.
4. G W Stachowiak, A W Batchelor , ‘‘Engineering Tribology’’, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 1

MATERIAL HANDLING EQUIPMENT DESIGN
(Common to MDE, MEA, MMD)

Course Code	**18MDE241**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

This subject provides students with:

A basic understanding of material handling facilities and the fundamental principles of material handling;

A quantitative techniques for designing material handling systems and an understandingof their limitations;

An understanding of safety issues and regulations in material handling.

Module 1: Introduction: Elements of Material Handling System,Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipment.

Selection of Material Handling Equipment: Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of

Material Handling Systems; functions and parameters affecting service; packing and storage of materials. **10 Hours**

Module 2: Conveyor Design: Introduction to apron conveyors, Pneumatic conveyors, Belt Conveyors, Screw conveyors and vibratory conveyors and theirapplications, Design of Belt conveyor-Belt selection procedure and calculation of drop energy, Idler design.

10 Hours

Module 3: Design of hoisting elements: Welded and roller chains -Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs-lifting magnets - Grabbing attachments -Design of arresting gear -Brakes: shoe, band and cone types

10 Hours

Module 4: Design of cranes: Hand-propelled and electrically driven E.O.T overhead Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes. **10 Hours**

Module 5: Design of Bucket Elevators: Introduction, Types of Bucket Elevator, Design of Bucket Elevator - loading and bucket arrangements, Cage elevators , shaft way, guides, counter weights.

Packaging and storage of bulk materials: Steps for design of packages, protective packaging, testing the physical characteristics of packaging, container testing, types of storage and industrial containers, Automatic guided vehicles, Automatic storage and retrieval system. **10 Hours**

Course Outcomes:

At the end of the course, students will be able to:

C01	Select appropriate equipment for material handling and understand the basic roles of the different equipment.
C02	Apply appropriate techniques for improving existing material handling systems; recognize the importance of safety and applicatons of optimization techniques to material handling.

Reference Books:

1. Conveyor Equipment Manufacturer' s Association, " Belt conveyors for bulk materials" 6th edition,The New CEMA Book
2. Rudenko N., " Materials handling equipment " , Elnvee Publishers, 1970
3. Ishwar G Mulani and Mrs.Madhu I Mulani, " Engineering Science and application design for belt conveyor" , Madhu I. Mulani, 2002.
4. Spivakovsy A.O. and Dyachkov V.K., " Conveying Machines, Volumes I and II" , MIR Publishers, 1985.
5. Alexandrov, M., " Materials Handling Equipments " , MIR Publishers, 1981.
6. Boltzharol, A., " Materials Handling Handbook" , The Ronald press company 1958.
7. Kulwiac R. A., 'Material Handling Hand Book' , 2nd edition, JohnWilly Publication, NewYork.
8. James M. Apple, ' Material Handling System Design' , John-Willlwy and Sons Publication, NewYork.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 1

COMPUTER APPLICATIONS IN DESIGN
(Common to MDE,MEA,MMD)

Course Code	**18MEA242**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To understand the concepts and tools of computer applications as used in the engineering profession.
CL02	To learn the principles of CAD/CAM/CAE Systems, Graphics programming, Geometric Modeling Systems, CAD, CAM and CAE Integration, and standards for Communicating between Systems.
CL03	To learn to create technically correct surface and solid models that are common to and useful for visualization and problem solving mechanical engineering.

Course Content:

Module 1 : Introduction To CAD/CAM/CAE Systems: Overview, Definitions of CAD. CAM and CAE, Integrating the Design and Manufacturing Processes through a Common Database-A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example.

Components of CAD/CAM/CAE Systems: Hardware Components ,Vector-Refresh(Stroke-Refresh) Graphics Devices, Raster Graphics Devices, Hardware Configuration, Software Components, Windows-Based CAD Systems. **10 Hours**

Module 2:Basic Concepts of Graphics Programming : Graphics Libraries, Coordinate Systems, Window and Viewport, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden-Line and Hidden-Surface Removal, Back-Face Removal Algorithm, Depth-Sorting, or Painters, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System. Standards for communicating Between Systems: Exchange Methods of Product Definition

Data, Initial Graphics Exchange Specification, Drawing Interchange Format, Standard for the Exchange of Product Data. Tutorials, Computational exercises involving Geometric Modeling of components and their assemblies. **10 Hours**

Module 3: Geometric Modeling Systems: Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, Euler Operators, Boolean Operations, Calculation of Volumetric Properties, Non manifold Modeling Systems, Assembly Modeling Capabilities, Basic Functions of Assembly Modeling, Browsing an Assembly, Features of Concurrent Design, Use of Assembly models, Simplification of Assemblies, Web-Based Modeling. Representation and Manipulation of Curves: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermite Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve.

10 Hours

Module 4: B-Spline curve, evaluation of a B-Spline Curve, composition of B-Spline Curves, differentiation of a B-Spline curve, Non uniform Rational B-Spline (NURBS) Curve, evaluation of a NURBS curve, Differentiation of a NURBS curve, interpolation curves, Interpolation using a Hermite curve, Interpolation using a B-Spline curve, intersection of curves. Representation and Manipulation of Surfaces: Types of surface equations, Bilinear surface, Coon's Patch, Bicubic Patch, Bezier Surface, Evaluation of a Bezier Surface, Differentiation of a Bezier surface, B-Spline surface, evaluation of a -B-Spline surface, differentiation of a B-spline surface, NURBS surface, interpolation surface, intersection of surfaces. **10 Hours**

Module 5: CAD and CAM Integration: Overview of the Discrete Part Production Cycle, Process Planning, Manual Approach, Variant Approach, Generative Approach, Computer-Aided Process Planning Systems, CAM-ICAPP, MIPLAN and Multi CAPP, Met CAPP, ICEM-PART, Group Technology, Classification and Coding, existing Coding Systems, Product Data Management (PDM) Systems. **10 Hours**

Course Outcomes:

At the end of the course, students should be able to:

C01	Develop expertise in generation of various curves, surfaces and volumes used in geometric modeling systems.
C02	Design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
C03	Analyze a problem, and identify and define the computing requirements appropriate to its solution.

Text Books:

1. Kunwoo Lee, ‘‘Principles of CAD/CAM/CAE systems’’-Addison Wesley, 1999

2. Radhakrishnan. P., etal.,‘‘CAD/CAM/CIM’’-New Age International, 2008

Reference Books:

1. Ibrahim Zeid, ‘‘CAD/CAM – Theory & Practice’’, McGraw Hill, 1998.

2. Bedworth, Mark Henderson & Philip Wolfe, ‘‘Computer Integrated Design and

Manufacturing'' -McGraw hill inc., 1991.

3. Pro-Engineer, Part modeling Users Guide, 1998

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 1

ROTOR DYNAMICS

(Common to MDE, MEA, MMD)

Course Code	**18MDE243**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To understand the rotor dynamics phenomena with the help of simple rotor models and subsequently the modern analysis methods for real life rotor systems.
CL02	To understandmodelingofbearings,shaftsandrotorstages(compressors,turbines includingblades)to predict instabilitylike whirlingincluding gyroscopicand Corialis effect.

Course Content:

Module 1:

FluidFilmLubrication: Basictheoryoffluidfilmlubrication,derivationofgeneralizedReynoldsequations,boundaryconditions,fluid film stiffness and dampingcoefficients, stabilityand dynamic response forhydrodynamicjournal bearing, and two lobejournalbearings.

Stability ofFlexibleShafts: Introduction,equationofmotionofaflexibleshaftwithrigidsupport,radialelasticfrictionforces,rotary friction, friction Independent of velocity, friction dependent on frequency, different shaft stiffness constants, gyroscopic effects, nonlinearproblems oflargedeformation applied forces, instabilityofrotors in magneticfield.

12 Hours

Module 2:CriticalSpeed: Dunkerley'smethod,Rayleigh'smethod,Stodola'smethod.RotorBearing System:Instabilityofrotorsduetotheeffectof hydrodynamicoil layerin thebearings, support flexibility, simplemodelwith one concentrated mass at the center.

08 Hours

Module 3:

mentofelementtransfermatrices,the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions.

Module 4:Turborotor System Stability by Finite Element Formulation: General turborotor system, generalized forces and co-ordinates system, assembly element matrices, consistent mass matrix formulation, Lumped mass model, linearised model for journal bearings, system dynamic equations. Fix stability analysis, non-dimensional stability analysis, unbalance response and transient analysis. **12 Hours**

Module 5:Blade Vibration: Centrifugal effect, Transfer matrix and finite element approaches. **08 Hours**

Course Outcomes:

C01	Provides the student understanding of modeling rotating machine elements theoretically.
C02	Upon completion of this course, students will have gained an understanding of the design, application, and reliability evaluation of bearings in rotating machinery applications.

Reference Books:

1. Cameron, “Principles of Lubrication”, Longman Publishing Group, 1986
2. Bolotin , “Nonconservative problems of the Theory of elastic stability”, Macmillan, 1963
3. Peztel, Lockie , “Matrix Methods in Elasto Mechanics”, McGraw-Hill, 1963.
4. Timosenko , “Vibration Problems in Engineering”, Oxford City Press, 2011
5. Zienkiewicz, “The finite element method in engineering science”, McGraw-Hill, 1971

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 2

DESIGN OPTIMIZATION

(Common to MDE, MEA, MMD,CAE)

Course Code	**18CAE251**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

CourseLearning Objectives:

CL01	To understand the fundamentals of optimisation methods and their applications to manufacturing process and product design.
CL02	To learn optimisation models including design objectives, constraints and variables.
CL03	To learn appropriate optimisation techniques and programs.
CL04	To understand the limitations of solutions obtained from optimisation, and to use optimal design tools/software.

Course Content:

Module 1:EngineeringDesignPractice: EvolutionofDesignTechnology,IntroductiontoDesignandtheDesignProcess,DesignversusAnalysis, RoleofComputers in Design Cycle,Impact ofCAE on Design, Numerical Modelingwith FEAand Correlation with Physical Tests.

Applications ofOptimizationinEngineering Design: Automotive, Aerospaceand GeneralIndustryApplications, Optimization ofMetallic and CompositeStructures, Minimization and MaximizationProblems, MDO and MOO. **10 Hours**

Module 2: OptimumDesignProblemFormulation:TypesofOptimizationProblems,TheMathematicsofOptimization,DesignVariablesand DesignConstraints,FeasibleandinfeasibleDesigns,Equality andInequality Constraints,DiscreteandContinuousOptimization,Linearand NonLinear Optimization.
OptimizationTheory–FundamentalConcepts,GlobalandLocalMinimum,GradientVectorandHessianMatrix,Concept ofNecessary and Sufficient Conditions, Constrained and Unconstrained Problems,LagrangeMultipliers and Kuhn TuckerConditions.
10 Hours

Module 3:SensitivityAnalysis: Linear andNonLinear Approximations. Gradient Based Optimization Methods– Dual and Direct.
OptimizationDisciplines: Conceptual DesignOptimizationandDesignFine Tuning, CombinedOptimization,Optimizationof Multiple Static andDynamicLoads,Transient Simulations,Equivalent StaticLoadMethods.InternalandExternal Responses,DesignVariablesin Each Discipline. **10 Hours**

Module 4:ManufacturabilityinOptimizationProblems: DesignForManufacturing,ManufacturingMethodsandRules,ApplyingManufacturingConstraints to Optimization Problems.

DesignInterpretation: UnboundProblems,OverConstrainedProblems,ProblemswithNoofMultipleSolutions,ActiveandInactiveConstraints, Constraint Violations and Constraint Screening, Design MoveLimits,Local and Global Optimum. **10 Hours**

Module 5:Dynamic Programming: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming,Initial valueproblem, Examples. **10 Hours**

CourseOutcomes:
At the end of the course, students will be able to:

C01	Identify and apply relevant problem solving methodologies.
C02	Design components, systems and/ or processes to meet required specification.
C03	Optimizeanexistingdesignwithsingleormultipleobjectivefunctions.
C04	Apply decision-making methodologies to evaluate solutions for efficiency, effectiveness and sustainability.

TextBooks:
1. S.S.Rao, Engineering Optimization: Theoryand Practice, John Wiley, 2009
2. JasbirArora,Introduction to Optimum Design, McGrawHill, 2011.

ReferenceBooks:
1. Optimisation and Probabilityin System Engg-Ram, Van Nostrand.
2. Optimization methods -K. V. Mital and C. Mohan, New ageInternationalPublishers,

1999.
3. Optimization methods forEngg.Design -R.LFox, Addison – Wesley, 1971.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 2

AUTOMOBILE SYSTEMDESIGN

(Commonto MDE, MMD, MEA,CAE)

Course Code	18MEA252	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03

Course Objective:

CL01	To understand of the stages involved in automobile system design.
CL02	To expose the to industrialpractices in design of various systems of an tomobile.
CL03	To study importance and features of different systems like axle, differential, brakes, Steering, suspension, and balancing etc.
CL04	To study working of various Automobile Systems.
CL05	To know some modern trends in Automotive Vehicles.

Course Content:

Module 1: Body Shapes: Aerodynamic Shapes, drag forces for small family cars.

Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit.

12 Hours

Module 2: Design of I.C. Engine I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines.

08 Hours

Module 3: Design of I.C. Engine II: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3 cylinders).

10 Hours

Module 4: Transmission System: Design of transmission systems – gearbox (max of 4-speeds), differential.

Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension.

10 Hours

Module 5:Cooling System: Heat exchangers,application todesign ofcoolingsystem(watercooled).

EmissionControl: Common emission control systems, measurement ofmissions, exhaust gas emission testing.

10 Hours

CourseOutcomes:

Upon completion of this course, students will be able to:

C01	Gain an insight into aspects of vehicle design, operation and maintenance, which will be useful for taking up a position in the automotive industry.
C02	Applytheknowledgeincreatingapreliminarydesign of automobilesub systems.
C03	Identify construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.
C04	Identify Modern technology and safety measures used in Automotive Vehicles.

TextBooks:

1. DesignofAutomotiveEngines, -A.Kolchin&V. Demidov, MIR Publishers, Moscow.
2. Themotorvehicle, Newtonsteeds &Garratte-Iliffee&sonsLtd.,London.
3. I.C. Engines -Edward FObert,International text book company.

ReferenceBooks:

1. Introductionto combustion-Turns.
2. AutomobileMechanic-, N.K.Giri, KhannaPublications, 1994
3. I.C. Engines -Maleev, McGrawHill book company, 1976
4. Diesel enginedesign- HeldtP.M.,Chilton companyNew York.
5. Problems on designofmachine elements- V.M. Faires&Wingreen, McMillan Company.,

1965
6. DesignofI.C.Engines -John Heywood, TMH.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 2

COMPUTATIONAL FLUID DYNAMICS

(Common to MDE, MEA, MMD, CAE)

Course Code	**18MEA253**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	This course would create awareness about the theory behind fluid dynamics computations as applied in analysis tools.
CL02	This course provides core knowledge of the fundamentals of CFD, and an introduction to the methods and analysis techniques used in CFD.

Course Content:

Module 1: Basic Concepts: Dimensionless form of equations; Simplified mathematical models; Hyperbolic, Parabolic & Elliptic systems; Properties of numerical solutions (Consistency, Stability, Conservation, Convergence and Accuracy). **10 Hours**

Module 2: Finite Difference Methods: Discretisation; Boundary conditions; error propagation; Introduction to spectral methods; examples. **10 Hours**

Module 3: Finite volume method: Surface & volume integrals; Interpolation & differentiation; Boundary conditions; Examples. **10 Hours**

Module 4: Gausian Elimination; LU decomposition; Tridiagonal Systems; Iterative methods; convergence; ADI & other splitting methods.
Multi-grid method - Coupled equations; Simultaneous solutions, sequential solutions & under relaxation.Non linear systems. **10 Hours Module 5:** Initial value problem & Boundary value problems; Implicit & Explicit schemes;

2D and 3D examples.Heat and Mass transfer Problems; Multi Phase Flows. **10 Hours**

Course Outcomes:

At the end of the course,students will be able to:

C01	Understand the process of developing a geometrical model of the flow, applying appropriate boundary conditions, specifying solution parameters, and visualising and analysing the results.
C02	Apply CFD analysis to real engineering designs.

Text Books:

1. Computational Methods for Fluid Dynamics, 3rd edition - J.H. Ferziger& M. Peric, Springer,
2002.

2. Numerical Solutions of Partial Differential Equations, Finite Difference methods, 3rd ed., G.D. Smith, Oxford University Press. 1986.

Reference Books:

1. Computational Fluid Dynamics - T. J. Chung, Cambridge Univ. Press, 2002.
2. Partial Differential Equations for Scientists and Engineers - Farlow, John Wiley, 1982.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Design Laboratory -Lab2
(Common to MDE, MEA, MMD)

Course Code	**18MDEL26**	**CIE Marks**	**40**
Number of Practical Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam Hours**	**03**

Note:

1. These are independent laboratory exercises.
2. Student must submit a comprehensive report on the problems solved and give a presentation on the same for Internal Evaluation.
3. Any one of the experiments done from the following list has to be set in the examination for conduction and evaluation.

Course Content:

Experiment #1

Structural Analysis

Part A: FE Modeling of a stiffened Panel using a commercial preprocessor.

Part B: Buckling, Bending and Modal analysis of stiffened Panels.

Part C: Parametric Studies.

Experiment #2

Design Optimization

Part A: Shape Optimization of a rotating annular disk.

Part B: Weight Minimization of a Rail Car Suspension Spring.
Part C: Topology Optimization of a Bracket.

Experiment #3
Thermal analysis
Part A: Square Plate with Temperature Prescribed on one edge and Opposite edge insulated.
Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral
Surfaces Insulated.

Experiment #4
Thermal Stress Analysis
Part A: A Thick Walled Cylinder with specified Temperature at inner and outer Surfaces. Part B: A Thick Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

Experiment#5
CFD Analysis
Part A: CFD Analysis of a Hydro Dynamic Bearing using commercial code.
Part B: Comparison of predicted Pressure and Velocity distributions with Target solutions.
Part C: Experimental Investigations using a Journal Bearing Test Rig.
Part D: Correlation Studies.

Experiment #6
Welded Joints.
Part A : Fabrication and Testing.
Part B : FE Modeling and Failure Analysis .
Part C : Correlation Studies.

Experiment #7
Bolted Joints.
Part A : Fabrication and Testing.
Part B : FE Modeling and Failure Analysis .
Part C : Correlation Studies.

Experiment #8
Adhesive Bonded Joints.
Part A : Fabrication and Testing.
Part B : FE Modeling and Failure Analysis .
Part C : Correlation Studies.

III Semester

DESIGN FOR MANUFACTURE AND ASSEMBLY

(Common to MDE, MEA, MMD)

Course Code	**18MDE31**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

CourseLearning Objectives:

CL01	To understand various general design rules for manufacturability and criteria for material selection
CL02	To study various machining process and tolerance aspects in machining.
CL03	To know the design considerations for casting, forging and welding process.
CL04	To study the general design guidelines for manual assembly and development of DFA Methodology.

CourseContent:

Module 1: EffectofMaterials AndManufacturing ProcessOnDesign:Majorphasesofdesign.Effectofmaterial properties ondesignEffectof manufacturing processesondesign.Materialselectionprocess-

costperunitproperty,Weightedpropertiesandlimitsonproperties methods. TolerenceAnalysis:Processcapability,mean,varience,skewness,kurtosis,Processcapabilitymetrics,Cp, Cpk,Costaspects,Feature tolerances relevant to manufacturing and assembly, tolerance stacks,effects on assembly,methods of eliminating tolerance stacks, Geometriestolerances,Geometrictolerances,Surfacefinish,Reviewof relationshipbetweenattainabletolerancegradesand differentmachiningprocess.Cumulativeeffectoftolerance-Surefitlawandtruncatednormallaw **10Hours**

Module 2: Selective Assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1 : Group toleranceof matingpartsequal,Modeltotalandgrouptolerancesof shaftequal.Controlofaxialplay-Introducingsecondarymachining operations,Laminatedshims,examples. DatumFeatures:Functionaldatum,Datumformanufacturing,Changingthedatum.Examples. **10Hours**

Module 3: DesignConsiderations:Designofcomponentswithcastingconsideration.Pattern,Mould, andPartingline.CoredholesandMachined holes.Identifyingthepossibleandprobablepartingline.Castingrequiringspecialsandcores.Designingtoobviatesandcores.Welding considerations: requirements and rules, redesign of components for welding; case studies.

Component Design:Component designwithmachining considerations linkdesignforturningcomponents-milling, Drillingandother relatedprocessesincludingfinish-machiningoperations **12Hours**

Module 4: Forging considerations -Requirements and rules -Redesign of components for forging and Case studies.

True positional theory :Comparison between co-ordinate and convention method offeature location. Tolerance and true position tolerancing,virtualsize concept,floatingandfixedfasteners.Projectedtolerancezone.Assemblywith gasket,zeropositiontolerance. Functionalgauges, and Paperlayoutgauging **10Hours**

Module 5: Approaches to design for assembly-Qualitative evaluation procedures, knowledge based approach, Computer aided DFA methods. Assemblability measures. Boothroyd-Dewhurst DFA method -Redesign of a simple product-Case studies. **08 Hours**

CourseOutcomes:

At the end of the course, students will be able to:

C01	Describe the different types of manufacturing systems and comparetheir suitability foreconomic production of various components and products.
C02	Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.
C03	Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic

	production.

Reference Books:

1. HarryPeck,“ DesigningforManufacturing” ,PitmanPublications,1983.
2. Dieter,“ MachineDesign” - McGraw-HillHigherEducation, -2008
3. R.K.Jain, "EngineeringMetrology",KhannaPublishers,1986
4. Productdesignformanufacture andassembly-GeoffreyBoothroyd, Peterdewhurst, WinstonKnight,Merceldekker. Inc.CRCPress, ThirdEdition
5. MaterialselectionandDesign,Vol.20-ASMHandbook.
6. Alan Redford and Chal, (1994) Design for Assembly-Principles and Procedures. McGraw Hill International.
7. James G. Bralla, (1986) Hand Book of Product Design for Manufacturing. McGraw Hill Co

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 3

EXPERIMENTAL MECHANICS

(Common to MDE, MEA, MMD, CAE)

Course Code	**18CAE321**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To introduce the concepts of dynamic measurements and analysis of experimental data.
CL02	To expose them to the techniques of Data Acquisition, Signal conditioning and processing.
CL03	To introduce students to different aspects of measuring deformation, strains, and stresses for developing a mechanistic understanding of both the material and the structure behavior.
CL04	Tofamiliarizethestudentwithstateoftheartexperimentaltechniquesemployingstrai ngauges,photoelasticity, Moiréinteroferometry,brittlecoating,Moiréfringesandholography.

CourseContent:

Module 1:Introduction:Definitionofterms,calibration,standards,dimensionandunits,generalizedmeas urementsystem,Basicconceptsindynamic measurements,systemresponse,distortion,impedancematching,experimentplanning.

Analysisof ExperimentalData: Causeandtypesof experimentalerrors,erroranalysis.Statisticalanalysisof experimentaldata-probability distribution, Gaussian, Normaldistribution. Chi-square test, method of least square, correlation coefficient, multivariable regression, standarddeviationofmean,graphicalanalysisandcurvefitting,generalconsiderationindataanalysis. **10Hours**

Module 2: DataAcquisition andProcessing: Generaldataacquisition system,signalconditioning revisited,datatransmission, Analog-to-Digital and Digital-to-Analogconversion. Basiccomponents (storageanddisplay)ofdataacquisition system.Computerprogramasasubstitute for wiredlogic.

Force,TorqueandStrainMeasurement: Massbalancemeasurement,elasticelementfor forcemeasurement,torquemeasurement.Strain gages-strainsensitivityofgagemetals,gageconstruction,gagesensitivityandgagefactor,performance characteristics,environmental effects,Straingagecircuits,Potentiometer, WheatStone'sbridges,Constantcurrentcircuits.Strainanalysismethods-two element and threeelement,rectangularanddeltarosettes,correctionfortransversestraineffects,stressgage - planesheargage,stressintensityfactor gage.

10Hours

Module 3: StressAnalysis: TwoDimensionalPhotoelasticity-natureoflight,-wavetheoryoflight,-opticalinterference-Polariscopesstressopticlaw effect ofstressed modelinplaneandcircularpolariscopes, Isoclinics, Isochromatics fringeorder determination -Fringe multiplicationtechniques-Calibrationphotoelasticmodelmaterials.Separationmethodssheardifferencemethod,Analyticalseparationmethods,Model toprototypescaling

10Hours

Module 4: ThreeDimensionalPhotoelasticity: Stressfreezingmethod,Generalslice,Effectivestresses,Stressesseparation,Shear deferencemethod, Obliqueincidencemethod,secondaryprincipalsstresses,scatteredlightphotoelasticity,Polariscopeandstressdataanalyses**.** **10 Hours**

Module 5: Coating Methods: a)Photoelastic Coating Method-Birefringence coating techniques,Sensitivity Reinforcing and thickness effects -data reduction-Stressseparation techniques,Photoelastic straingauges.

b)BrittleCoatingsMethod:Brittle coatingtechniquePrinciplesdata analysis-coatingmaterials,Coatingtechniques.

c)MoireTechnique-Geometricalapproach,Displacementapproach-sensitivityofMoire datareduction,InplaneandoutplaneMoiremethods,Moirephotography,Moiregridproduction.

Holography: Introduction, Equation forplane waves andspherical waves, Intensity, Coherence, Spherical radiator asanobject (record process),Hurter,Driffeldcurves,Reconstructionprocess,Holograpicinterferomerty, Realtimeanddoubleexposuremethods,Displacement measurement,Isopachics.

10Hours

CourseOutcomes:

At the end of this course, students should be able to:

C01	Mount strain gages, take measurements and analyze the obtained data.
C02	Design strain gage-based transducers for measuring specific loads.
C03	Describe the different methods photo elasticity for strain measurement viz, stress freezing , and Moirés method.
C04	Undertakeexperimentalinvestigationstoverifypredictionsbyothermethods.
C05	Apply the principles and techniques of brittle coating analysis.
C06	Apply the principles and techniques of holographic interferometry.

TextBooks:

1 . Holman,“ ExperimentalMethodsforEngineers” 7th Edition,TataMcGraw-Hill Companies,Inc,NewYork,2007.

2 . R.S.Sirohi,H.C.RadhaKrishna,“ Mechanicalmeasurements” NewAgeInternational Pvt.Ltd.,NewDelhi,2004

3. ExperimentalStressAnalysis-Srinath,Lingaiah,Raghavan,Gargesa,Ramachandraand Pant,TataMcGrawHill,1984.

4. Instrumentation,MeasurementAndAnalysis-Nakra&Chaudhry,BCNakraKKChaudhry, TataMcGraw-HillCompanies,Inc,NewYork, SeventhEdition,2006.

ReferenceBooks:

1. MeasurementSystemsApplicationandDesign-DoeblinE.A.,4th(S.I.)Edition,McGrawHill,NewYork.1989
2. DesignandAnalysisofExperiments- MontgomeryD.C.,JohnWiley&Sons,1997.
3. ExperimentalStressAnalysis-DallyandRiley,McGrawHill,1991.
4. ExperimentalStressAnalysis-SadhuSingh,Khannapublisher,1990.
5. PhotoelasticityVolIandVolII- M.M.Frocht,.JohnWileyandsons,1969.
6. StrainGaugePrimer-PerryandLissner,McGrawHill,1962.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 3

Mechatronics System Design

(Common to MDE, MEA, MMD,CAE)

Course Code	**18MEA322**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To educate the student regarding integration of mechanical, electronics, electrical and computer systems in the design of CNC machine tools, Robots etc.
CL02	To provide students with an understanding of the Mechatronic design process, actuators, sensors, transducers, signal conditioning, MEMS and Microsystems and also the advance applications in Mechatronics.

Course Content:

Module 1: Introduction: Definition and introduction to Mechatronic Systems. Modeling & Simulation of physical systems. Overview of Mechatronic products and their functioning. Measurement systems, control systems, simple controllers. Study of sensors and transducers, Pneumatic and Hydraulic Systems, Mechanical actuation systems, Electrical actuation systems, Real time interfacing and hardware components for Mechatronics.

10 Hours

Module 2: Electrical Actuation Systems: Electrical systems, mechanical switches, solid state switches, solenoids, DC & AC motors, Stepper motors. System Models: Mathematical models, mechanical system building blocks, electrical system building blocks, thermal system building blocks, electro-mechanical systems, hydro-mechanical systems, pneumatic systems.

10 Hours

Module 3: Signal Conditioning: Signal conditioning, the operational amplifier, protection, filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, Pulse-modulation.

MEMS and Micro systems: Introduction, working principle, materials for MEMS and Micro systems, Micro system fabrication process, overview of Micro Manufacturing, Micro system Design, and Micro system packaging.

10 Hours

Module 4: Data Presentation Systems: Basic System Models, System Models, Dynamic Responses of System.

10 Hours

Module 5: Advanced Applications in Mechatronics: Fault Finding, Design arrangements and practical case studies, Design for manufacturing, User- friendly design.

10 Hours

Course Outcomes:
At the end of the course,students will be able to:

C01	Describe mechatronic systems and overview of control systems & actuators.
C02	Identify and describe the different types of actuators used in mechatronic systems
C03	Differentiate between various sensors, transducers and actuators and their applications.
C04	Identify and describe the different types of speed- and position-feedbackdevices.
C05	Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers.
C06	cuss the importance of feedback in controlling physical systems with the use of examples.
C07	lain the principle of operation of ac induction motor, dc motor, servomotor,

	and stepper motor.
C08	ntify and describe the types of controllers used in mechatronic systems.

Text Books:

1. W. Bolton, " Mechatronics" - Addison Wesley Longman Publication, 1999

2. HSU " MEMS and Microsystems design and manufacture" - Tata McGraw-Hill Education, 2002

Reference Books:

1. Kamm, " Understanding Electro-Mechanical Engineering an Introduction to Mechatronics" - IEEE Press, 1 edition ,1996
2. Shetty and Kolk " Mechatronics System Design" - Cengage Learning, 2010
3. Mahalik " Mechatronics" - Tata McGraw-Hill Education, 2003
4. HMT " Mechatronics" - Tata McGraw-Hill Education, 1998
5. Michel .B. Histand& David. Alciatore, " Introduction to Mechatronics & Measurement Systems"– . Mc Grew Hill, 2002
6. " Fine Mechanics and Precision Instruments" - Pergamon Press, 1971.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 3

Robust Design
(Common to MDE, MEA, MMD, CAE)

Course Code	**18MEA323**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

	CL01 To impart a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications.
CL02	To cover the statistical design of experiments for systematically examining functioning of the system.
CL03	To understandTaguchi' s orthogonal array techniques which are predominantly

	used in optimization of parameters.
CL04	To understand the applications of statistical models in analysing experimental data.

Course Content:

Module 1: Quality by Experimental Design : Quality, western and Taguchi quality philosophy, elements of cost, noise factors causes of variation,quadratic loss function and variation of quadratic loss functions. Robust design : steps in robust design,parameter design and tolerance design, reliability improvement through experiments, illustration through numerical examples.

Experimental design: classical experiments,factorial experiments, terminology, factor levels, interactions, treatment combination, randomization, 2-levelexperimental design for two factors and three factors, 3-level experiment deigns for two factors and three factors, factor effects, factor interactions, fractional factorial design, saturated design, central composite designs, and illustration through numerical examples.
10 Hours

Module 2: Measures of Variability: Measures of variability, concept of confidence level.Statistical distributions : normal, log normal and Weibull distributions. Hypothesis testing, probability plots, choice of sample size illustration through numerical examples. Analysis and interpretation of experimental data: Measures of variability, ranking method, column effect method and plotting method.Analysis of Variance (ANOVA) in factorial experiments: Yate' s algorithm for ANOVA, regression analysis, mathematical models from experimental data, illustration through numerical examples.

10 Hours

Module 3: Taguchi's Orthogonal Arrays : Types orthogonal arrays, selection of standard orthogonal arrays, linear graphs and interaction assignment, dummy level technique, compound factor method, modification of linear graphs, column merging method, branching design, strategies for constructing orthogonal arrays. Signal to Noise ratio (S-N ratios): Evaluation of sensitivity to noise, signal to noise ratios for static problems, smaller – the – better types, nominal – the – better – type, larger – the- better – type. Signal to Noise ratios for dynamic problems, illustrations through numerical examples.

10 Hours

Module 4: Parameter Design and Tolerance Design : Parameter and tolerance design concepts, Taguchi' s inner and outer arrays, Parameter design strategy, Tolerance deign strategy, Illustrations through numerical examples.

10 Hours

Module 5: Reliability Improvement Through Robust Design : Role of S-N ratios inreliability improvement ; Case study; Illustrating the reliability improvement ofrouting process of a printed wiring boards using robust design concepts.

10 Hours

Course Outcome:

At the end of this course, students will be able to:

C01	Apply methods to analyze and identify opportunities to improve design processes for robustness.
C02	Set up full and fraction Factorial experiment design.
C03	Perform ANOVA and Hypothesis Testing.
C04	Apply statistical models in analysing experimental data.
C05	Lead product development activities that include robust design techniques.

Text Books:

1.Madhav S. Phadake , " Quality Engineering using Robust Design" , Prentice Hall,1989.
2. Douglas Montgomery, " Design and analysis of experiments" , Willey India Pvt.Ltd., 2007.
3. Phillip J. Ross, Taguchi , " Techniques for Quality Engineering" ,McGraw Hill Int. Ed., 1996

Reference Books:

1. Thomas B. Barker , " Quality by Experimental Design" , Marcel Dekker Inc, ASQC Quality Press, 1985
2. C.F. Jeff Wu, Michael Hamada , " Experiments planning, analysis and parameter design optimization" , John Willey Ed., 2002
3. W.L. Condra, Marcel Dekker , " Reliability improvement by Experiments" , MarcelDekkerInc, ASQC Quality Press, 1985

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 4

Smart Materials and Structures
(Common to MDE, MEA, MMD,CAE)

Course Code	**18CAE331**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To understand the concepts of functional material, smart material and smart systems.
CL02	To expose the students to design smart structures for advanced engineering applications.

CL03	To introduce the concepts of shape memory alloys, ER and MR fluids, and MEMS.

Course Content:

Module 1: Smart Structures: Types of smart structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, depoling and coersive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor. Beam modeling: Beam modeling with induced strain rate effects, inchworm linear motor beam modeling with induced strain actuation-single actuators, dual actuators, pure extension, pure bending harmonic excitation, Bernoulli-Euler beam model, problems, piezo-electrical applications.

10 Hours

Module 2: Shape memory Alloy: Experimental phenomenology, shape memory effect, phase transformation, Tanaka' s constitutive model, testing of SMA wires, vibration control through SMA, multiplexing. Applications of SMA and problems. ER and MR fluids: Mechanisms and properties, fluid composition and behavior, the Bingham plastic and related models, pre-yield response, post-yield flow applications in clutches, dampers and others.

08 Hours

Module 3:Vibration absorbers: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena,characteristics, sensors, fiber optics in crack detection, applications. Control of structures: Modeling, control strategies and limitations, active structures in practice.

10 Hours

Module 4: MEMS: Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.

10 Hours

Module 5: Devices: Sensors and Actuators, conductivity of Semiconductors, crystal planes and orientation, Stress and Strain Relations, Flexural Beam Bending Analysis under simple loading conditions, polymers in MEMS, optical MEMS applications.

10 Hours

Course Outcomes:

At the end of this course, students will be able to:

C01	Understand the behavior and applicability of various smart materials.
C02	Design simple models for smart structures & materials.
C03	Devise experiments to verify the predictions.
C04	Judge the appropriate application of smart materials with respect to the feasibility of their fabrication and implementation, and to the economic aspects.

Text Books:

1. Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, ArtechHouse, Boston, 1996 (ISBN :0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

Reference Books:

1. Electroceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin;New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials - K. Otsuka and C. M. Wayman, Cambridge University Press, Cambridge; New York, 199~ (ISBN:052144487X).

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 4

COMPOSITE MATERIALS TECHNOLOGY
(Common to MDE, MEA, MMD)

Course Code	**18MDE332**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To impart a basic understanding of micro-mechanics of layered composites, analysis and design of composite structures and failure analysis of laminated panels.
CL02	To understand the principles, matrix and reinforcement material options,

	advantages and disadvantages of different manufacturing techniques of composites.
CL03	To comprehend recent developments in composites, including metal, ceramic and polymer matrix composites.
CL04	To know the use of composites in engineering applications.

Course Content:

Module 1: Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.

Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants fororthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law fortwo-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

10 Hours

Module 2: Micro Mechanical Analysis of aLamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.Experimental Characterization of Lamina- Elastic Moduli and Strengths. Failure Criteria: Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensortheory, Numerical problem, practical recommendations.

10 Hours

Module 3:Macro Mechanical Analysis of Laminate: Introduction, code, Kirchhoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation).

10 Hours

Module 4:Analysis of Composite Structures: Optimization of Laminates, composite laminates of uniform strength, application of optimal compositestructures, composite pressure vessels, spinning compositedisks, composite lattice structures.

Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.

10 Hours

Module 5:Manufacturing and Testing: Layup and curing - open and closed mould processing,Hand lay-up techniques, Bag moulding and filamentwinding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair.

NDT tests– Purpose, Types of defects, NDT method - Ultrasonicinspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

10 Hours

CourseOutcomes:

At the end of the course, students should be able to:

C01	Understand the use of fibre -reinforced composites in structural applications.
C02	Develop a basic understanding of the use of composite materials, micro-mechanics of layered composites, analysis and design of composite structures and failure analysis of laminated panels.
C03	Apply the basic micro-mechanics theories in the design of fibre reinforced composites.
C04	Analyze the performance of composites in engineering applications.

Text Books:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Material s & Structures, Universities Press,2004.

Reference Books:

1. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
3. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
4. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009.
5. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.
6. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.
7. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

PROFESSIONAL ELECTIVE 4

Acoustics and Noise Control Engineering

(Common to MDE, MEA, MMD, CAE)

Course Code	**18MDE333**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Course Learning Objectives:

CL01	To provide introduction to students the fundamentals of acoustics related to generation, transmission and control techniques.
CL02	To provide basic knowledge and understanding of noise and vibration control

	necessary for professional practice as a noise control engineer.
CL03	To expose them to acoustic instrumentation and techniques of sound measurement.
CL04	To understand Noise reduction and control techniques in Machinery, auditorium, and HVAC systems.

Course content:

Module 1: Introduction to Acoustics: Basics of acoustics - speed of sound, wavelength, frequency, and wave number, acoustic pressure and particle velocity, acoustic intensity and acoustic energy density, spherical wave, directivity factor and directivity index, levels and the decibel, combination of sound sources, octave bands, weighted sound levels. Sound sources and Propagation – Plane and spherical waves, near and far field, free and reverberant field - Anechoic and Reverberant chambers.

10 Hours

Module 2: Acoustics Evaluation Techniques: Room Acoustics ,Reverberation time, Acoustic materials, Absorption and Absorption Coefficient, Evaluation techniques.

10 Hours

Module 3:Noise and physiological effects: Noise and physiological effects , Acoustic criteria, the human ear, hearing loss, industrial noise criteria, speech interference level,

noise criteria for interior spaces , Loudness, hearing, hearing loss, hearing protectors, Mechanism -Weighted Networks -Noise standards for traffic - Community noise -Aircraft - Environmental noise, Articulation index, and Machinery acoustics.

10 Hours

Module 4: Acoustic Instrumentation: Sound level and intensity meters - Octave analyzers, octave band filters, acoustic analysers, dosimeter, measurement of sound power, sound power measurement in a reverberant room, sound power measurement in an anechoic chamber, sound power survey measurements, measurement of the directivity factor, calibration, noise measurement procedures.

Sound power estimation - Instruments for building acoustics -Speech Interference - Sound systems and Auditorium acoustics.

10 Hours

Module 5: Noise control techniques: At source and transmission path-Barriers and Enclosures- HVAC system noise, Machinery acoustics and levels- Near field monitoring and diagnostics - Active noise control techniques. Noise control in rooms, sound absorption.

10 Hours

Course Outcomes:

After studying this course, students will:

C01	Distinguish among different sound generation and propagation mechanisms and their representations, understand different categories of noise effects on

	humans.
C02	Understand how to use pressure wave expressions to describe sound transmission in different media.
C03	Analyze complex noise environments and predict sound levels in desired locations.
C04	Evaluate acoustic enclosures, barriers and walls for effective noise control.
C05	Become familiar with sound measurement instrumentation.
C06	Select appropriate noise control techniques for the solution of practical noise problems and evaluate their performance.
C07	Apply the noise control techniques considered in an integrated way to a practical design case.

Text Books:

1. J.D. Irwin and E.R.Graf, (2001), Industrial Noise and Vibration control, Prentice Hall Inc.

Reference books:

1. Bies and Colin. H. Hanson, (2001): Engg. Noise Control, E &FN SPON.
2. Noise Control Hand Book of Principles and Practices, David M.Lipsdomls Van Nostrand Reinhold Company.
3. Acoustic and Noise Control, (2000), B.J. Smith, R.J.Peters, Stephanie Owen.
4. Harris, C.K.—Handbook of Noise Control.
5. Petrusowicz and Longmore —Noise and Vibration control for industrialists
6. Thumann and Miller- Secrets of Noise control
7. R. D. Ford—Introduction to Acoustics.
8. Douglas P. Reynolds —Engineering Principles of Acoustics.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech in Communication Systems/ Digital Communication & Networking/ Digital Communication Engineering/ Digital Electronics & Communication Systems/ Digital Electronics & Communication (ECS)
Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18ELD11	Advanced Engineering Mathematics	04	--	03	40	60	100	4
2	PCC	18ECS12	Advanced Digital Signal Processing	04	--	03	40	60	100	4
3	PCC	18EVE13	Advanced Embedded System	04	--	03	40	60	100	4
4	PCC	18ECS14	Advanced Communication Systems-1	04	--	03	40	60	100	4
5	PCC	18ECS15	Advanced Communication Networks	04	--	03	40	60	100	4
6	PCC	18ECSL16	Advanced Digital Signal Processing Lab	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted forthe same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Techin Communication Systems/ Digital Communication & Networking/ Digital Communication Engineering/ Digital Electronics & Communication Systems/ Digital Electronics & Communication (ECS)
Choice Based Credit System (CBCS)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18ECS21	Advanced Communication Systems-2	04	--	03	40	60	100	4
2	PCC	18ECS22	Antenna Theory and Design	04	--	03	40	60	100	4
3	PCC	18ECS23	Error Control Coding	04	--	03	40	60	100	4
4	PEC	18XXX24X	Professional Elective 1	04	--	03	40	60	100	4
5	PEC	18XXX25X	Professional Elective 2	04	--	03	40	60	100	4
6	PCC	18ECSL26	Advanced Communication Lab	--	04	03	40	60	100	2
7	PCC	18ECS27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective

Professional Elective 1		Professional Elective 2	
Course Code under 18XXX24X	**Course title**	**Course Code under 18XXX25X**	**Course title**
18ECS241	Wireless Sensor Networks	18ECS251	Multimedia Over Communication links
18EVE242	Nanoelectronics	18ESP252	Statistical Signal Processing
18ECS243	Cryptography and Network Security	18ELD253	Micro Electro Mechanical Systems

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Techin Communication Systems/ Digital Communication & Networking/ Digital Communication Engineering/ Digital Electronics & Communication Systems/ Digital Electronics & Communication (ECS)
Choice Based Credit System (CBCS)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18ECS31	LTE 4G Broadband	04	--	03	40	60	100	4
2	PEC	18XXX32X	Professional Elective 3	04	--	03	40	60	100	4
3	PEC	18XXX33X	Professional Elective 4	04	--	03	40	60	100	4
4	Project	18ECS34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	Internship	18ECSI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: **PCC: Professional core, PEC: Professional Elective**

Professional Elective 3		**Professional Elective 4**	
Course Code under 18XXX32X	**Course title**	**Course Code under 18XXX33X**	**Course title**
18ECS321	Advances in Image Processing	18ECS331	RF and Microwave Circuit Design
18ESP322	Array Signal Processing	18ESP332	Pattern Recognition & Machine Learning
18ECS323	Real Time Systems	18ECS333	IoT

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.
SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech in Communication Systems/ Digital Communication & Networking/ Digital Communication Engineering/ Digital Electronics & Communication Systems/ Digital Electronics & Communication (ECS)
Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	18ECS41	Project work Phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

FIRST SEMESTER SYLLABUS

<table>
<tr><td colspan="4">ADVANCED ENGINEERING MATHEMATICS
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – I</td></tr>
<tr><td>Course Code</td><td>18ELD11</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• To learn principles of advanced engineering mathematics through linear algebra and calculus of variations.
• To understand probability theory and random process that serve as an essential tool for applications of electronics and communication engineering sciences</td></tr>
</table>

<table>
<tr><td>Modules</td><td>Revised Bloom's Taxonomy (RBT) Level</td></tr>
<tr><td colspan="2">Module -1</td></tr>
<tr><td><u>Linear Algebra-I</u>
Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions.Matrix form of linear transformations-Illustrative examples (Text Book:1).</td><td>L1,L2</td></tr>
<tr><td colspan="2">Module -2</td></tr>
<tr><td><u>Linear Algebra-II</u>
Computation of eigen values and eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process (Text. Book:1).</td><td>L1,L2</td></tr>
<tr><td colspan="2">Module -3</td></tr>
<tr><td>Calculus of Variations : -
Concept of functional-Eulers equation.Functionaldependent on first and higher order derivatives, Functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries. (Text.Book:2)</td><td>L1,L2</td></tr>
<tr><td>Module -4</td><td></td></tr>
<tr><td>Probability Theory:-Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions-</td><td>L1,L2</td></tr>
</table>

Module -5	
Engineering Applications on Random processes:- Classification. Stationary, WSS and ergodic random process. Auto-correlation function-properties, Gaussian random process. (Text Book: 3)	**L1,L2**

Course Outcomes: After studying this course, students will be able to:

- Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
- Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.
- Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.
- Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.
- Analyze random process through parameter-dependent variables in various random processes.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. David C.Lay, Steven R.Lay and J.J.McDonald: "LinearAlgebra and its Applications", 5^{th}Edition, Pearson Education Ltd., 2015
2. Elsgolts, L.:"Differential Equations and Calculus of Variations", MIR Publications, 3^{rd} Edition, 1977.
3. T.Veerarajan: "Probability, Statistics and Random Process",3^{rd} Edition,Tata Mc-Graw Hill Co.,2016.

Reference Books:

1. Gilbert Strang: Introduction to Linear Algebra, 5^{th}Edition, Wellesley-Cambridge Press., 2016
2. Richard Bronson: "Schaum's Outlines of Theory and Problems of Matrix Operations", McGraw-Hill, 1988.
3. Scott L.Miller,DonaldG.Childers: "Probability and Random Process with application to Signal Processing", Elsevier Academic Press,2^{nd} Edition,2013.

4. E. Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.

Web links:

1. http://nptel.ac.in/courses.php?disciplineId=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://ocw.mit.edu/courses/mathematics/
4. www.wolfram.com

<table>
<tr><td colspan="5" align="center"><u>ADVANCED DIGITAL SIGNAL PROCESSING</u>
[As per Choice Based Credit System (CBCS) Scheme
SEMESTER – I</td></tr>
<tr><td>Course Code</td><td colspan="2">18ECS12</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td colspan="2">04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td colspan="2">50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="5" align="center">Credits – 04</td></tr>
<tr><td colspan="5">Course objectives: This course will enable students to
Understand Multirate digital signal processing principles and its applications.
Estimate the various spectral components present in the received signal using different spectral estimation methods such as Parametric and Nonparametric.
Design and implement an optimum adaptive filter using LMS and RLS algorithms.
Understand the concepts and mathematical representations of Wavelet transforms.</td></tr>
<tr><td colspan="4" align="center">Modules</td><td align="center">RBT Levels</td></tr>
<tr><td colspan="4" align="center">Module-1</td><td></td></tr>
<tr><td colspan="4">Multirate Digital Signal Processing: Introduction, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion, Applications of multirate signal processing, Digital filter banks, two channel quadrature mirror filter banks, M-channel QMF bank. (Text 1)</td><td>L1, L2, L3</td></tr>
<tr><td colspan="4" align="center">Module-2</td><td></td></tr>
<tr><td colspan="4">Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations. The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters. (Text 1)</td><td>L1, L2, L3</td></tr>
<tr><td colspan="4" align="center">Module-3</td><td></td></tr>
<tr><td colspan="4">Adaptive filters: Applications of Adaptive Filters-Adaptive Channel Equalization, Adaptive noise cancellation, Linear Predictive coding of Speech Signals, Adaptive direct form FIR filters-The LMS algorithm, Properties of LMS algorithm. Adaptive direct form filters- RLS algorithm. (Text 1)</td><td>L1, L2, L3</td></tr>
<tr><td colspan="4" align="center">Module-4</td><td></td></tr>
<tr><td colspan="4">Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods.</td><td>L1, L2,</td></tr>
</table>

Parametric Methods for Power Spectrum Estimation: Relationship between the auto correlation and the model parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Model parameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methods for the AR Model parameters, ARMA Model for Power Spectrum Estimation. (Text 1)	L3
Module-5	
WAVELET TRANSFORMS: The Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future. **Continuous Wavelet and Short Time Fourier Transform:** Wavelet Transform, Mathematical preliminaries, Properties of wavelets. Discrete Wavelet Transform: Haar scaling functions, Haar wavelet function, Daubechies Wavelets. (Chapters 1, 3 & 4 of Text 2)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Design adaptive filters for a given application
- Design multirate DSP Systems
- Implement adaptive signal processing algorithm
- Design active networks
- Understand advanced signal processing techniques, including multi-rate processing and time-frequency analysis techniques

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. “Digital Signal Processing, Principles, Algorithms and Applications”, JohnG. Proakis, Dimitris G.Manolakis, Fourth edition, Pearson-2007.
2. Insight into Wavelets- from Theory to Practice”, K.P Soman, Ramachandran, Resmi- PHI Third Edition-2010.

ADVANCED EMBEDDED SYSTEM [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject	**18EVE13**	**CIE**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Describe the hardware software co-design and firmware design approaches
- Explain the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Program ARM CORTEX M3 using the various instructions, for different applications.

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems (Text 1: Selected Topics from Ch -1, 2, 3).	**L1, L2, L3**
Module -2	
Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Text 1: Selected Topics From Ch-7, 9, 12, 13).	**L1, L2, L3**
Module -3	
ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 2: Ch 1, 2, 3)	**L1, L2, L3**
Module -4	

Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Text 2: Ch-4, 5, 6).	**L1, L2, L3**
Module -5	
Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Text 2: Ch-7, 8, 10).	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Explain the hardware software co-design and firmware design approaches.
- Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.
2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.

Reference Book:

James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008.

Advanced Communications Systems -1(Theory & Practice)						
Course Code	:	**18ECS14**		**CIE Marks**	:	**40**
Hrs/Week	:	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	:	**60**
Credits	:	**4**		**SEE Duration**	:	**3 Hrs**

Course Learning Objectives (CLO):
Students shall be able to

1. Understand different modulation, demodulation and equalization techniques and use them to analyze the error performance of digital modulation techniques in presence of AWGN noise.
2. Analyze and demonstrate the model of discrete time channel with ISI & the model of discrete time channel by equalizer.
3. Apply various types of equalizers used for channel modeling and adjusting the filter coefficients
4. Develop the concept of Spread Spectrum Communications over wideband channels.

Module -1	**10 Hrs**

Signal Representation – Low pass representation of bandpass signals, Low pass representation of bandpass random process [Text 1 , Chapter 2: 2.1, and 2.9 only]
Modulation: Representation of digitally modulated Signals , Modulation Schemes without memory (Band Limited Schemes - PAM,BPSK,QPSK,MPSK,MQAM, Power Limited Schemes – FSK,MFSK, DPSK,DQPSK), modulation schemes with memory (Basics of CPFSK and CPM – Full Treatment of MSK), Transmit PSD for Modulation Schemes. (Section 3.4 [Text 1 , Chapter 3: 3.1, 3.2 and 3.3]

Module -2	**10 Hrs**

Demodulation - Vector Channel, Vector Channel +AWGN, Performance parameters, Optimum Coherent Detection for power limited and Bandlimited schemes, Optimal Coherent detection for schemes with memory, Optimal Non – Coherent detection for schemes without and with memory (FSK, DPSK,DQPSK), Comparison of detection schemes. [Text 1, Chapter 4: 4.1, 4.2.- 4.2.2, 4.3, 4.4, 4.5.1, 4.5.2, 4.5.5 and 4.6]

Module - 3	**10 Hrs**

Bandlimited Channels: Bandlimited channel characterization, signalling through band limited linear filter channels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes, Optimum receiver for channel with ISI and AWGN.
Linear Equalizers: Zero forcing Equalizer, MSE and MMSE, Baseband and Passband Linear Equalizers. Performance of ZFE and MSE.(Excluding 9.4-3, 9.4-4)[Text 1, Chapter 9: 9.1, 9.2 - 9.2.1, 9.2.2, 9.2.3, 9.3-9.3.1, 9.3.2 and 9.4

Unit – IV	**10 Hrs**

Non-Linear Equalizers: Decision - feedback equalization, Predictive DFE, Performance of DFE.[Text 1, Chapter 9: 9.5: 9.5-1 only] **Adaptive equalization**: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive Fractionally spaced Equalizer (Tap Leakage Algorithm), Adaptive equalization of Trellis - coded signals.[Text 1, Chapter 10: 10.1, 10.1-1, 10.1-2, 10.1-3, 10.1-6,10.1-7, 10.2, 10.3]	
Unit – V	**10 Hrs**
Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS spread spectrum signals , generation of PN sequences, Frequency hopped spread spectrum signals , Time hopping SS, Synchronization of SS systems. [Text 1, Chapter 12: 12.1, 12.2 (except 12.2-1), 12.2-2, 12.2-5, 12.3, 12.4, 12.5]	

Expected Course Outcomes:

After going through this course the student will be able to:

- Explain the concept of low pass and Bandpass signals representations at the Transmitter, the process of Detection and Estimation at the receiver in the presence of AWGN only.
- Evaluate Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-bandlimited and bandlimited channels.
- Design single carrier equalizers for various symbol modulation schemes and detection methods for defined channel models, and compute parameters to meet desired rate and performance requirements.
- Design and Evaluate Non band limited and Non power limited spread spectrum systems for communications in a Jamming environment, multiuser situation and low power intercept environment.

Text Books

1. John G. Proakis, MasoudSalehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893

Reference Books

2. Bernard Sklar,"Digital Communications: Fundamentals and Applications: Fundamentals &Applications",2e,Pearson Education(2009),ISBN:978-8131720929
3. Simon Haykin ,"Digital Communications Systems",1e,Wiley(2014),ISBN:978-8126542314

ADVANCED COMPUTER COMMUNICATION NETWORKS [As per Choice Based Credit System (CBCS) scheme] SEMESTER –I			
Subject Code	18ECS15	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50 (10 Hours Per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Develop an awareness towards current practice in Networking
- Learn various aspects involved in wireless networks
- Develop an awareness regarding the Packet Processing ,Routing issues in computer networks
- Understand some of the shortest path routing protocols
- Develop an awareness towards the network control and traffic management
- Understand the congestion control and flow control mechanisms

Modules	Revised Bloom's Taxonomy
Module -1	
Functional Elements and Current Practice in Networking: Networking as Resource Sharing, Analogy with the Operating System of a Computer, The Functional Elements: Multiplexing, Switching, Routing, Network Management, Traffic Controls and Timescales, Current Practice: Network Infrastructure, Networking Architectures, Telephone and ISDN Networks, X.25 and Frame Relay Networks, The Internet, Asynchronous Transfer Mode (ATM) Networks. (Text 1)	**L1, L2, L3**
Module -2	
Wireless Networks: Bits over a Wireless Network, TCP Performance over Wireless Links, Adaptive and Cross-Layer Techniques, Random Access: Aloha, S-Aloha, and CSMA/CA, Wireless Local Area Networks, Wireless Ad Hoc Networks, Link Scheduling and Network Capacity, Scheduling Constraints, Centralized Scheduling, Capacity of a WANET, Wireless Sensor Networks: An Overview (Text 1)	**L1, L2, L3**
Module -3	
Packet Processing: Addressing and Address Lookup, Addressing, Addressing in IP Networks: Subnets and Classless Inter domain Routing, Efficient Longest Prefix Matching: Level-Compressed Tries, Hardware-Based Solutions, Packet Classification **Routing:** Engineering Issues, Shortest Path Routing of Elastic Aggregates, Elastic Aggregates and Traffic Engineering, Optimal Routing, Algorithms for Shortest Path Routing: Dijkstra's Algorithm, The Bellman–Ford Algorithm, Routing Protocols, Distance Vector Protocols, Link State Protocols.(Text 1)	**L1, L2, L3**
Module -4	

Traffic Management: Introduction, framework for traffic management, traffic models, traffic classes, traffic scheduling (Text 3). **Control of Networks:** Objectives and methods of control, routing optimization in circuit and datagram networks, Queuing models in circuit and datagram networks (Text 2).	**L1, L2, L3**
Module -5	
Congestion and flow control: Congestion control ,Window congestion control, Rate congestion control, control problems in ATM Networks (Text 2), flow control model, flow control classification, open loop flow control, closed loop flow control (Text 3).	**L1, L2, L3, L4**

Course outcomes: After studying this course, students will be able to:

- Choose appropriate Network Infrastructure and Networking Architectures which suits current practice in networking
- Identify the suitable random access methods which suits wireless networks
- Identify IP configuration for the network with suitable routing mechanisms
- Analyze and develop various network traffic management and control techniques
- Analyze and develop various congestion and flow control

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Anurag Kumar, D. Manjunath, Joy Kuri, "Communication Networking : An Analytical Approach" , Morgan Kaufmann publications, ISBN: 0-12-428751-4, 2004.
2. J. Walrand and P. Varaya, "High performance communication networks", Harcourt Asia (Morgan Kaufmann), 2000.
3. S. Keshav "An Engineering Appproach to Computer Networking", Pearson Education, ISBN: 978-81-317-1145-3, 2011.

Reference Book:

1. Andrew S Tanenbaum , "Computer Networks", 4th edition , Pearson Education

<table>
<tr><td colspan="4" align="center"><u>Advanced Digital Signal Processing Lab</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I</td></tr>
<tr><td>Course Code</td><td>18ECSL16</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>01Hr Tutorial (Instructions) + 03 Hours Laboratory</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td></td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">Credits – 02</td></tr>
<tr><td colspan="4">Course objectives: This laboratory courseenables students to get practical Experience in Digital Signal processing ,analysis and realization of LTI systems .</td></tr>
<tr><td colspan="3">Laboratory Experiments:</td><td>RBT Levels</td></tr>
<tr><td colspan="3">01. Generate various fundamental discrete time signals.</td><td rowspan="14">L1, L2,L3</td></tr>
<tr><td colspan="3">02. Basic operations on signals (Multiplication, Folding, Scaling).</td></tr>
<tr><td colspan="3">03. Find out the DFT & IDFT of a given sequence without using inbuilt instructions.</td></tr>
<tr><td colspan="3">04. Interpolation & decimation of a given sequence.</td></tr>
<tr><td colspan="3">05. Generation of DTMF (Dual Tone Multiple Frequency) signals.</td></tr>
<tr><td colspan="3">06. Estimate the PSD of a noisy signal using periodogram and modified periodogram.</td></tr>
<tr><td colspan="3">07. Estimation Of PSD using different methods (Bartlett, Welch, Blackman-Tukey).</td></tr>
<tr><td colspan="3">08. Design of Chebychev Type I,II Filters.</td></tr>
<tr><td colspan="3">09. Cascade Digital IIR Filter Realization.</td></tr>
<tr><td colspan="3">10. Parallel Realization of IIR filter.</td></tr>
<tr><td colspan="3">11. Estimation of power spectrum using parametric methods (yule-walker & burg).</td></tr>
<tr><td colspan="3">12. Design of LPC filter using Levinson-Durbin algorithm.</td></tr>
<tr><td colspan="3">13. Time-Frequency Analysis with the Continuous Wavelet Transform.</td></tr>
<tr><td colspan="3">14. Signal Reconstruction from Continuous Wavelet Transform Coefficients.</td></tr>
<tr><td colspan="4">Course outcomes: On the completion of this laboratory course, the students will be able to have hands on experience on,
• Filter design.
• Filter Realization
• Signal Manipulations
• Wavelet Transforms
• Estimating PSD using various techniques</td></tr>
</table>

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- The experiments can be conducted in Matlab or using any other related tools.
- Strictlyfollowtheinstructionsasprintedonthecoverpageofanswerscriptforbr eakupofmarks.
- Change of experiment is allowed only once and Marks allotted to the Procedure part will be made zero.

<table>
<tr><td colspan="4"><u>RESEARCH METHODOLOGY AND IPR</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –I</td></tr>
<tr><td>Course Code</td><td>18RMI17</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>02</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>25</td><td>SEE Marks</td><td>60</td></tr>
<tr><td colspan="4">Credits - 02</td></tr>
<tr><td colspan="4">Course objectives:
To give an overview of the research methodology and explain the technique of defining a research problem
To explain the functions of the literature review in research.
To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
To explain various research designs and their characteristics.
To explain the details of sampling designs, and also different methods of data collections.
To explain the art of interpretation and the art of writing research reports.
To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
To discuss leading International Instruments concerning Intellectual Property Rights. ■</td></tr>
<tr><td colspan="3">Module-1</td><td>Teaching Hours/ RBT Level</td></tr>
<tr><td colspan="3">Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. ■</td><td>05

L1, L2</td></tr>
<tr><td colspan="4">Module-2</td></tr>
</table>

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **Reviewing the literature:** Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. ■	**05** **L1, L2**
Module-3	
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. ■	**05** **L1, L2**
Module-4	
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout. **Interpretation and Report Writing (continued):** of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. ■	**05** **L1, L2, L3, L4**
Module-5	

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.	**05** **L1, L2, L3, L4**

Course outcomes:
At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of interpretation and the art of writing research reports
- Discuss various forms of the intellectual property, its relevance and

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

SECOND SEMESTER SYLLABUS

ADVANCED COMMUNICATIONS SYSTEMS -2 [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Course Code	**18ECS21**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Learning Objectives (CLO):
Students shall be able to
1. Describe modelsfor fading channels, and concepts of diversity in time, frequency and space.
2. Demonstrate the concept of synchronization, maximal ratio combining, Rake Receivers, multicarrier OFDM and MIMO.
3. Analyze the capacity and error performance and implementation of maximal ratio combining, Rake receivers, OFDM and MIMO in presence of AWGN noise
   Design simple MIMO-OFDM system for a deterministic multipath channel.

Modules	RBT Levels
Module-1	
Synchronization – Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery, Performance of ML estimators.[Text 1, Chapter 5] **Fading** – Large scale, small scale; Statistical characterization of multipath channels – Delay and Doppler spread, classification of multipath channels, scattering function; Binary signaling over frequency non selective Rayleigh fading channel. [Text 1, Chapter 13]	**L1,L2**
Module-2	
Fading Contd: - Diversity techniques for performance improvement with binary signaling over FNS, Slow fading channels – power combining and Maximal ratio combining; Frequency selective channels – Rake receivers, Performance, Tap weight Synchronization, Application to CDMA. [Text 1, Chapter 13] **Multicarrier Signalling:**A brief overview of Frequency Diversity. [Text 2, Sec 3.4.1, 3.4.2] Multicarrier Communications in AWGN channel- Single carrier	**L1,L2**

vs Multicarrier, OFDM, FFT Implementation, Spectral Characteristics, Power and bit allocation, Peak to Average Power Ratio, Channel Coding Considerations [Text 1, 11.2.1 to 11.2.9] and [Text 2, Sec 3.4.4]	
Module-3	
Capacity of wireless channel: AWGN channel capacity [Sec 5.1 All subsections], Resources of AWGN channel [5.2 All sub sections], Linear time invariant Gaussian channel[5.3 All sub sections], Capacity of Fading Channels [Sec5.4 All subsections]. [Text 2 Chapter 5]	**L1,L2**
Module-4	
MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels,Physical modeling of MIMO channels, Modeling of MIMO fading channels. [Text 2, Chapter 7]	
Module-5	
MIMO capacity and multiplexing architectures: The V-BLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Receiver architectures – (Linear decorrelator, Successive cancellation, Linear MMSE receiver), Information theoretic optimality, Connections with CDMA multiuser detection and ISI equalization, Slow fading MIMO channel. [Sections 8.1 to 8.4, Text 2]	**L1,L2**

Expected Course Outcomes:

After going through this course the student will be able to:

- Explain the concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver.
- Evaluate the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.
- Develop & analyze schemes to improve performance in a multipath fading environment including maximal ratio combining, RAKE receivers, OFDM and MIMO.
- Develop and evaluate the performance of aOFDM MIMO scheme to meet specified rate in a given multipath environment.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.

• The total marks will be proportionally reduced to 60 marks as SEE marks is 60.
Text Books: 1. John G. Proakis, MasoudSalehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893 2. David Tse, PramodViswanath, "Fundamentals of Wireless Communication",1e,Cambridge University Press(2005), ISBN:0521845270
Reference Books Simon Haykin ,"Digital Communications Systems",Wiley(2014),ISBN:978-0-471-64735-5

<table>
<tr><td colspan="4" align="center"><u>ANTENNA THEORY AND DESIGN</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I</td></tr>
<tr><td>Subject Code</td><td>18ECS22</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam Marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• Introduce and discuss different types of Antennas, various terminologies, excitations.
• Study different types of Arrays, Pattern-multiplication, Feeding techniques.
• Calculate gain of aperture antennas, Reflector antennas and analyze general feed model.
• Define, describe, and illustrate principle behind antenna synthesis.
• Introduction of Method of moments, Pocklington’s integral equation, Source modeling.</td></tr>
</table>

<table>
<tr><td align="center">Modules</td><td align="center">Revised Bloom’s Taxonomy (RBT) Level</td></tr>
<tr><td colspan="2">Module -1</td></tr>
<tr><td>Antenna Fundamentals and Definitions: Radiation Mechanisms, Overview, EM Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation patterns, Directivity and Gain, Antenna impedance, Radiation efficiency, Antenna polarization.</td><td align="center">L1,L2</td></tr>
<tr><td colspan="2">Module -2</td></tr>
<tr><td>Arrays: Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Non-uniformly excited equally spaced linear arrays, Mutual coupling.

Antenna Synthesis: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method, Comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods, Dolph Chebyshev linear array, Taylor line source method.</td><td align="center">L1,L2,L3, L4</td></tr>
<tr><td colspan="2">Module -3</td></tr>
<tr><td>Resonant Antennas: Wires and Patches, Dipole antenna, Yagi-Uda antennas, Micro-strip antenna.

Broadband antennas: Traveling wave antennas Helical antennas, Biconical antennas, Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.</td><td align="center">L1,L2,L3, L4</td></tr>
</table>

Module -4	
Aperture antennas: Techniques for evaluating gain, Reflector antennas-Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice.	**L1,L2,L3, L4**
Module -5	
CEM for antennas: The method of moments: Introduction of the methods moments, Pocklington's integral equation, Integral equation and Kirchhoff's networking equations, Source modeling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics.	**L1,L2**

Course Outcomes: After studying this course, students will be able to:
- Classify different types of antennas
- Define and illustrate various types of array antennas
- Design antennas like Yagi-Uda, Helical antennas and other broad band antennas
- Describe different antenna synthesis methods
- Apply methods like MOM

Question paper pattern:
- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:
Stutzman and Thiele, “Antenna Theory and Design”, 2nd Edition, John Wiley, 2010.

Reference Books:
1. C. A. Balanis, “Antenna Theory Analysis and Design”, John Wiley, 2nd Edition 2007.
2. J. D. Krauss, “Antennas and Wave Propagation”, McGraw Hill TMH, 4th Edition, 2010.
3. A.R.Harish, M.Sachidanada, “Antennas and propagation”, Pearson Education, 2015.

<table>
<tr><td colspan="5"><u>ERROR CONTROL CODING</u>
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – 2</td></tr>
<tr><td>Subject Code</td><td>18ECS23</td><td>CIE Marks</td><td colspan="2">20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE marks</td><td colspan="2">80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td colspan="2">03</td></tr>
<tr><td colspan="5">CREDITS – 04</td></tr>
<tr><td colspan="5">Course objectives: This course will enable students to:
Understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel.
Apply modern algebra and probability theory for the coding.
Compare Block codes such as Linear Block Codes, Cyclic codes etc and Convolutional codes.
Detect and correct errors for different data communication and storage systems.
Implement different Block code encoders and decoders.
Analyze and implement convolutional encoders and decoders.
Analyze and apply soft and hard Viterbi algorithm for decoding of convolutional codes.</td></tr>
<tr><td colspan="4">Modules</td><td>RBT Level</td></tr>
<tr><td colspan="5">Module 1</td></tr>
<tr><td colspan="4">Information theory: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem.(Chap. 5 of Text 1)
Introduction to algebra: Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2^m) and its properties, (Only statements of theorems without proof) Computation using Galois filed GF (2^m) arithmetic, Vector spaces and Matrices. (Chap. 2 of Text 2)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="5">Module 2</td></tr>
<tr><td colspan="4">Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes. (Chap. 3 of Text 2)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="5">Module 3</td></tr>
<tr><td colspan="4">Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes.(Chap. 4 of Text2)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="5">Module 4</td></tr>
<tr><td colspan="4">BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. (Chap. 6 (6.1,6.2,6.7) of Text</td><td></td></tr>
</table>

2) Primitive BCH codes over GF (q), **Reed -Solomon codes.** (Chap. 7 (7.2,7.3) of Text 2) **Majority Logic decodable codes**: One -step majority logic decoding, Multiple-step majority logic. (Chap. 8 (8.1,8.4) of Text 2)	L1,L2,L3
Module 5	
Convolution codes: Encoding of convolutional codes: Systematic and Nonsystematic Convolutional Codes, Feedforward encoder inverse, A catastrophic encoder, Structural properties of convolutional codes: state diagram, state table, state transition table, tree diagram, trellis diagram. Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding. (11.1,11.2, 12.1,13.1 of Text 2)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Analyse a discrete memoryless channel, given the source and transition probabilities.
- Apply the concept of modern linear algebra for the error control coding technique.
- Construct and Implement efficient LBC, Cyclic codes etc encoder and decoders.
- Apply decoding algorithms for efficient decoding of Block codes and Convolutional codes.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

4. David C.Lay, Steven R.Lay and J.J.McDonald: "LinearAlgebra and its Applications", 5thEdition, Pearson Education Ltd., 2015
5. Elsgolts, L.:"Differential Equations and Calculus of Variations", MIR Publications, 3rd Edition, 1977.
6. T.Veerarajan: "Probability, Statistics and Random Process",3rd Edition,Tata Mc-Graw Hill Co.,2016.

Reference Books:

5. Gilbert Strang: Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press., 2016
6. Richard Bronson: "Schaum's Outlines of Theory and Problems of Matrix Operations",
McGraw-Hill, 1988.
7. Scott L.Miller,DonaldG.Childers: "Probability and Random Process with application to Signal Processing", Elsevier Academic Press,2nd Edition,2013.
8. E. Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.

Professional Elective 1

<table>
<tr><td colspan="4">Wireless Sensor Networks
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II</td></tr>
<tr><td>Course Code</td><td>18ECS241</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40 (08 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">Credits – 04/03</td></tr>
<tr><td colspan="4">Course Outcomes:
At the end of this course, students will be able to
• Design wireless sensor network system for different applications under consideration.
• Understand the hardware details of different types of sensors and select right type of sensor for various applications.
• Understand radio standards and communication protocols to be used for wireless sensor</td></tr>
</table>

<table>
<tr><td>Modules</td><td>RBT Levels</td></tr>
<tr><td>Module-1</td><td></td></tr>
<tr><td>Introduction:Sensor Mote Platforms, WSN Architecture and Protocol Stack (Chap. 1Text 1)
WSN Applications:Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications, (Chap. 2 Text 1)</td><td>L1, L2, L3</td></tr>
<tr><td>Module-2</td><td></td></tr>
<tr><td>Factors InfluencingWSN Design:Hardware Constraints Fault Tolerance
Scalability Production Costs WSN Topology, Transmission Media, Power Consumption, (Chap. 3 Text 1)
Physical Layer: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards (Chap. 4 of Text 1)</td><td>L1, L2, L3</td></tr>
<tr><td>Module-3</td><td></td></tr>
<tr><td>Medium Access Control:Challenges for MAC , CSMA Mechanism, Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access(Chap. 5 of Text 1)

Network Layer: Challenges for Routing, Data-centric and Flat-Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols (Chap. 7 of Text 1)</td><td>L1, L2, L3</td></tr>
</table>

Module-4	
Transport Layer: Challenges for Transport Layer, Reliable Multi-Segment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol , Event-to-Sink Reliable Transport (ESRT) Protocol, GARUDA (Chap. 8 Text 1) **Application Layer:** Source Coding (Data Compression), Query Processing, Network Management (Chap. 9 Text 1)	L1, L2, L3
Module-5	
Time Synchronization: Challenges for Time Synchronization , Network Time Protocol, Timing-Sync Protocol for Sensor Networks(TPSN), Reference-Broadcast Synchronization (RBS), Adaptive Clock Synchronization (ACS)(Chap. 11 of Text1) **Localization;** Challenges in Localization, Ranging Techniques, Range-Based Localization Protocols, Range-Free Localization Protocols.(Chap. 12 Text 1)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Acquire knowledge of characteristics of mobile/wireless communication channels
- Apply statistical models of multipath fading
- Understand the multiple radio access techniques

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as see marks is 60.

Text books:

1. **Ian F. Akyildiz** and **Mehmet Can Vuran** “Wireless Sensor Networks”,John Wiley & Sons Ltd. ISBN 978-0-470-03601-3 (H/B), 2010.
2. **Ananthram Swami, et. Al.,** Wireless Sensor Networks Signal Processing and Communications Perspectives”, John Wiley & Sons Ltd. ISBN 978-0-470-03557-3 2007.

NANOELECTRONICS [**As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – II**			
Subject Code	**18EVE242**	**CIE**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Enhance basic engineering science and technological knowledge of nanoelectronics.
- Explain basics of top-down and bottom-up fabrication process, devices and systems.
- Describe technologies involved in modern day electronic devices.
- Appreciate the complexities in scaling down the electronic devices in the future.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
Module -1	
Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).	**L1, L2**
Module -2	
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques,spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties(Text1)	**L1,L2,L3**
Module -3	

Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text1). **Carbon Nanostructures:**Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes (Text 2).	**L1-L3**
Module -4	
Fabrication techniques: Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly techniques. **Physical processes:** modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text1).	**L1-L3**
Module -5	
Methods of measuring properties: atomic, crystollography, microscopy, spectroscopy (Text 2). **Applications**: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP's, NEMS, MEMS (Text1).	**L1-L3**

Course outcomes: After studying this course, students will be able to:

- Know the principles behind Nanoscience engineering and Nanoelectronics.
- Apply the knowledge to prepare and characterize nanomaterials.
- Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials.
- Design the process flow required to fabricate state of the art transistor technolo gy.
- Analyze the requirements for new materials and device structure in the future t echnologies.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.
2. Charles P Poole, Jr, Frank J Owens, "Introduction to Nanotechnology", John Wiley, Copyright 2006, Reprint 2011.

Reference Book:

Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, "Hand Book of Nanoscience Engineering and Technology", CRC press, 2003.

<table>
<tr><td colspan="4"><u>CRYPTOGRAPHY AND NETWORK SECURITY</u>
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>18ECS243</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours Per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
• Understand the basics of symmetric key and public key cryptography.
• Understand some basic mathematical concepts and pseudorandom number generators required for cryptography.
• Authenticate and protect the encrypted data.
• Enrich knowledge about Email, IP and Web security.</td></tr>
<tr><td colspan="3">Modules</td><td>RBT Level</td></tr>
<tr><td colspan="4">Module 1</td></tr>
<tr><td colspan="3">Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6)
SYMMETRIC CIPHERS: Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, Chapter 4)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="4">Module 2</td></tr>
<tr><td colspan="3">Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5)
Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8, Chapter 9: Section 9.1, 9.3, 9.4)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="4">Module 3</td></tr>
<tr><td colspan="3">Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP (Text 2: Chapter 16)</td><td>L1,L2, L3</td></tr>
<tr><td colspan="4">Module 4</td></tr>
<tr><td colspan="3">One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA],One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4)</td><td>L1,L2,L3</td></tr>
</table>

<table>
<tr><td colspan="2">Module 5</td></tr>
<tr><td>E-mail Security: Pretty Good Privacy-S/MIME (Text 1: Chapter 17: Section 17.1, 17.2).
IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations. (Text 1: Chapter 18: Section 18.1 to 18.4).
Web Security: Web Security Considerations, SSL (Text 1: Chapter 15: Section 15.1, 15.2).</td><td>L1,L2, L3</td></tr>
<tr><td colspan="2">Course Outcomes: After studying this course, students will be able to:
• Use basic cryptographic algorithms to encrypt the data.
• Generate some pseudorandom numbers required for cryptographic applications.
• Provide authentication and protection for encrypted data.</td></tr>
<tr><td colspan="2">Question paper pattern:
• Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
• Each full question can have a maximum of 4 sub questions.
• There will be 2 full questions from each module covering all the topics of the module.
• Students will have to answer 5 full questions, selecting one full question from each module.
• The total marks will be proportionally reduced to 60 marks as SEE marks is 60.</td></tr>
<tr><td colspan="2">Text Books:
1. William Stallings , “Cryptography and Network Security Principles and Practice”, Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3
2. Bruce Schneier, “Applied Cryptography Protocols, Algorithms, and Source code in C”, Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X

Reference Books:
1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, Atul Kahate, TMH, 2003.</td></tr>
</table>

Professional Elective 2

<table>
<tr><td colspan="4"><u>MULTIMEDIA OVER COMMUNICATION LINKS</u>
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>18ECS251</td><td>CIE Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours Per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
• Gain fundamental knowledge in understanding the basics of different multimedia networks, applications, media types like text and image.
• Analyse media types like audio and video and gain knowledge on multimedia systems.
• Analyse Audio compression techniques required to compress Audio.
• Analyse compression techniques required to compress video.
• Gain fundamental knowledge about the Multimedia Communications in different Networks.</td></tr>
<tr><td colspan="3">Modules</td><td>RBT Level</td></tr>
<tr><td colspan="4">Module 1</td></tr>
<tr><td colspan="3">Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology.(Chap. 1 of Text1)
Information Representation: Introduction, Text, Images. (Chap. 2- Sections 2.2 and 2.3 of Text 1)</td><td>L1, L2, L3</td></tr>
<tr><td colspan="4">Module 2</td></tr>
<tr><td colspan="3">Information Representation: Audio and Video. (Chap. 2 - Sections 2.4 and 2.5 of Text 1)
Distributed multimedia systems: Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems. (Chap. 4 - Sections 4.1 to 4.5 of Text 2)</td><td>L1,L2, L3</td></tr>
<tr><td colspan="4">Module 3</td></tr>
<tr><td colspan="3">Multimedia Processing in Communication: Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders. (Chap. 3 - Sections 3.1, 3.2, 3.6, 3.7 of Text 2)</td><td>L1,L2, L3</td></tr>
<tr><td colspan="4">Module 4</td></tr>
<tr><td colspan="3">Multimedia Communication Standards: Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4. (Chap. 5 - Sections 5.1 to 5.4 and 5.5.1 of</td><td>L1,L2, L3</td></tr>
</table>

Text 2)	
Module 5	
Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks. (Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2).	L1,L2, L3
Course Outcomes: After studying this course, students will be able to: • Understand basics of different multimedia networks and applications. • Analyze media types like audio and video to represent in digital form. • Understand different compression techniques to compress audio. • Understand different compression techniques to compress audio video. • Describe the basics of Multimedia Communication Across Networks	
Question paper pattern: • Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks. • Each full question can have a maximum of 4 sub questions. • There will be 2 full questions from each module covering all the topics of the module. • Students will have to answer 5 full questions, selecting one full question from each module. • The total marks will be proportionally reduced to 60 marks as SEE marks is 60.	
Text Books: 1. Fred Halsall, "Multimedia Communications", Pearson education, 2001, ISBN -9788131709948. 2. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004. ISBN - 9788120321458. **Reference Book**: Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002, ISBN -9788177584417.	

STATISTICAL SIGNAL PROCESSING **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – II**			
Course Code	**18ESP252**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course objectives: This course will enable students to:

- Understand random processes and its properties
- Understand the basic theory of signal detection and estimation
- Identify the engineering problems that can be put into the frame of statistical signal processing
- Solve the identified problems using the standard techniques learned through this course,
- Make contributions to the theory and the practice of statistical signal processing.

Modules	**RBT Levels**
Module-1	
Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes(Text 1).	**L1, L2**
Module-2	
Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schurrecursion; Levinsonrecursion(Text 1).	**L2, L3**
Module-3	
Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation(Text 1).	**L1, L2**
Module-4	
Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms (Text 1).	**L2, L3**
Module-5	
Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beam-forming, linearly constrained minimum-variance beam-formers, side-lobe cancellers. (Text 2).	**L2, L3**

Course outcomes: After studying this course, students will be able to:

- Characterize an estimator.
- Design statistical DSP algorithms to meet desired needs
- Apply vector space methods to statistical signal processing problems
- Understand Wiener filter theory and design discrete and continuous Wiener filters
- Understand Kalman Filter theory and design discrete Kalman filters
- Use computer tools (such as Matlab) in developing and testing stochastic DSP algorithms

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

1. Monson H.Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley & Sons (Asia) Pvt.Ltd., 2002.
2. Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing” ,McGraw-HillInternationalEdition,2000.

<table>
<tr><td colspan="4"><u>MICRO ELECTRO MECHANICAL SYSTEMS</u>
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>18ELD253</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:

• Know an overview of microsystems, their fabrication and application areas.
• Teach working principles of several MEMS devices.
• Develop mathematical and analytical models of MEMS devices
• Know methods to fabricate MEMS devices
• Expose the students to various application areas where MEMS devices can be used.</td></tr>
</table>

Modules	**RBT Level**
Module 1	
Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.	L1, L2
Module 2	
Working Principles of Microsystems: Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. **Engineering Science for Microsystems Design and Fabrication:** Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.	L1, L2
Module 3	
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.	L1,L2,L3
Module 4	
Scaling Laws in Miniaturization:	L1,L2,L3

Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	
Module 5	
Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro-manufacturing. **Microsystem Design:** Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Understand the technologies related to Micro Electro Mechanical Systems.
- Describe the design and fabrication processes involved with MEMS devices.
- Analyse the MEMS devices and develop suitable mathematical models
- Understand the various application areas for MEMS devices

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, John Wiley & Sons, 2008. ISBN: 978-0-470-08301-7

Reference Books:

1. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Micro electromechanical Systems (MEMS), Cenage Learning.

ADVANCED COMMUNICATION LAB [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Laboratory Code	**18ECSL26**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**01Hr Tutorial (Instructions)+ 03 Hours Laboratory**	**SEE Marks**	**60**
		Exam Hours	**03**
CREDITS – 02			

Course objectives: This laboratory course enables students to get practical experience in

- Radiation pattern of antennas.
- Determining gain and directivity of a given antenna.
- Working of Klystron source.
- S-parameters of some microwave passive devices.

Laboratory Experiments: **NOTE:** Experiments can be done using Hardware tools such as Spectrum analyzers, Signal sources, Power Supplies, Oscilloscopes, High frequency signal sources, Fiber optic kits, Microwave measurement benches, DSP processor kit, FPGA kit, Logic analyzers, PC setups, etc. Software tools based experiments can be done using, FEKO or equivalent open source simulator, MATLAB etc.	**Revised Bloom's Taxonomy (RBT) Level**
1. Matlab/C implementation to obtain the radiation pattern of an antenna.	L3,L4
2. Study of radiation pattern of different antennas.	L2, L3
3. Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.	L3,L4
4. Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.	L3,L4
5. Study of radiation pattern of E & H plane horns.	L2, L3
6. Significance of Pocklington's integral equation.	L1,L2
7. Study of digital modulation techniques using CD4051 IC.	L2, L3
8. Conduct an experiment for Voice and data multiplexing using optical fiber.	L3,L4
9. Determination of the modes transit time, electronic timing range and sensitivity of Klystron source.	L3, L4
10. Determination of VI characteristics of GUNN diode, and measurement of guide wave length, frequency, and VSWR.	L3,L4
11. Determination of coupling coefficient and insertion loss of directional couplers and Magic tree.	L3,L4
12. Build a hardware pseudo-random signal source and determine statistics of the generated signal source.	L1,L2,L3,L4

Course outcomes: On the completion of this laboratory course, the students will be able to: • Plot the radiation pattern of some antennas using Matlab and wave guide setup • Obtain the S-parameters of Magic tee and directional couplers. • Test the IC CD4051 for modulation techniques. • Study multiplexing techniques using OFC kit.
Conduct of Practical Examination: 1. All laboratory experiments are to be included for practical examination. 2. Students are allowed to pick one experiment from the lot. 3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. 4. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

THIRD SEMESTER SYLLABUS

LTE 4G Broadband [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – III			
Subject Code	**18ECS31**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Explain the system architecture of LTE and E-UTRAN as per the standards
- Understand the Multiple Access process incorporated in the radio physical layer.
- Associate MAC of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer and for transferring to the EPS bearer.
- Explain the mobility principles and procedures in the idle and active state.
- Analyse the main factors affecting LTE performance including mobile speed and

Modules	RBT Level
Module -1	
Evolution Beyond Release 8, LTE-Advanced for IMT-Advanced, LTE Specifications and 3GPP Structure. **System Architecture Based on 3GPP SAE:** Basic System Architecture Configuration with only E-UTRAN Access Network, System Architecture with E-UTRAN and Legacy 3GPP Access Networks, System Architecture with E-UTRAN and Non-3GPP Access Networks, IMS Architecture, PCC and QoS.	**L2, L3**
Module -2	
Introduction to OFDMA, SC-FDMA and MIMO in LTE: LTE Multiple Access Background, OFDMA Basics, SC-FDMA Basics MIMO Basics. **Physical Layer:** Transport Channels and their Mapping to the Physical Channels, Modulation, Uplink User Data Transmission, Downlink User Data Transmission, Uplink Physical Layer Signaling Transmission, PRACH Structure, Downlink Physical Layer Signaling Transmission.	**L2, L3**
Module -3	

Physical Layer Procedures, UE Capability Classes and Supported Features Physical Layer Measurements and Parameter Configuration. **LTE Radio Protocols:** Protocol Architecture, The Medium Access Control The Radio Link Control Layer, Packet Data Convergence Protocol.	**L1, L2, L3**
Module -4	
Radio Resource Control (RRC): X2 Interface Protocols Understanding the RRC ASN.1 Protocol Definition, Early UE Handling in LTE. **Mobility:** Mobility Management in Idle State, Intra-LTE Handovers 190, Inter-system Handovers Differences in E-UTRAN and UTRAN Mobility.	**L2, L3**
Module -5	
Radio Resource Management: Overview of RRM Algorithms, Admission Control and QoS Parameters, Downlink Dynamic Scheduling and Link Adaptation, Uplink Dynamic Scheduling and Link Adaptation, Interference Management and Power Settings, Discontinuous Transmission and Reception (DTX/DRX), RRC Connection Maintenance. **Performance:** Layer 1 Peak Bit Rates, Terminal Categories Link Level Performance, Link Budgets Spectral Efficiency Latency, LTE Reframing to GSM Spectrum Dimensioning.	**L1, L2, L3**

Course outcomes:

- Understand the system architecture and the function standard specified components of the system of LTE 4G.
- Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from a number of users.
- Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
- Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:
'LTE for UMTS Evolution to LTE-Advanced' Harri Holma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.
Reference Books:
1. 'Fundamentals of LTE', by Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews), Rias Muhamed, 1st Edition, Sept 2010, Prentice Hall Communications Engineering and Emerging Technologies Series from Ted Rappaport,ISBN13: 9780137033119, ISBN10: 0137033117. 2. ' LTE – The UMTS Long Term Evolution ; From Theory to Practice' by Stefania Sesia, Issam Toufik, and Matthew Baker, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.

Professional Elective 3

Advances in Image Processing [As per Choice Based credit System (CBCS) Scheme SEMESTER – III			
Subject Code	**18ECS321**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:
1. Acquire fundamental knowledge in understanding the representation of the digital image and its properties
2. Equip with some pre-processing techniques required to enhance the image for further analysis purpose.
3. Select the region of interest in the image using segmentation techniques.
4. Represent the image based on its shape and edge information.
5. Describe the objects present in the image based on its properties and structure.

Modules	**RBT Level**
Module 1	
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.	L1
Module 2	
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.	L1, L2
Module 3	
Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.	L1, L2, L3
Module 4	
Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.	L1, L2, L3
Module 5	
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons	L1, L2, L3

and object marking, Morphological segmentations and watersheds.	

Course Outcomes: After studying this course, students will be able to:
1.Understand the representation of the digital image and its properties
2.Apply pre-processing techniques required to enhance the image for its further analysis.
3.Use segmentation techniques to select the region of interest in the image for analysis
4.Represent the image based on its shape and edge information.
5.Describe the objects present in the image based on its properties and structure.
6.Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Cengage Learning, 2013, ISBN: 978-81-315-1883-0

Reference Books:

1. Geoff Doughertry, Digital Image Processing for Medical Applications, Cambridge university Press, 2010
2. S.Jayaraman, S Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, 2011.

Array Signal Processing **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – III**			
Course Code	**18ESP322**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Objectives: This course will enable students to:

- Understand various aspects of array signal processing.
- Explain the Concepts of Spatial Frequency along with the Spatial Samplings
- Describe array design methods and direction of arrival estimation techniques.

Modules	**RBT Level**
Module 1	
Spatial Signals: Signals in space and time, Spatial Frequency Vs Temporal Frequency, Review of Co-ordinate Systems, Maxwell's Equation, Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system –Wave number vector, Slowness vector.	**L1,L2**
Module 2	
Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.	**L1,L2**
Module 3	
Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.	**L1,L1**
Module 4	
Uniform Linear Arrays: Beam pattern in θ, u and ψ -space, Uniformly Weighted Linear Arrays. **Beam Pattern Parameters:** Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering.	**L1,L1**
Module 5	
Array Design Methods: Visible region, Duality between Time - Domain and Space -Domain Signal Processing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward -Lawson Frequency-Sampling Design.	**L2,L3**

Non parametric method -Beam forming, Delay and sum Method, Capons Method.	

Course Outcomes: At the end of the course, the students will be able to

- Understand the important concepts of array signal processing
- Understand the various array design techniques
- Understand the basic principle of direction of arrival estimation techniques

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

1. Harry L. Van Trees "Optimum Array Processing Part IV of Detection, Estimation, and Modulation Theory" John Wiley & Sons, 2002, ISBN: 9780471093909.

Reference Books:

1. Don H. Johnson Dan E. Dugeon, "Array Signal Processing: Concepts and Techniques", Prentice Hall Signal Processing Series, 1st Edition ,ISBN-13: 978-0130485137.
2. Petre Stoica and Randolph L. Moses "Spectral Analysis of Signals" Prentice Hall, 2005,ISBN: 0-13-113956-8.
3. Sophocles J. Orfanidis, "Electromagnetic Waves and Antennas", ECE Department Rutgers University, 94 Brett Road Piscataway, NJ 08854-8058. http://www.ece.rutgers.edu/~orfanidi/ewa/

Real Time Systems **[As per Choice Based credit System (CBCS) Scheme** **SEMESTER – III**			
Subject Code	**18ECS323**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:
- Understand basics of Real Time systems.
- Distinguish a real-time system with other systems.
- Identify the functions of operating system
- Evaluate the need for Real time operating system.
- Design and develop embedded applications by means of real-time operating systems.

Modules	**RBT Level**
Module 1	
Introduction to Real-Time Embedded Systems: Brief history of Real Time Systems, A brief history of Embedded Systems. **System Resources:** Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Re-entrant Functions.	L1, L2
Module 2	
Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Montonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies. **I/O Resources:** Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture. **Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems.	L1, L2
Module 3	
Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion. **Soft Real-Time Services:** Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services.	L1, L2
Module 4	
Embedded System Components: Firmware components, RTOS system software mechanisms, Software application components. **Debugging Components:** Exceptions assert, Checking return codes, Single-step debugging, kernel scheduler traces, Test access ports, Trace ports, Power-On self test and diagnostics.	L1, L2, L3

Module 5	
Performance Tuning: Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length. **High availability and Reliability Design:** Reliability and Availability, Similarities and differences, Reliability, Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design.	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Analyze Real time operating systems.
- Describe the functions of Real time operating systems.
- Demonstrate embedded system applications.
- Design a Real Time operating system.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

Sam Siewert, “Real-Time Embedded Systems and Components”, Cengage Learning India Edition, 2007.

Reference Books:

1. Krishna CM and Kang Singh G, “Real time systems”, Tata McGraw Hill, 2003, ISBN: 0-07-114243-64
2. Qing Li and Carolyn Yao, “Real-Time Concepts for Embedded Systems”, CMP Books, 2003, ISBN:1578201241
3. Jane W. S. Liu, “Real Time Systems”, Prentice Hall, 2000, ISBN: 0130996513
4. Phillip A. Laplante, “Real-Time Systems Design and Analysis”, John Wiley & Sons, 2004.

Professional Elective 4

RF AND MICROWAVE CIRCUIT DESIGN **[As per Choice Based Credit System (CBCS) Scheme]** **SEMESTER – III**			
Subject Code	**18ECS331**	**IA Marks**	**40**
Number of Lecture Hours/Week	**04**	**Exam marks**	**60**
Total Number of Lecture Hours	**50** **(10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to

- Understand waves propagating in Networks.
- Use the Smith Chart for various applications.
- Understand the basic considerations in active networks
- Design active networks.
- Understand RF/MW Frequency Mixer and Phase Shifter Design

Modules	**RBT Level**
Module 1	
Wave propagation in networks: Introduction, Reasons for Using RF/Microwaves, Applications, RF Waves, RF and Microwave circuit design, Introduction to Components Basics, Analysis of Simple Circuit in Phasor Domain, RF Impedance Matching, Transmission Media, High Frequency Parameters, Formulation of S-parameters, Properties of S-Parameters, Transmission Matrix, Generalized S-parameters.	L1,L2
Module 2	
Smith chart and its Applications: Introduction, Smith Chart, Derivation of Smith Chart, Smith Chart Circular and Radial Scales, Application of Smith chart.	L1,L2
Module 3	
Basic consideration in active networks: Stability Considerations, Gain Considerations and Noise Considerations.	L1,L2
Module 4	
RF/Microwave Amplifiers: Small Signal Design: Introduction, Types of amplifier, Design of different types of amplifiers **RF/Microwave Frequency Conversion: Mixers**: Introduction, Mixer Types, Conversion Losses for SSB Mixers, SSB versus DSB mixers, One diode mixers, Two diode Mixers.	L1,L2,L3
Module 5	
RF/Microwave Control Circuit Design: Introduction, PN Junction Devices, Phase shifters, Digital phase shifters,	L1,L2,L3

Semiconductor phase shifters, PIN diode attenuators. **RF and Microwave IC design**: MICs, MIC materials, Types of MICs, Hybrid verses Monolithic ICs, Chip mathematics	

Course Outcomes: After studying this course, students will be able to:

- Discuss and analyse waves propagation in Networks
- Apply the Smith Chart for finding various parameters in transmission lines
- Analyse the basic considerations in active networks
- Describe and design active networks
- Design RF/MW Frequency Mixers and phase shifters

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education edition, 2004.

Reference Book:

Reinhold Ludwig, and Pavel Bretchko, "RF circuit design theory and applications", Pearson Education edition, 2004.

<table>
<tr><td colspan="5" align="center"><u>PATTERN RECOGNITION and MACHINE LEARNING</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III</td></tr>
<tr><td>Course Code</td><td>18ESP332</td><td>CIE Marks</td><td colspan="2">40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td colspan="2">60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td colspan="2">03</td></tr>
<tr><td colspan="5" align="center">Credits – 04</td></tr>
<tr><td colspan="5">Course objectives: The objective of the course is to discusses main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems. Special emphasis will be given to regression, classification, regularization, feature selection and density estimation in supervised mode of learning.</td></tr>
<tr><td colspan="4" align="center">Modules</td><td>RBT Levels</td></tr>
<tr><td colspan="4" align="center">Module-1</td><td></td></tr>
<tr><td colspan="4">Introduction: Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory
Distributions: Binary and Multinomial Variables, The Gaussian Distribution, The Exponential Family, Nonparametric Methods.(Ch.: 1,2)</td><td>L1,L2</td></tr>
<tr><td colspan="4" align="center">Module-2</td><td></td></tr>
<tr><td colspan="4">Supervised Learning
Linear Regression Models: Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison
Classification & Linear Discriminant Analysis: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Mode(Ch. :3,4)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="4" align="center">Module-3</td><td></td></tr>
<tr><td colspan="4">Supervised Learning
Kernels: Dual Representations, Constructing Kernels, Radial Basis Function Network, Gaussian Processes
Support Vector Machines: Maximum Margin Classifiers, Relevance Vector Machines
Neural Networks: Feed-forward Network, Network Training, Error Backpropagation(Ch:5,6,7)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="4" align="center">Module-4</td><td></td></tr>
<tr><td colspan="4">Unsupervised Learning:
Mixture Models: K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures, Alternative View of EM.
Dimensionality Reduction: Principal Component Analysis,</td><td>L1,L2,L3</td></tr>
</table>

Factor/Component Analysis, Probabilistic PCA, Kernel PCA, Nonlinear Latent Variable Models **(Ch.: 9,12)**	
Module-5	
Probabilistic Graphical Models: Bayesian Networks, Conditional Independence, Markov Random Fields, Inference in Graphical Models, Markov Model, Hidden Markov Models **(Ch.:8,13)**	**L1,L2,L3**

Course Outcomes: At the end of this course, students will be able to

- Identify areas where Pattern Recognition and Machine Learning can offer a solution.
- Describe the strength and limitations of some techniques used in computational Machine Learning for classification, regression and density estimation problems.
- Describe and model data.
- Solve problems in Regression and Classification.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

1. Pattern Recognition and Machine Learning. Christopher Bishop. Springer, 2006

IoT **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – III**			
Course Code	**18ECS333**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			
Course objectives: This course will enable students to: • Introduce concept of IOT and its applications in today's scenario. • Understand IOT content generation and transport through networks • Understand the devices employed for IOT data acquisition and communication access technologies • Introduce some use cases of IOT			

Module-1	**RBT**
What is IOT Genesis, Digitization, Impact, Connected Roadways, Buildings, Challenges **IOT Network Architecture and Design** Drivers behind new network Architectures, Comparing IOT Architectures, M2M architecture, IOT world forum standard, IOT Reference Model, Simplified IOT Architecture.	**L1, L2**
Module-2	
IOT Network Architecture and Design Core IOT Functional Stack, Layer1(Sensors and Actuators) , Layer 2(Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IOT Network management. Layer 3(Applications and Analytics) – Analytics vs Control, Data vs Network Analytics IOT Data Management and Compute Stack	**L2,L3**
Module-3	
Engineering IOT Networks Things in IOT – Sensors, Actuators, MEMS and smart objects. Sensor networks, WSN, Communication protocols for WSN Communications Criteria, Range Frequency bands, power consumption, Topology, Constrained Devices, Constrained Node Networks IOT Access Technologies, IEEE 802.15.4 Competitive Technologies – Overview only of IEEE 802.15.4g, 4e, IEEE 1901.2a Standard Alliances – LTE Cat0, Cat-M, NB-IOT	**L2,L3**

Module-4	
Engineering IOT Networks IP as IOT network layer, Key Advantages, Adoption, Optimization, Constrained Nodes, Constrained Networks, IP versions, Optimizing IP for IOT. Application Protocols for IOT – Transport Layer, Application Transport layer, Background only of SCADA, Generic web based protocols, IOT Application Layer Data and Analytics for IOT – Introduction, Structured and Unstructured data, IOT Data Analytics overview and Challenges.	**L3,L4**
Module-5	
IOT in Industry (Three Use cases) • IOT Strategy for Connected manufacturing, Architecture for Connected Factory • Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary substation grid block and automation. • Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart street lighting.	**L3,L4**

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Course Outcomes: After studying this course, students will be able to:

- Understand the basic concepts IOT Architecture and devices employed.
- Analyze the sensor data generated and map it to IOT protocol stack for transport.
- Apply communications knowledge to facilitate transport of IOT data over various available communications media.
- Design a use case for a typical application in real life ranging from sensing devices to analyzing the data available on a server to perform tasks on the device.

Text Book:

Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743

Reference Books:

Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examination and Syllabus
M.Tech POWER EECRTONICS (EPE)

Eligibility: Bachelor's degree in Engineering or Technology in
(a)Electrical and Electronics Engineering (b) Electronics and Communication Engineering
(c) Electronics and Telecommunication Engineering (d) Telecommunication Engineering
(e) Electronics and Instrumentation Engineering (f) Instrumentation Engineering
(g) Biomedical Engineering (h) Medical Electronics (i) AMIE in appropriate branch
(i) GATE: EC, IT, EE

(Effective from Academic year 2018-19)

BOARD OF STUDIES IN ELECTRICAL AND ELECTRONICS ENGINEERING

July 2018

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018 - 19
M.Tech POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18EEE11	Mathematical Methods in Control	04	--	03	40	60	100	4
2	PCC	18EPE12	Power Semiconductor Devices and Components	04	--	03	40	60	100	4
3	PCC	18EPE13	Power Electronic Converters	04	--	03	40	60	100	4
4	PCC	18EPE14	Modelling and Design of Controllers	04	--	03	40	60	100	4
5	PCC	18EPE15	Modelling and Analysis of Electrical Machines	04	--	03	40	60	100	4
6	PCC	18EPEL16	Power Electronics Laboratory - 1	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018 - 19
M.Tech POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18EPE21	Electric Drives	04	--	03	40	60	100	4
2	PCC	18EPE22	Switched - Mode Power Supplies	04	--	03	40	60	100	4
3	PCC	18EPE23	Power System Harmonics	04	--	03	40	60	100	4
4	PEC	18EPE24X	Professional elective 1	04	--	03	40	60	100	4
5	PEC	18EPE25X	Professional elective 2	04	--	03	40	60	100	4
6	PCC	18EPEL26	Power Electronics Laboratory - 2	--	04	03	40	60	100	2
7	PCC	18EPE27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		Professional Elective 2	
Course Code under 18EPE24X	**Course title**	**Course Code under 18EPE25X**	**Course title**
18EPE241	Converters for Solar and Wind Power Systems	18EPE251	FACTS Controllers
18EPE242	Uninterruptible Power Supply	18EPE252	Digital Power Electronics
18EPE243	Hybrid Electric Vehicles	18EPE253	Embedded Systems

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairperson, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018 - 19
M.Tech POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18EPE31	HVDC power Transmission	04	--	03	40	60	100	4
2	PEC	18EPE32X	Professional elective 3	04	--	03	40	60	100	4
3	PEC	18EPE33X	Professional elective 4	04	--	03	40	60	100	4
4	Project	18EPE34	Project work phase -1	--	02	--	100	--	100	2
5	Internship	18EPEI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		Professional elective 4	
Course Code under 18EPE32X	**Course title**	**Course Code under 18EPE33X**	**Course title**
18EPE321	MPPT in Solar Systems	18EPE331	Advanced Control Systems
18EPE322	EMC in Power Electronics	18EPE332	Power Quality Problems and Mitigation
18EPE323	Multilevel Converters for Industrial Applications	18EPE333	Multi-Terminal DC Grids

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairperson, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfying the internship requirements.

Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018 - 19
M.Tech POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	18EPE41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	**--**	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairperson, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

I SEMESRER M.Tech
POWER ELECTRONICS

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

MATHEMATICAL METHODS IN CONTROL
(Professional Core Course)

Course Code	18EEE11	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To introduce linear algebra in a best suitable approach for solving large number of equations using transformation methods.
- To understand the techniques of numerical methods for estimating high accuracy in finding the roots and, in solving differential equations and their applications. ■

Module-1		Teaching Hours
Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions. Matrix form of linear transformations-Illustrative examples. ■		**10**
Revised Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding	
Module-2		
Solution of Systems of Linear Equations: Direct methods-Relaxation method, Partition method, Croute's Triangularisation method. Eigen values and Eigen vectors. Bounds on Eigen Values. Jacobi method & Givens method for symmetric matrices. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding , L_3 – Applying	
Module-3		
Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process. SVD and Applications. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding , L_3 – Applying	
Module-4		
Probability: Random variables, Probability distributions: Binomial, Poisson, Normal distributions, Joint probability distribution (discrete and continuous)-Illustrative examples. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding	
Module-5		
Moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions-examples. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

18EEE11 MATHEMATICAL METHODS IN CONTROL
(Professional Core Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

1. Understand the fundamentals of vector space and bases in reference to transformations.
2. Solve system of linear equations using direct and iterative methods.
3. Use the idea of Eigen values and Eigen vectors for the application of SVD.
4. Describe the basic notions of discrete and continuous probability distributions.
5. Find out responses of linear systems using statistical and probability tools. ■

Graduate Attributes (As per NBA):

Critical Thinking, Problem Solving, Research Skill, Usage of Modern Tools.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question consisting of 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks				
1	Linear Algebra and its Applications	David C.Lay et al	Pearson	5th Edition,2015
2	Numerical Methods for Scientific and Engineering Computation	M. K. Jain et al	New Age International	9th Edition, 2014
Reference Books				
3	Signals, Systems, and Inference	Alan V. Oppenheim and George C. Verghese	Pearson	2012
4	Numerical methods for Engineers	Steven C Chapra and Raymond P Canale	McGraw-Hill	7th Edition, 2015
5	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th Edition, 2017
7	**Web links:** 1. *http://nptel.ac.in/courses.php?disciplineId=111* 2. *http://www.class-central.com/Course/math(MOOCs)* 3. *http://ocw.mit.edu/courses/mathematics/*			

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

POWER SEMICONDUCTOR DEVICES AND COMPONETS
(Professional Core Course)

Course Code	18EPE12	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To enhance the knowledge of fundamentals of semiconductor physics, power electronics and power computation in circuits
- To enhance the knowledge of fundamentals of various semiconductor devices, their operation and characteristics.
- To explain the design and operation of drive circuits and snubber circuits.
- To explain the controlling of temperature rise of the semiconductor devices and designing of magnetic components used for the power electronic circuits. ■

Module-1		Teaching Hours
Power Electronics: Introduction, Converter Classification, Power Electronics Concepts, Electronic Switches, Switch Selection, Spice, PSpice and Capture, Representation of switches in Pspice -The Voltage-Controlled Switch, Transistors, Diodes and Thyristors (SCRs). **Power Computations**: Introduction, Power and Energy, Inductors and Capacitors, Energy Recovery, Effective Values, Apparent Power and Power Factor, Power Computations for Sinusoidal AC Circuits, Power Computations for Nonsinusoidal Periodic Waveforms, Power Computations Using Pspice. **Basic Semiconductor Physics:** Introduction, Conduction Processes in Semiconductors pn Junctions, Charge Control Description of pn-Junction Operation, Avalanche Breakdown. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Power Diodes: Introduction, Basic Structure and I – V characteristics, Breakdown Voltage Considerations, On –State Losses, Switching Characteristics, Schottky Diodes. **Bipolar Junction Transistors:** Introduction, Vertical Power Transistor Structures, Z-V Characteristics, Physics of BJT Operation, Switching Characteristics, Breakdown Voltages, Second Breakdown, On-State Losses, Safe Operating areas. **Power MOSFETs :** Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Operating Limitations and Safe Operating Areas. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Thyristors: Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Methods of Improving di/dt and dv/dt Ratings. **Gate Turn-Off Thyristors:** Introduction, Basic Structure and Z-V Characteristics, Physics of Turn-Off Operation, GTO Switching Characteristics, Overcurrent Protection of GTOs. **Insulated Gate Bipolar Transistors:** Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Latchup in IGBTs, Switching Characteristics, Device Limits and SOAs. **Emerging Devices and Circuits:** Introduction, Power Junction Field Effect Transistors, Field-Controlled Thyristor, JFET-Based Devices versus Other Power Devices, MOS-Controlled Thyristors, Power Integrated Circuits, New Semiconductor Materials for Power Devices. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

18EPE12 POWER SEMICONDUCTOR DEVICES AND COMPONETS
(Professional Core Course) (continued)

Module-4		Teaching Hours
Snubber Circuits: Function and Types of Snubber Circuits, Diode Snubbers, Snubber Circuits for Thyristors, Need for Snubbers with Transistors, Turn-Off Snubber, Overvoltage Snubber, Turn-On Snubber, Snubbers for Bridge Circuit Configurations, GTO Snubber Considerations. **Gate and Base Drive Circuits:** Preliminary Design Considerations, dc-Coupled Drive Circuits, Electrically Isolated Drive Circuits, Cascode-Connected Drive Circuits, Thyristor Drive Circuits, Power Device Protection in Drive Circuits, Circuit Layout Considerations ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Component Temperature Control and Heat Sinks: Control of Semiconductor Device Temperatures, Heat Transfer by Conduction, Heat sinks, Heat Transfer by Radiation and Convection. **Design of Magnetic Components:** Magnetic Materials and Cores, Copper Windings, Thermal Considerations, Analysis of a Specific Inductor Design, Inductor Design Procedures, Analysis of a Specific Transformer Design, Eddy Currents, Transformer Leakage Inductance, Transformer Design Procedure, Comparison of Transformer and Inductor Sizes. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss power electronic concepts, electronic switches and semiconductor physics.
- Explain representation of switches in P-spice and power computations.
- Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; power diodes, power BJT, power MOSFET.
- Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; thyristors, power IGBT, power FET.
- Design Snubber circuits for the protection of power semiconductor devices.
- Design gate and base drive circuits for power semiconductor devices
- Design a heat sink to control the temperature rise of semiconductor devices
- Design magnetic components inductors and transformers used in the power electronic circuits. ■

Graduate Attributes (As per NBA):

Engineering Knowledge Problem, Analysis, Design / development of solutions, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power Electronics	Daniel W Hart	McGraw Hill	
2	Power Electronics Converters, Applications, and Design	Ned Mohan et al	Wiley	3rd Edition,2014
3	Semiconductor Device Modeling with Spice	G. Massobrio, P. Antognetti	McGraw-Hill	2nd Edition, 2010
4	Power Semiconductor Devices	B. Jayant Baliga	Springer	2008

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

POWER ELECTRONIC CONVERTERS (Professional Core Course)

Course Code	18EPE13	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To impart knowledge of PWM techniques in controlling the converter operation.
- To impart knowledge of designing and analyzing DC – DC PWM converters and control modules.
- To impart knowledge of designing and analyzing DC – AC and AC – DC converters.
- To impart knowledge of analyzing different types of resonant converters and their control.
- To impart knowledge of AC –AC converters and multilevel controllers. ■

Module-1		Teaching Hours
PWM DC/DC Converters: Forward Converters - Analysis of the Basic Circuit, Galvanically Isolated Forward Converter, Boost Converter - Analysis of the Basic Scheme, Variation of the Output Voltage, Boundary Between the Continuous and the Discontinuous Mode , Discontinuous Mode Power Losses, Indirect Converter - Boundary Between the Continuous and the Discontinuous Mode, Discontinuous Mode, Indirect Converter with Galvanic Separation, Push – Pull (Symmetric) Converters - Analysis of Idealized Circuit in Continuous Mode, Output Characteristics, Selection of Components, DC Premagnetization of the Core, Half-Bridge Converter, Bridge Converter, Hamilton Circuit, Ćuk Converters - Elimination of the Current Ripple, Ćuk Converters with Galvanic Isolation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Control Modules: Basic Principles and Characteristics of PWM Control Modules - Circuit Analysis, Simple PWM, Voltage-Controlled PWM, Current-Controlled PWM- Compensated PWM, IC Control Modules - Control Module TL494, Control Module SG1524/2524/3524, Control Module TDA 1060. **DC/AC Converters – Inverters:** Single-Phase Voltage Inverters - Pulse-Controlled Output Voltage, Pulse-Width Modulated Inverters - Unipolar PWM, Three-Phase Inverters-Overmodulation ($m_a > 1$), Asynchronous PWM, Space Vector Modulation - Space Vector Modulation: Basic Principles, Application of Space Vector Modulation Technique, Direct and Inverse Sequencing, Real Drive Influence. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
AC/DC Converters – Rectifiers: Half-Wave Single-Phase Rectifiers , Full-Wave Rectifiers - Commutation of Current, Output Filters - Capacitive Filter, L Filter,Voltage Doublers, Three-Phase Rectifiers, Phase Controlled Rectifiers - Full-Wave Thyristor Rectifiers, Three-Phase Thyristor Bridge Rectifiers, Twelve-Pulse Rectifiers, Rectifiers with Circuit for Power Factor Correction, Active Rectifier - Active Rectifier with Hysteresis Current Controller, PWM Rectifiers - Advanced Control Techniques of PWM Rectifiers , PWM Rectifier with Current Output, PWM Rectifiers in Active Filters, Some Topologies of PWM Rectifiers, Applications of PWM Rectifiers. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

18EPE13 POWER ELECTRONIC CONVERTERS
(Professional Core Course) (continued)

Module-4		**Teaching Hours**
Resonant Converters: Resonant Circuits - Resonant Converters of Class D, Series Resonant Converters, Parallel Resonant Converters, Series – Parallel Resonant Converter, Series Resonant Converters Based on GTO Thyristors, Class E Resonant Converters, DC/DC Converters Based on Resonant Switches - ZCS Quasi-resonant Converters, ZVS Quasi-resonant Converters, Multiresonant Converters, ZVS Resonant DC/AC Converters, Soft Switching PWM DC/DC Converters -Phase Shift Bridge Converters, Resonant Transitions PWM Converters, Control Circuits of Resonant Converters - Integrated Circuit Family UCx861-8, Integrated Circuits for Control of Soft, Switching PWM Converters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
AC/AC Converters: Single-Phase AC/AC Voltage Converters - Time Proportional Control Three-Phase Converters, Frequency Converters, Direct Frequency Converters, Introduction to AC/AC Matrix Converters - Basic Characteristics, Bidirectional Switches, Realization of Input Filter, Current Commutation, Protection of Matrix Converter, Application of Matrix Converter. **Introduction to Multilevel Converters:** Basic Characteristics -Multilevel DC/DC Converters, Time Interval: $nT < t < nT + DT$, $n = 0, 1, 2$,Time Interval: $nT + DT < t < (n + 1)T$, Multilevel Inverters - Cascaded H-Bridge Inverters, Diode-Clamped Multilevel Inverters, Flying Capacitor Multilevel Inverter, Other Multilevel Inverter Topologies, Control of Multilevel Inverters - Multilevel SPWM, Space Vector Modulation, Space Vector Control, Selective Harmonic Elimination. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Use the knowledge of PWM techniques in controlling different power electronic converters.
- Apply the knowledge of power electronics in design and analysis of DC –DC PWM converters.
- Design and analyze DC –AC and AC – DC converters and control their operation using PWM techniques.
- Design and analyze different resonant converters and their control circuits.
- Analyze AC – AC converters and multilevel converters. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power Electronics Converters and Regulators	Branko L. Doki ć Branko Blanu š a	Springer (International Publishing, Switzerland)	3rd Edition, 2015
2	Power Electronics Converters, Applications, and Design	Ned Mohan at el	Wiley	3rd Edition,2014

<table>
<tr><td colspan="4" align="center">M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I</td></tr>
<tr><td colspan="4" align="center">MODELLING AND DESIGN OF CONTROLLERS (Professional Core Course)</td></tr>
<tr><td>Course Code</td><td align="center">18EPE14</td><td>CIE Marks</td><td align="center">40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td align="center">04</td><td>Exam Hours</td><td align="center">03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td align="center">50</td><td>SEE Marks</td><td align="center">60</td></tr>
<tr><td colspan="4" align="center">Credits - 04</td></tr>
</table>

Course objectives:

- To impart knowledge required for modeling and computer simulation of power electronic converters and systems.
- To explain control system essentials in representing system in digital domain.
- To explain the designing of digital controllers by different methods.
- To explain the design and analysis of optimal and robust controllers by different methods.
- To impart knowledge of discrete computation essentials. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Computer Simulation of Power Electronic Converters and Systems: Introduction, Challenges in Computer Simulation, Simulation Process, Mechanics of Simulation, Solution Techniques for Time-Domain Analysis, Widely Used, Circuit-Oriented Simulators, Equation Solvers.
Modelling of Systems: Input-Output relations, Differential Equations and Linearization, State Space Representation, Transfer Function Representation, Block Diagrams, Lagrange method, Circuit Averaging, Bond Graphs, Space Vector Modelling. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Control System Essentials: Representation of system in digital Domain, The Z – Transform, Digital Filter, Mapping between s – plane and z – plane, Effect of Sampling, Continuous to Discrete Domain Conversion, Control System Basics, Control Principles, State - Space Method. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Digital Controller Design: Controller Design Techniques, Bode Diagram Method, PID Controller, Root Locus Method, State Space Method, Full State Feedback, Regulator Design by Pole Placement, Estimation Design, Tracker : Controller Design. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Digital Controller Design (continued): Controlling Voltage, Controlling Current, Control of Induction motor, Output Feedback, Induction motor Control with Output Feedback.
Optimal and Robust Controller Design: Least Squares Principle, Quadratic Forms, Minimum Energy Principle, Least Square Solution, Weighted Least Squares, Recursive Least Squares, Optimal Control: Linear Quadratic, Induction motor example, Robust Controller Design. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

18EPE14 MODELLING AND DESIGN OF CONTROLLERS
(Professional Core Course) (continued)

Module-5		**Teaching Hours**
Discrete Computation Essentials: Numeric Formats, Tracking the Base Point in the Fixed Point System, Normalization And Scaling, Arithmetic Algorithms. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Describe the role of computer simulations in the analysis and design of power electronics systems.
- Understand the functional modeling of static systems.
- Use sampling technique to determine a digital equivalent to a continuous time system.
- Understand the control basics of digital systems.
- Design digital controllers in discrete time and frequency domain.
- Design optimal and robust controllers by different methods.
- Explain essentials of discrete computation. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power Electronics Converters, Applications, and Design	Ned Mohan, Tore M. Undeland, William P. Robbins	Wiley	3rd Edition,2014
2	Power Electronics Essentials and Applications	L.Umanand	Wiley	1st Edition,2014

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - I			
MODELLING AND ANALYSIS OF ELECTRICAL MACHINES (Core Course)			
Subject Code	18EPE15	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To provide basic concepts of modelling of dc and ac machines.
- To provide knowledge of theory of transformation of three phase variable to two phase variable.
- To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modelling.
- To provide modeling concepts of single phase and three phase transformers.
- To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modelling. ■

Module-1		**Teaching Hours**
Basic Concepts of Modelling: Basic two pole machine representation of commutator machines, 3-phase synchronous machine with and without damper bar and 3-phase induction machine, Kron's primitive machine-voltage, current and torque equations. **DC Machine Modelling:** Mathematical model of separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor, linearization techniques for small perturbations. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Reference Frame Theory: Real time model of a two phase induction machine, transformation to obtain constant matrices, three phase to two phase transformation, power equivalence. **Dynamic Modelling of Three Phase Induction Machine:** Generalized model in arbitrary frame, electromagnetic torque, deviation of commonly used induction motor models-stator reference frames model, rotor reference frames model, synchronously rotating reference frames model, equations in flux linkages, per unit model, dynamic simulation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Small Signal Equations of the Induction Machine: Derivation of small signal equations of induction machine, space phasor model, DQ flux linkages model derivation, control principle of the induction motor. **Transformer Modelling:** Introduction, single phase transformer model, three phase transformer connections, per phase analysis, normal systems, per unit normalization, per unit three phase quantities, change of base, per unit analysis of normal system, regulating transformers for voltage and phase angle control, auto transformers, transmission line and transformers. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
Modelling of Synchronous Machines: Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park's equations, torque equations in substitute variables, rotor angle and angle between rotors, per unit system, analysis of steady state operation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

18EPE15 MODELLING AND ANALYSIS OF ELECTRICAL MACHINES
(Professional Core Course) (continued)

Module-5	Teaching Hours
Dynamic Analysis of Synchronous Machines: Dynamic performance during sudden change in input torque and during a 3-phase fault at the machine terminals, approximate transient torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque; first swing transient stability limit, comparison of actual and approximate transient torque-angle characteristics during a 3-phase fault at the machine terminals, critical clearing time, equal area criterion, computer simulation. ■	**10**
Revised Bloom's Taxonomy Level — L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the basic concepts of modeling.
- Develop mathematical models for DC motors for transient state analysis.
- Use reference frame theory to transform three phase to two phase.
- Develop dynamic model for three phase induction motor in stator ad rotor reference frames.
- Develop mathematical model of single phase transformers.
- Model synchronous machine using Park's transformation for the analysis of steady state operation.
- Model synchronous machine to perform dynamic analysis under different conditions. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Ethics,

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Generalized Theory of Electrical Machines	P.S.Bimbra	Khanna Publications	5th Edition,1995
2	Electric Motor Drives - Modelling, Analysis & Control	R. Krishnan	PHI Learning Private Ltd	Indian Edition, 2009
3	Analysis of Electrical Machinery and Drive Systems	P.C.Krause, et al	Wiley	2nd Edition,2010
4	Power System Analysis	Arthur R Bergen and Vijay Vittal	Pearson	2nd Edition,2009
5	Power System Stability and Control	Prabha Kundur	Mc Graw Hill	1st Edition,1994
6	Dynamic Simulation of Electric Machinery using Matlab / Simulink	Chee-Mun Ong	Prentice Hall	1998

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - I			
POWER ELECTRONIS LABORATORY-1 (Professional Core Course)			
Course Code	18EPEL16	CIE Marks	40
Number of Practical Hours/Week	04	Exam Hours	03
Total Number of Practical Hours	56	SEE Marks	60
Credits - 02			

Course objectives:

- To conduct experiment on various power electronic devices to analyze their static and dynamic characteristics.
- To conduct experiments and enhance understanding of different power electronic converters. ■

Sl. NO	Experiments
1	Analysis of static and dynamic characteristic of MOSFET and IGBT.
2	Performance of single phase fully controlled and semi-controlled converter for RL load for continuous current mode.
3	Performance of single phase fully controlled and semi-controlled converter for RL load for discontinuous current mode.
4	Study of effect of source inductance on the performance of single phase fully controlled converter.
5	Performance analysis of three phase fully controlled and semi-controlled converter for RL load for continuous current mode.
6	Performance analysis of three phase fully controlled and semi-controlled converter for RL load for discontinuous current mode.
7	Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation.
8	Performance analysis of two quadrant chopper.
9	Diode clamped multilevel inverter.
10	ZVS operation of a Synchronous buck converter.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Analyze the static and dynamic characteristics of various semiconductor devices.
- Apply the knowledge of converters in assessing the performance of single phase and three phase fully controlled and semi controlled converters for RL load for continuous current modes.
- Apply the knowledge of converters in assessing the performance of single phase and three phase fully controlled and semi controlled converters for RL load for discontinuous current modes.
- Assess the performance of single phase bridge inverter for RL load and control the voltage by pulse width modulation.
- Apply the knowledge of power electronics in performance analysis of chopper and synchronous buck converter. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Modern Tool Usage, Individual and Team work, Communication.

M.TECH POWER ELECTRONICS (EPE) **Outcome Based Education(OBE) and Choice Based Credit System (CBCS)** **SEMESTER - I**			
RESEARCH METHODOLOGY AND IPR **(Professional Core Course) and (Common to all M.Tech Programmes)**			
Course Code	18RMI17	CIE Marks	40
Number of Lecture Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	25	SEE Marks	60
Credits - 02			

Course objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.
- To explain several parametric tests of hypotheses and Chi-square test.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights. ■

Module		Teaching Hours
Module-1		
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. **Defining the Research Problem:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. **Data Collection**: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - I		
18RMI17 RESEARCH METHODOLOGY AND IPR **(Professional Core Course) and (Common to all M.Tech Programmes)**		
Module-4		**Teaching Hours**
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. **Intellectual Property:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Course outcomes: At the end of the course the student will be able to: • Discuss research methodology and the technique of defining a research problem • Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review. • Explain various research designs and their characteristics. • Explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections • Explain several parametric tests of hypotheses and Chi-square test. • Explain the art of interpretation and the art of writing research reports • Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR. ■		

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

18RMI17RESEARCH METHODOLOGY AND IPR
(Professional Core Course) and (Common to all M.Tech Programmes)

Graduate Attributes (As per NBA): Problem analysis, Investigation, Design, Individual and teamwork, Communication skills, Professionalism.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

1	Research Methodology: Methods and Techniques	C.R. Kothari, Gaurav Garg	New Age International	4th Edition, 2018
2	Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2)	Ranjit Kumar	SAGE Publications Ltd	3rd Edition, 2011
3	Study Material (For the topic Intellectual Property under module 5)	Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013		

Reference Books

1	An introduction to Research Methodology	Garg B.L et al	RBSA Publishers	2002
2	An Introduction to Multivariate Statistical Analysis	Anderson T.W	Wiley	3rd Edition, 2003
3	Research Methodology	Sinha, S.C, Dhiman	Ess Ess Publications	2002
4	Research Methods: the concise knowledge base	Trochim	Atomic Dog Publishing	2005
5	How to Write and Publish a Scientific Paper	Day R.A	Cambridge University Press	1992
6	Conducting Research Literature Reviews: From the Internet to Paper	Fink A	Sage Publications	2009
7	Proposal Writing	Coley S.M. Scheinberg, C.A	Sage Publications	1990
8	Intellectual Property Rights in the Global Economy	Keith Eugene Maskus	Institute for International Economics	2000

*** END ***

II SEMESRER M.Tech
POWER ELECTRONICS

<table>
<tr><td colspan="4">M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II</td></tr>
<tr><td colspan="4">ELECTRIC DRIVES (Professional Core Course)</td></tr>
<tr><td>Course Code</td><td>18EPE21</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50</td><td>SEE Marks</td><td>60</td></tr>
<tr><td colspan="4">Credits - 04</td></tr>
<tr><td colspan="4">Course objectives:
• To give an introduction to drive, their characteristics and breaking.
• To explain the basic elements of drives, classification of drives, their dynamics and speed control
• To explain selection of drive for a specific application.
• To explain control of an electric drive using microprocessor. ■</td></tr>
</table>

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Characteristics Electric motors: Introduction, Characteristics of DC motors, Three phase Induction Motors and Synchronous Motors, Braking of Electric Motors. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Dynamics of Electric Drives: Introduction, Classification of Electric Drives, Basic Elements of an Electric Drive, Dynamic Conditions of Drive System, Stability Considerations of Electric Drive.
Control of Electric Motors: Induction Motor Drives. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Control of Electric Motors (continued): Synchronous Motor Drives, DC Drives. Permanent Magnet Synchronous Motor, Classification of Permanent Magnet Synchronous Motor, Cycloconverters fed Synchronous Motor. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Control of Electric Motors (continued): Permanent Magnet Synchronous Motor, Classification of Permanent Magnet Synchronous Motor, Cycloconverters fed Synchronous Motor.
Applications: Drive Considerations foe Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives, Cement Mills, Sugar Mills, Machine Tools, Paper Mills, Coal Mines, Centrifugal Pumps, Turbo - compressors. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-5</td></tr>
<tr><td colspan="2">Microprocessors and Control of Electrical Drives: Introduction, Dedicated Hardware Systems versus Microprocessor Control, Applications Area and Functions of Microprocessors in Drive Technology, Control of Electric Drives using Microprocessors,Control System Design of Microprocessors based Variable Speed Drives, Stepper motors. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3"></td></tr>
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M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

18EPE21 ELECTRIC DRIVES
(Professional Core Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Explain characteristics of DC motors, induction motors and synchronous motors.
- Explain braking of electric motors.
- Classify electric drives.
- Discuss dynamics conditions and stability considerations of Electric drive.
- Control the speed of electric motors.
- Suggest a drive for a specific application.
- Explain using microprocessor in the control of an electric drive. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Electric Drives Concepts and Applications	Vedam Subrahmanyam	Mc Graw Hill	2nd Edition, 2016

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II			
SWITCHED - MODE POWER SUPPLIES (Professional Core Course)			
Course Code	18EPE22	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To give an overview on SMPS, its characteristics, new technologies, basic principles and control modes.
- To introduce the topology of DC/DC converter used and the method of selecting key peripheral components of SMPS.
- To explain the power factor correction circuit design of SMPS, the design of high-frequency transformer, the examples of SMPS optimization design, and the key design points of SMPS.
- To introduce the SMPS testing technology and the protection circuit design of SMPS. ■

Module-1		**Teaching Hours**
Switching-Mode Power Supply (SMPS): Overview, Classification of Integrated Regulated Power Supply, Characteristics of SMPS, New Development Trend of SMPS, Basic Principles of SMPS, Control Mode Type of SMPS, Working Mode of SMPS, Feedback Type of SMPS, Load Characteristics of SMPS. **Topologies of the DC/DC Converter:** Topologies of the DC/DC Converter, Basic Principle of Buck Converter, Basic Principle of - Boost Converter, Buck-Boost Converter, Charge Pump Converter, (Single-ended primary inductor converter)SEPIC, Flyback Converter, Forward Converter, Push-Pull Converter, Half/Full Bridge Converter, Soft Switching Converter, Half-Bridge LLC Resonant Converter,2-Switch Forward Converter. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Method for Selecting Key Peripheral Components of SMPS: Selection Method for - Fixed Resistor, Capacitors, Inductor Characteristics and Selection Method for Magnetic Beads, Selection Method for EMI Filter - Input Bridge Rectifier, Output Rectifier, Transient Voltage Suppressor (TVS), Power Switching Tube, Optical Coupler, Adjustable Precision Shunt Regulator, SMPS Protection Elements. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Power Factor Correction Circuit Design of SMPS: Brief Introduction to Power Factor Correction (PFC), Basic Principle of Passive PFC Circuit, Design Examples of Passive PFC Circuit, Basic Principle of Active PFC Circuit, Design Examples of Active PFC Circuit, Principle and Application of High-Power PFC, Measures to Suppress PFC Electromagnetic Interference, PFC Configuration Scheme. **Design of High-Frequency Transformer:** Selection Method for Magnetic Cores by the Empirical Formula or Output Power Table, Waveform Parameters of the High-Frequency Transformer Circuit, Formula Derivation of Selecting High-Frequency Transformer Magnetic Core Based on AP Method, Design of Flyback High-Frequency Transformer, Design of Forward High-Frequency Transformer, Loss of High-Frequency Transformer. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 – Applying.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

18EPE22 SWITCHED - MODE POWER SUPPLIES
(Professional Core Course) (continued)

Module-4		Teaching Hours
Key Design Points of SMPS: SMPS Design Requirements, Design of High-Efficiency SMPS, Methods of Reducing No-Load and Standby Power Consumption of SMPS, Stability Design of Optocoupler Feedback Control Loop SMPS Layout and Wiring, Design of Constant Voltage/Current SMPS, Design of Precision Constant Voltage/Current SMPS, Design of Remote Turn-Off Circuit for SMPS,Typical Application and Printed Circuit Design of New Single-Chip SMPS, Electromagnetic Interference Waveform Analysis and Safety Code Design of SMPS, Radiator Design of Single-Chip SMPS, Radiator Design of Power Switching Tube (MOSFET), Common Troubleshooting Methods of SMPS. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-5		
SMPS Testing Technology: Parameter Testing of SMPS, Performance Testing of SMPS, SMPS Measurement Skills, Accurate Measurement Method of Duty Ratio, Method to Detect the Magnetic Saturation of High-Frequency Transformer with Oscilloscope, Digital Online Current/Resistance Meter, Electromagnetic Compatibility Measurement of SMPS, Waveform Test and Analysis of SMPS. **Protection and Monitoring Circuit Design of SMPS:** Design of Drain Clamp Protection Circuit, Overvoltage Protection Circuit Constituted by Discrete Components, Application of Integrated Overvoltage Protector, Design of Undervoltage Protection Circuit, Design of Overcurrent and Overpower Protection Circuit, Design of Soft-Start Circuit, Mains Voltage Monitor, Transient Interference and Audio Noise Suppression Technology of SMPS, Design of Overheating Protection Component and Cooling Control System. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain a SMPS, its characteristics, new technologies, basic principles and control modes.
- Suggest a suitable DC/DC converter for an SMPS.
- Explain the method of selecting key peripheral components of SMPS.
- Design the power factor correction circuit of SMPS.
- Explain selection of magnetic core and designing of high-frequency transformer.
- Explain designing of different SMPS.
- Explain testing technology of SMPS.
- Design protection and monitoring circuit for SMPS.■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Ethics, Communication.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Optimal Design of Switching Power Supply	Zhanyou Sha et al	Wiley	2015

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II			
POWER SYSTEM HARMONICS (Professional Core Course)			
Course Code	18EPE23	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To explain about different sources of harmonics in power system.
- To explain effects of harmonics and mitigation of harmonics.
- To explain modeling of power system components for harmonic studies.
- Introducing different methods of harmonic studies. ■

Module		Teaching Hours
Module-1		
Fundamentals of Harmonics: Introduction, Examples of harmonic waveforms, characteristics of harmonics in power systems, measurement of harmonic distortion, power in passive elements, calculation of passive elements, resonance, capacitor banks and reactive power supply, capacitor banks and power factor correction, bus voltage rise and resonance, harmonics in transformers. **Harmonics in Power system:** Introduction, sources of harmonics, transformers, rotating machines, fluorescent lights, static var compensators, cycloconverters. Single phase controlled rectifiers, three phase converters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Effects of Harmonic Distortion on Power System: Introduction, thermal losses in a harmonic environment, harmonic effects on power system equipment, capacitor banks, transformers, rotating machines, protection, communication and electronic equipment. **Mitigation of Power system Harmonics:** Introduction, harmonic filters, power converters, transformers, rotating machines, capacitor banks, harmonic filter design, active filters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Limits of Harmonic Distortion: Introduction, voltage harmonic distortion limits, current harmonic distortion limits. **Harmonic studies – Modelling of System Components:** Introduction, impedance in the presence of harmonics, skin effect, modelling of the high voltage grid, generator modelling, modelling of shunt capacitor banks, series capacitor banks, load models, induction motor modelling. **Transformer Modelling:** Introduction, modelling of two winding transformers, phase sequence admittance matrices, transmission of voltage and current across two winding transformers, transmission matrices and phase admittance matrix, modelling of three and four winding transformers. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Modelling of Transmission lines/Cables: Introduction, skin effect, modelling of power lines, Line's series impedance, mutual coupling between conductors, mutually coupled lines, line's shunt capacitance, surge impedance and velocity of propagation, line's series impedance and shunt capacitance – single phase equivalents, the transmission (ABCD) matrix, the admittance matrix, conversion between the transmission and admittance matrices, the nominal pi model – single phase equivalent, the equivalent pi model – voltage and current the line, line losses, the equivalent pi model – single phase equivalent, variations in the network's short circuit capacity, examples – the nominal and equivalent models. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

18EPE23 POWER SYSTEM HARMONICS
(Professional Core Course) (continued)

Module-5		**Teaching Hours**
Power System Harmonic Studies: Introduction, harmonic analysis using a computer program, harmonic analysis using spread sheet, harmonic distortion limits, harmonic filter rating, and practical considerations. Harmonic study of simple system, 300 -22 kV power system and low voltage system. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the fundamentals that facilitate the understanding of the issues of harmonics.
- Explain the causes for generation of harmonics.
- Explain the effects of harmonics distortion on power system equipment and loads and suppression of harmonics in power systems.
- Discuss standard limits of harmonic distortion and modeling of power system components for harmonic analysis study.
- Model transmission lines and cables for harmonic analysis.
- Discuss implementation of harmonic studies. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Power System Harmonics	George J Wakileh	Springer	Reprint, 2014
2	Power System Harmonic Analysis	Jos Arrillaga et al	Wiley	Reprint, 2014
3	Power System Harmonic	J. Arrillaga, N.R. Watson	Wiley	2nd Edition, 2003
4	Harmonics and Power Systems	Francisco C. DE LA Rosa	CRC Press	1st Edition, 2006

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II			
CONVERTERS FOR SOLAR AND WIND POWER SYSTEMS (Professional Elective Course)			
Course Code	18EPE241	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To give an overview of the latest developments in the PV and WT penetrations in the worldwide power systems.
- To discusses the various high-efficiency topologies for PV inverters as well as some generic control structures.
- To describe the grid requirements for PV installations, to give a deep analysis of the basic PLL and to discuss different quadrature signal generator methods,
- To discuss islanding detection methods and to describe the most typical WT grid converter topologies together with generic control structures, the most recent grid requirements for WT grid connection and the grid codes.
- To extrapolate the knowledge of single-phase PLL structure for three-phase systems, new robust synchronization structures to cope with the unbalance grid or frequency adaptation.
- To explain the most used grid converter control structures for WT and to extrapolate the control issue for the case of grid faults.
- To explain designing of grid interface filters, methods actively used to damp the resonance for LCL filters and methods for controlling the grid current. ■

Module-1		Teaching Hours
Introduction: Wind Power Development, Photovoltaic Power Development, The Grid Converter – The Key Element in Grid Integration of WT and PV Systems. **Photovoltaic Inverter Structures:** Introduction, Inverter Structures Derived from H-Bridge Topology, Inverter Structures Derived from NPC Topology, Typical PV Inverter Structures, Three-Phase PV Inverters, Control Structures, Conclusions and Future Trends. **Grid Requirements for PV:** Introduction, International Regulations, Response to Abnormal Grid Conditions, Power Quality, Anti-islanding Requirements. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Grid Synchronization in Single-Phase Power Converters: Introduction, Grid Synchronization Techniques for Single-Phase Systems, Phase Detection Based on In-Quadrature Signals, Some PLLs Based on In-Quadrature Signal Generation, Some PLLs Based on Adaptive Filtering, The SOGI Frequency-Locked Loop. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Islanding Detection: Introduction, Non-detection Zone, Overview of Islanding Detection Methods, Passive Islanding Detection Methods, Active Islanding Detection Methods. **Grid Converter Structures for Wind Turbine Systems:** Introduction, WTS Power Configurations, Grid Power Converter Topologies, WTS Control. **Grid Requirements for WT Systems:** Introduction, Grid Code Evolution (Germany), Frequency and Voltage Deviation under Normal Operation, Active Power Control in Normal Operation, Reactive Power Control in Normal Operation (Germany), Behaviour under Grid Disturbances (Germany), Discussion of Harmonization of Grid Codes. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

18EPE241 CONVERTERS FOR SOLAR AND WIND POWER SYSTEMS
(Professional Elective Course) (continued)

Module-4		**Teaching Hours**
Grid Synchronization in Three-Phase Power Converters: Introduction, The Three-Phase Voltage Vector under Grid Faults, The Synchronous Reference Frame PLL under Unbalanced and Distorted Grid Conditions, The Decoupled Double Synchronous Reference Frame PLL (DDSRF-PLL), The Double Second-Order Generalized Integrator FLL (DSOGI-FLL). **Grid Converter Control for WTS:** Introduction, Model of the Converter, AC Voltage and DC Voltage Control, Voltage Oriented Control and Direct Power Control, Stand-alone, Micro-grid, Droop Control and Grid Supporting. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Control of Grid Converters under Grid Faults: Introduction, Overview of Control Techniques for Grid-Connected Converters under Unbalanced Grid Voltage Conditions, Control Structures for Unbalanced Current Injection, Power Control under Unbalanced Grid Conditions, Flexible Power Control with Current Limitation. **Grid Filter Design:** Introduction, Filter Topologies, Design Considerations, Practical Examples of LCL Filters and Grid Interactions, Resonance Problem and Damping Solutions, Nonlinear Behaviour of the Filter. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:

At the end of the course the student will be able to:

- Explain developments in the PV and WT penetrations in the worldwide power systems.
- Discuss the various high-efficiency topologies for PV inverters and generic control structures.
- Describe the grid requirements for PV installations, and different quadrature signal generator methods,
- Explain grid synchronization techniques for single phase power converters.
- Explain islanding detection methods and typical WT grid converter topologies, control structures, the grid requirements for WT grid connection and the grid codes.
- Explain grid synchronization of three phase power converters and new robust synchronization structures to cope with the unbalance and distorted grid conditions.
- Explain the grid converter control structures for WT and the control issue for the case of grid faults.
- Design grid interface filters used to damp the resonance for LCL filters and methods for controlling the grid current. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Grid Converters for Photovoltaic and Wind Power Systems	Remus Teodorescu at al	Wiley	2011

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II			
UNINTERRUPTIBLE POWER SUPPLY (Professional Elective Course)			
Course Code	18EPE242	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To explain the classification of UPS, batteries for UPS, parallel operation and performance evaluation and control of UPS systems.
- To describe sources of harmonics, effects of harmonics in UPS, and their mitigation using active filters.
- To describe different topologies of active filters, their applications, configurations, control methods, modelling and analysis, and stability issues.
- To explain the analysis, control, and steady-state operation of unified power quality conditioners.
- To give the concept of reduced parts converters, their operation, modelling, simulation and analysis.
- To explain reduced part active filters and power quality conditioners, modelling, analysis and design of digital control. ■

Module-1		**Teaching Hours**
Uninterruptible Power Supplies: Classification, Batteries for UPS Applications, Flywheels for UPS Applications, Comparative Analysis of Flywheels and Electrochemical Batteries, Applications of UPS Systems, Parallel Operation, Performance Evaluation of UPS Systems, Power Factor Correction in UPS Systems, Control of UPS Systems, Converters for UPS Systems, Battery Charger/Discharger. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Active Filters: Harmonic Definition, Harmonic Sources in Electrical Systems, Effects of Harmonics, Harmonic Mitigation Methods, Classification of Active Filters, Active Filters for DC/DC Converters, Modelling and Analysis, Control Strategies, Stability Assessment. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Unified Power Quality Conditioners: Series–Parallel Configuration, Current Control, Voltage Control, Power Flow and Characteristic Power. **Reduced-Parts Uninterruptible Power Supplies:** Concept of Reduced-Parts Converters Applied to Single-Phase On-Line UPS Systems, New On-Line UPS Systems Based on Half-Bridge Converters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
New On-Line UPS Systems Based on a Novel AC/DC Rectifier: New Three-Phase On-Line UPS System with Reduced Number of Switches, New Single-Phase to Three-Phase Hybrid Line-Interactive/On-Line UPS System. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Reduced-Parts Active Filters: Reduced-Parts Single-Phase and Three-Phase Active Filters, Reduced-Parts Single-Phase Unified Power Quality Conditioners, Reduced-Parts Single-Phase Series–Parallel Configurations, Reduced-Parts Three-Phase Series–Parallel Configurations. **Modelling, Analysis, and Digital Control:** Systems Modelling Using the Generalized State Space Averaging Method, Digital Control. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

18EPE242 UNINTERRUPTIBLE POWER SUPPLY
(Professional Elective Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Explain classification of UPS, batteries for UPS, parallel operation and performance evaluation and control of UPS systems.
- Describe sources of harmonics and their mitigation using active filters.
- Describe topologies of active filters, their applications, control methods, modeling analysis, and stability issues.
- Explain steady-state operation and control of unified power quality conditioners.
- Explain an on-line ups system based on novel AC/DC rectifier.
- Explain the concept of reduced parts active filters, their modeling and control. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Uninterruptible Power Supplies and Active Filters	Ali Emadi et al	CRC Press	2005
2	Uninterruptible Power Supplies and Standby Power Systems	Alexander C King, William Knight	McGraw-Hill	2003

M.TECH POWER ELECTRONICS (EPE) **Outcome Based Education(OBE) and Choice Based Credit System (CBCS)** **SEMESTER - II**			
HYBRID ELECTRIC VEHICLES (Professional Elective Course)			
Course Code	18EPE243	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
- To explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.
- To discuss various electric drives suitable for hybrid electric vehicles
- To discuss different energy storage technologies used for hybrid electric vehicles and their control.
- To explain modeling and simulation of electric hybrid vehicles by different techniques, sizing of components and design optimization and energy management. ■

Module-1	**Teaching Hours**
Introduction: Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs. **Hybridization of the Automobile:** Vehicle Basics, Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs). **HEV Fundamentals:** Introduction, Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Plug-in Hybrid Electric Vehicles: Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs, Vehicle-to-Grid Technology. **Power Electronics in HEVs:** Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC–DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC–DC Converter, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Modelling and Simulation of HEV Power Electronics, Emerging Power Electronics Devices, Circuit Packaging, Thermal Management of HEV Power Electronics. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-3	
Electric Machines and Drives in HEVs: Introduction, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-4	
Batteries, Ultracapacitors, Fuel Cells, and Controls: Introduction, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Modelling Based on Equivalent Electric Circuits, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

18EPE243 HYBRID ELECTRIC VEHICLES
(Professional Elective Course) (continued)

Module-5	**Teaching Hours**
Modelling and Simulation of Electric and Hybrid Vehicles: Introduction, Fundamentals of Vehicle System Modelling, HEV Modelling Using ADVISOR, HEV Modelling Using PSAT, Physics-Based Modelling, Bond Graph and Other Modelling Techniques, Consideration of Numerical Integration Methods, Conclusion. **HEV Component Sizing and Design Optimization**: Introduction, Global Optimization Algorithms for HEV Design, Model-in-the-Loop Design Optimization Process, Parallel HEV Design Optimization Example, Series HEV Design Optimization Example, Conclusion. **Vehicular Power Control Strategy and Energy Management:** A Generic Framework, Definition, and Needs, Methodology to Implement, Benefits of Energy Management. ■	**10**

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.

Course outcomes:

At the end of the course the student will be able to:

- Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
- Explain plug – in hybrid electric vehicle architecture, design and component sizing.
- Explain the use of different power electronics devices in hybrid electric vehicles.
- Suggest a suitable electric drive for a specific type of hybrid electric vehicle.
- Explain the use of different energy storage devices used for hybrid electric vehicles, their technologies and control.
- Simulate electric hybrid vehicles by different techniques for the performance analysis. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Modern Tool Usage, Individual and Team work, Communication.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Hybrid Electric Vehicles principles and Applications with Practical Perspectives	Chris Mi,M. Abul Masrur,David Wenzhong Gao	Wiley	2011

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II			
FACTS CONTROLLERS (Professional Elective Course)			
Course Code	18EPE251	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To discuss the growth of complex electrical power networks and to introduce the lack of controllability of the active- and reactive-power flows in energized networks.
- To describe the conventional controlled systems and introduce the basic operating principles of new FACTS devices
- To describe the various components of a general SVC, its control system, an overview of the voltage-control characteristics of SVC and the principles of design of the SVC voltage regulator.
- To explain the concepts of SVC control in such applications as stability enhancement, damping subsynchronous oscillations, improvement of HVDC link performance and the basic issues relating to the design of SVC controllers in different applications.
- To explain the concepts of series compensation, TCSC controller and its operation, characteristics, modeling and applications.
- To introduce voltage source converter based facts devices. ■

Module-1		Teaching Hours
Control Mechanism of Transmission System: Background, Electrical Transmission Networks, Conventional Control Mechanisms, Flexible ac Transmission Systems (FACTS), Emerging Transmission Networks. **Reactive-Power Control in Electrical Power Transmission Systems:** Reactive Power, Uncompensated Transmission Lines, Passive Compensation. **Principles of Conventional Reactive-Power Compensators:** Introduction, Synchronous Condensers, The Saturated Reactor (SR), The Thyristor-Controlled Reactor (TCR), The Thyristor-Controlled Transformer (TCT). ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Principles of Conventional Reactive-Power Compensators (continued): The Fixed Capacitor–Thyristor-Controlled Reactor (FC–TCR), The Mechanically Switched Capacitor–Thyristor-Controlled Reactor (MSC–TCR), The Thyristor-Switched Capacitor (TSC), The Thyristor-Switched Capacitor–Thyristor-Controlled Reactor (TSC–TCR), A Comparison of Different SVCs. **SVC Voltage Control:** Introduction Voltage Control. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
SVC Voltage Control (continued): Effect of Network Resonances on the Controller Response, The 2nd Harmonic Interaction between the SVC and ac Network, Application of the SVC to Series-Compensated ac Systems, 3rd Harmonic Distortion, Voltage-Controller Design Studies. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
SVC Applications: Introduction, Increase in Steady-State Power-Transfer Capacity, Enhancement of Transient Stability, Augmentation of Power-System Damping - Principle of the SVC, Auxiliary Control, Torque Contributions of SVC Controllers, Effect of the Power System, Effect of the SVC, SVC Mitigation of Subsynchronous Resonance (SSR) - Principle of SVC Control, Configuration and Design of the SVC Controller, Rating of an SVC, Prevention of Voltage Instability- Principles of SVC Control- A Case Study, Configuration and Design of the SVC Controller, Rating of an SVC.		**10**

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

18EPE251 FACTS CONTROLLERS
(Professional Elective Course) (continued)

Module-4 (continued)		**Teaching Hours**
The Thyristor-Controlled Series Capacitor (TCSC): Series Compensation, The TCSC Controller, Operation of the TCSC, The TSSC, Analysis of the TCSC, Capability Characteristics, Harmonic Performance, Losses, Response of the TCSC, Modelling of the TCSC. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
TCSC Applications: Introduction, Open-Loop Control, Closed-Loop Control, Improvement of the System-Stability Limit, Enhancement of System Damping, Subsynchronous Resonance (SSR) Mitigation, Voltage-Collapse Prevention. **VSC based FACTS Controllers:** Introduction, The STATCOM, The SSSC, The UPFC, Comparative Evaluation of Different FACTS Controllers. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the growth of complex electrical power networks, the lack of controllability of the active- and reactive-power flows in energized networks.
- Describe the conventional controlled systems and the basic operating principles of FACTS.
- Describe the various components of a general SVC, its control system, control characteristics and the design of the SVC voltage regulator.
- Explain the use of SVC in stability enhancement, damping subsynchronous oscillations, improvement of HVDC link performance.
- Explain the concepts of series compensation, TCSC controller and its operation, characteristics, modeling and applications.
- Explain the operation of voltage source converter based FACTS. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Thyristor-Based FACTs Controllers for Electrical Transmission Systems	R. Mohan Mathur Rajiv K. Varma	Wiley	2002
2	Understanding FACTS : concepts and technology of flexible AC Transmission systems	Narain G. Hingorani Laszlo Gyugyi.	Wiley	2000
3	Facts Controllers in Power Transmission and Distribution	K. R. Padiyar	New Age International	2007

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

DIGITAL POWER ELECTRONICS (Professional Elective Course)

Course Code	18EPE252	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To give introduction to multi quadrant operation and choppers, digital power electronic circuits, power semiconductor devices applied in power electronics and the important factors involved in digital power electronics.
- To explain basic mathematics of digital control systems and mathematical modeling of digitally controlled power electronic devices such as rectifiers, inverters and converters
- To explain open loop and closed loop control of power electronic devices and energy factor application of AC and DC motor drives. ■

Module		Teaching Hours
Module-1		
Introduction: Historical review, Traditional parameters, Multiple-quadrant operations and choppers, Digital power electronics: pump circuits and conversion Technology, Shortage of analog power electronics and conversion technology, Power semiconductor devices applied in digital power electronics. **Energy Factor (EF) and Sub-sequential Parameters:** Introduction, Pumping energy (PE), Stored energy (SE), Energy factor (EF), Variation energy factor (EFV),Time constant, τ, and damping time constant, τd, Examples of applications, Small signal analysis. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Basic Mathematics of Digital Control Systems: Introduction, Digital Signals and Coding, Shannon's sampling theorem, Sample-and-hold devices, Analog-to-digital conversion, Digital-to-analog conversion, Energy quantization, Introduction to reconstruction of sampled signals, Data conversion: the zero-order hold, The first-order hold, The second-order hold, The Laplace transform (the s-domain), The z-transform (the z-domain), **Mathematical Modelling of Digital Power Electronics:** Introduction, A zero-order hold (ZOH) for AC/DC controlled rectifiers, A first-order transfer function for DC/AC pulse-width-modulation Inverters, A second-order transfer function for DC/DC converters, A first-order transfer function for AC/AC (AC/DC/AC) converters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3		
Digitally Controlled DC/AC Inverters: Introduction, Mathematical modelling for DC/AC PWM inverters, Single-phase half-wave VSI, Single-phase full-bridge PWM VSI, Three-phase full-bridge PWM VSI, Three-phase full-bridge PWM CSI, Multistage PWM inverter, Multilevel PWM inverter. **Digitally Controlled DC/DC Converters:** Introduction, Mathematical Modelling for power DC/DC converters, Fundamental DC/DC converter, Developed DC/DC converters, Soft-switching converters, Multi-element resonant power converters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-4		
Digitally Controlled AC/AC Converters: Introduction, Traditional modelling for AC/AC (AC/DC/AC) converters, Single-phase AC/AC converter, Three-phase AC/AC voltage controllers, SISO cycloconverters, TISO cycloconverters, TITO cycloconverters, AC/DC/AC PWM converters, Matrix converters. **Open-loop Control for Digital Power Electronics:** Introduction, Stability analysis, Unit-step function responses, Impulse responses.		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II		
18EPE252 DIGITAL POWER ELECTRONICS **(Professional Elective Course) (Continued)**		
Module-5		**Teaching Hours**
Closed-Loop Control for Digital Power Electronics: Introduction, PI control for AC/DC rectifiers, PI control for DC/AC inverters and AC/AC (AC/DC/AC) converters, PID control for DC/DC converters. **Energy Factor Application in AC and DC Motor Drives:** Introduction, Energy storage in motors, A DC/AC voltage source, An AC/DC current source, AC motor drives, DC motor drives. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:

At the end of the course the student will be able to:

- Explain traditional parameters computation, multiple quadrant operation and choppers.
- Explain the disadvantages of analog power electronics and conversion technology, energy factor and sub-sequential parameters.
- Explain basic mathematics of digital control systems and mathematical modeling of digitally controlled power electronic devices such as rectifiers, inverters and converters.
- Describe mathematical modeling of AC/DC rectifiers, DC/AC inverters, DC/DC converters and AC/AC (AC/DC/AC) converters are working in the discrete-time state.
- Discuss DC/AC pulse-width-modulation (PWM) inverters and AC /AC converters modeled as a first-order-hold (FOH) element in digital control systems.
- Discuss DC/DC converter modeled as a second order-hold (SOH) element in digital control systems.
- To explain open loop and closed loop control of power electronic devices and energy factor application of AC and DC motor drives. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Digital Power Electronics and Applications	Fang Lin Luo, Hong Ye, Muhammad Rashid	Elsevier	2005

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II			
EMBEDDED SYSTEMS (Professional Elective Course)			
Course Code	18EPE253	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To impart knowledge of embedded systems with suitable examples, explanation of process, classification of embedded systems.
- To explain the processor architecture, memory organization, communication with processor and interrupt services.
- To explain the program modeling concepts, inter-process communication and synchronization of processes. ■

Module-1		Teaching Hours
Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Embedded Systems – on –chip (Soc) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design of Process in Embedded System, Formulation of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skill required for an Embedded System Designer. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Processor Architecture and Memory Organisation: 8051 Architecture, Real world Interfacing, Introduction to Advanced Architecture, Processor and Memory Organization, Instruction Level Parallelism, Performance Metrics, Memory – Types, Memory – Maps and Addresses, Processor Selection, Memory Selection. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Devices and Communication Buses, Interrupt Services: IO Types and Examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing Features in Device Ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Serial Bus Device Protocols – Parallel Communication Network Using ISA,PCI, PCI –X and Advanced Protocols. **Device Drivers and Interrupts Service Mechanisms:** Programmed – I/O Busy – wait Approach without Interrupt Service Mechanism, ISR Concept, Interrupt Sources, Interrupt Servicing Mechanism, Direct Memory Access. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Program Modelling concepts: Program Models, DFG Models, State Machine Programming Models for Event – controlled Program Flow, Modelling of Multiprocessor Systems, UML Modelling. **Interprocess Communication and Synchronization of Processes, Threads and Tasks:** Multiple Processes in an Application, Multiple Threads in an Application, Tasks, Task Status, Task and Data, Clear – cut Distention Between Functions, ISRS and Tasks by their Characteristics, Concept of Semaphores, Shared Data, Interprocess Communication, Signal Function, Semaphore Functions, Message Queue Functions, Mailbox Functions, Pipe Functions, Socket Functions, RPC Functions. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - II	
18EPE253 EMBEDDED SYSTEMS (Professional Elective Course) (Continued)	
Module-5	**Teaching Hours**
Real - Time Operating Systems: OS Services, Process Management, Timer Functions, Event Functions, Memory management, Device, File and IO Subsystems Management , Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real – time Operating Systems, Basic Design Using an RTOS, Rtos Task Scheduling Models, Interrupt Latency and Response of the task as performance Metrics, OS Security Issues. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Explain design process in embedded system and formulation of system design.
- Describe processor architecture and memory organization.
- Describe the devices; serial port, parallel port devices, timing devices, devices for synchronous iso-synchronous and asynchronous communication.
- Describe device drivers and interrupt mechanisms.
- Explain the programming concepts and source code engineering tools for embedded programming.
- Explain real time programming and program modeling concepts during single and multi-processor system software development process.
- Describe real time operating systems concepts. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Embedded Systems: Architecture, Programming and Design	Raj Kamal	Mc Graw Hill	2nd Edition,2014

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

POWER ELECTRONIS LABORATORY-2

Course Code	18EPEL26	CIE Marks	40
Number of Practical Hours/Week	04	Exam Hours	03
Total Number of Practical Hours	56	SEE Marks	60

Credits - 02

Course objectives:

- To conduct experiments to assess the performance of separately excited DC motor fed by single phase and three phase fully controlled converter in continuous and discontinuous current modes.
- To conduct experiments to assess the performance of Chopper fed DC drives for class A and class C commutation in continuous current mode.
- To simulate different converters and analyze the waveform in continuous and discontinuous current modes.
- To simulate forward converter, fly back converter and resonant converter to study their performance. ■

Sl. NO	Experiments
1	Study and performance analysis of single phase fully controlled converter fed separately excited DC Motor for continuous current mode.
2	Study and performance analysis of single phase fully controlled converter fed separately excited DC Motor for discontinuous current mode.
3	Study and performance analysis of three phase fully controlled converter fed separately excited DC Motor for continuous current mode.
4	Study and performance analysis of three phase fully controlled converter fed separately excited DC Motor for discontinuous current mode.
5	Performance analysis of a practical chopper fed DC Drives system for class-A and class-C commutation and analysis of wave forms in continuous mode.
6	Simulation study of buck, boost and buck- boost converter (basic topologies) and analysis of wave forms for continuous current mode (CCM).
7	Simulation study of buck, boost and buck-boost converter (basic topologies) and analysis of wave forms for discontinuous current mode (DCM).
8	Simulation study of forward converter and fly back converter and performance analysis of various wave forms.
9	Resonant converter simulation study and analysis.
10	Closed loop operation of a buck and boost converter.

Revised Bloom's Taxonomy Level	L_1- Remembering, L_2 – Understanding L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.

Course outcomes:

At the end of the course the student will be able to:

- Conduct experiments on single phase / three phase fully controlled converter fed separately excited DC motor to assess the performance in continuous and discontinuous current modes.
- Conduct experiments to assess the performance of Chopper fed DC drives for class A and class C commutation in continuous current mode.
- Simulate different converters for analyzing the waveform in continuous and discontinuous current modes.
- Simulate forward converter, fly back converter and resonant converter to study their performance. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Modern Tool Usage, Individual and Team work, Communication.

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - II

TECHHNICAL SEMINAR

Course Code	18EPE27	CIE Marks	100
Number of contact Hours/week	02	Exam Hours	--
Total No. of contact Hours	--	SEE Marks	--

Credits - 02

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.
Each student, under the guidance of a Faculty, is required to

- Choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with

Marks distribution for CIE of the course 18EPE27 seminar:

Seminar Report: 30 marks
Presentation skill:50 marks
Question and Answer:20 marks

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

*** END ***

III SEMESRER M.Tech
POWER ELECTRONICS

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

HVDC POWER TRANSMISSION (Professional Core Course)

Course Code	18EPE31	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To give an introduction to DC power transmission and describe the basic components of a converter, and describe the methods for compensating the reactive power demanded by the converter and the methods for simulation of HVDC systems
- To describe the types of filters for removing harmonics and the characteristics of the system impedance resulting from AC filter designs and different methods of control of HVDC converter and system.
- To explain the design techniques for the main components of an HVDC system.
- To explain the protection of HVDC system and other converter configurations used for the HVDC transmission and the recent trends for HVDC applications. ■

Module-1	Teaching Hours
HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, Review of the HVDC System Reliability, HVDC Characteristics and Economic Aspects. **Power Conversion:** Thyristor, 3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

Module-2	
Harmonics of HVDC and Removal: Introduction, Determination of Resulting Harmonic Impedance, Active Power Filter. **Control of HVDC Converter and System:** Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

Module-3	
Control of HVDC Converter and System (continued): HVDC Control Functions, Reactive Power and Voltage Stability. **Interactions between AC and DC Systems**: Definition of Short Circuit Ratio and Effective Short Circuit Ratio, Interaction between HVDC and AC Power System. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

Module-4	
Main Circuit Design: Converter Circuit and Components, Converter Transformer, Cooling System, HVDC Overhead Line, HVDC Earth Electrodes, HVDC Cable, HVDC Telecommunications Current Sensors, HVDC Noise and Vibration. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

Module-5	
Fault Behaviour and Protection of HVDC System: Valve Protection Functions, Protective Action of an HVDC System, Protection by Control Actions, Fault Analysis. **Other Converter Configurations for HVDC Transmission**: Introduction, Voltage Source Converter (VSC), CCC and CSCC HVDC System, 10.4 Multi-Terminal DC Transmission. **Trends for HVDC Applications:** Wind Farm Technology, Modern Voltage Source Converter (VSC) HVDC Systems, 800 kV HVDC System. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

18EPE31 HVDC POWER TRANSMISSION
(Professional Core Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Explain importance of DC power transmission.
- Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter
- Explain the methods for simulation of HVDC systems and its control.
- Describe filters for eliminating harmonics and the characteristics of the system impedance resulting from AC filter designs
- Explain the design techniques for the main components of an HVDC system.
- Explain the protection of HVDC system and other converter configurations used for the HVDC transmission.
- Explain the recent trends for HVDC applications. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	HVDC Transmission: Power Conversion Applications in Power Systems	Chan-Ki Kim et al	Wiley	2009
2	Direct Current Transmission	E.W. Kimbark	Wiley	1971
3	High Voltage Direct Current Transmission	Arrilaga	IET	2nd Edition, 1998
4	HVDC Transmission	S. Kamakshaiah et al	Mc Graw Hill	2011
5	HVDC and FACTs Controllers; Applications of Static Converters in Power Systems	Vijay K Sood	BSP Books	2013
6	HVDC Power Transmission Systems	K. R. Padiyar	New Age International	2012

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

MPPT IN SOLAR SYSTEMS (Professional Elective Course)

Course Code	18EPE321	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To explain the PV cell, its characteristics and its models, equivalent circuits and circuit parameter calculations.
- To explain different methods of tracking maximum power point and effect of noise on MPPT and reduction of noise.
- To explain distributed Maximum Power Point Tracking of PV arrays and its analysis.
- To explain the design of high energy efficiency power converters for PV MPPT. ■

Module-1		Teaching Hours
PV Modelling: From the Photovoltaic Cell to the Field, The Electrical Characteristic of a PV Module, The Double-Diode and Single-Diode Models, From Data Sheet Values to Model Parameters, Example: PV Module Equivalent Circuit Parameters Calculation, The Lambert W Function for Modelling a PV Field, Example. **Maximum Power Point Tracking:** The Dynamic Optimization Problem, Fractional Open-Circuit Voltage and Short-Circuit Current, Soft Computing Methods, The Perturb and Observe Approach. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Maximum Power Point Tracking (continued): Improvements of the P&O Algorithm, Evolution of the Perturbative Method, PV MPPT via Output Parameters, MPPT Efficiency. **MPPT Efficiency: Noise Sources and Methods for Reducing their Effects:** Low-Frequency Disturbances in Single-Phase Applications, Instability of the Current-Based MPPT Algorithms, Sliding Mode in PV System, Analysis of the MPPT Performances in a Noisy Environment, Numerical Example. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Distributed Maximum Power Point Tracking of Photovoltaic Arrays: Limitations of Standard MPPT, A New Approach: Distributed MPPT, DC Analysis of a PV Array with DMPPT, Optimal Operating Range of the DC Inverter Input Voltage. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Distributed Maximum Power Point Tracking of Photovoltaic Arrays (continued): AC Analysis of a PV Array with DMPPT. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Design of High-Energy-Efficiency Power Converters for PV MPPT Applications: Introduction, Power, Energy, Efficiency, Energy Harvesting in PV Plant Using DMPPT Power Converters, Losses in Power Converters, Losses in the Synchronous FET Switching Cells, Conduction Losses, Switching Losses. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

18EPE321 MPPT IN SOLAR SYSTEMS
(Professional Elective Course) (continued

Course outcomes:

At the end of the course the student will be able to:

- Explain the PV cell, its characteristics and its models, equivalent circuits and circuit parameter calculations.
- Explain different methods of tracking maximum power point.
- Explain the sources of noise, effect of noise on MPPT and reduction of noise.
- Explain Distributed Maximum Power Point Tracking of PV arrays.
- Conduct DC analysis of PV array with DMPPT.
- Conduct AC analysis of PV array with DMPPT.
- Explain the use of high energy efficiency power converters for PV MPPT application.■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Power electronics and Control Techniques for Maximum energy harvesting in Photovoltaic systems	Nicola Femia et al	CRC Press	2013

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

EMC IN POWER ELECTRONICS (Professional Elective Course)

Course Code	18EPE322	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To explain different electromagnetic disturbances and their classification.
- To explain measurement of the high frequency characteristics of EMI filter elements, their selection and measurement.
- To explain suppression of noise in relay systems.
- To explain designing and analysis of EMI filters.
- To explain conduction of test as per IEC specifications and reducing internal EMI. ■

Module-1		Teaching Hours
Electromagnetic Disturbances: Introduction, Classification of disturbances by frequency content, by character and transmission mode. **Conducted EMI Measurement:** Introduction, EMI measuring instruments, Basic terms and conducted EMI references, Measuring the interference voltage and current, Spectrum analysers, EMI measurements for consumer applications, Measuring impulse like EMI. **EMI in Power Electronic Equipment:** EMI from power semiconductors, controlled rectifier circuits, EMI calculation for semiconductor equipment. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
EMI Filter Elements: Measuring High Frequency Characteristics OF EMI Filter Elements, Capacitors, Choke Coils, Resistors. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Noise Suppression: Noise Suppression in Relay Systems, Application of AC Switching Relays, Application of RC – Snubbers to Power Semiconductors, Shielded Transformers, Capacitor Filters, EMI Generation and Reduction at its Source, Influence of Layout and Control of Parasitics. **EMI Filter Circuit selection and measurement:** Definition of EMI Filter Parameters, ENI Filter Circuits, Insertion Loss Test Methods. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
EMI Filter Design: EMI Filter Design for Insertion Loss, Calculation of Worst – case Insertion Loss, Design Method for Mismatched Impedance Condition, Design Method for EMI Filters with Common – Mode Choke Coils, Damped EMI Filters and Lossy Filter Elements, HF Characteristics of Noise Filter Circuit Elements, EMI Filter Layout. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Testing for Susceptibility to Power Line Disturbances: Surge Voltages in AC Power Mains, EMC Tests per IEC Specifications, Other EMS Test Methods. **Reduction Techniques for internal EMI:** Conductive Noise Coupling, Electromagnetic Coupling, Electromagnetic Coupling Reduction Methods, Wiring Layout Methods to Reduce EMI Coupling, PCB Design Considerations. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

18EPE322 EMC IN POWER ELECTRONICS
(Professional Elective Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Describe Electromagnetic interference and its classification and measurement of conducted high frequency disturbance.
- Survey electromagnetic interference specific to power electronic equipment.
- Explain the characteristics of circuit elements used for noise suppression.
- Explain EMI suppression methods used in semiconductor and electromechanical devices.
- Explain design of EMI filter circuits and filtering methods.
- Explain susceptibility and noise withstand capability test.
- Explain EMS reduction techniques for power electronic equipment. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Electromagnetic Compatibility in Power Electronics	Laszlo Tihanyi	Newnes	1st Edition, 1995

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

MULTILEVEL CONVERTERS FOR INDUSTRIAL APPLICATIONS (Professional Elective Course)

Course Code	18EPE323	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To provide an overview of medium-voltage power converters and their applications.
- To describe the generalized multilevel converter topology and to derive the classic converters with a common DC bus and to analyze the common characteristics of the symmetric topologies.
- Explain the analysis of the operation of the diode-clamped multilevel converter, and a multilevel space vector modulation and to characterize the balancing boundary of the passive front-end converter
- To describe the operation and analysis of the flying capacitor multilevel converter.
- To explain asymmetric topology with hybrid modulation and a common DC source called a cascade asymmetric multilevel converter (CAMC) with five voltage levels and its advantages.
- To analysee the behaviour of the CAMC as a distribution static compensator (DSTATCOM) and shunt active power filter in improving the power quality in medium-voltage distribution systems as custom power devices.
- To analyse the behaviour of the diode-clamped topology configured as a back-to-back converter for several working conditions. ■

Module-1		Teaching Hours
Converters: Introduction, Medium-Voltage Power Converters, Multilevel Converters, Applications. **Multilevel Topologies:** Introduction, Generalized Topology with a Common DC Bus, Converters Derived from the Generalized Topology, Symmetric Topologies without a Common DC Link, Summary of Symmetric Topologies, Asymmetric Topologies. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating	
Module-2		
Diode-Clamped Multilevel Converter: Introduction, Converter Structure and Functional Description, Modulation of Multilevel Converters, Voltage Balance Control, Effectiveness Boundary of Voltage Balancing in DCMC Converters, Performance Results. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating	
Module-3		
Flying Capacitor Multilevel Converter: Introduction, Flying Capacitor Topology, Modulation Scheme for the FCMC, Dynamic Voltage Balance of the FCMC. **Cascade Asymmetric Multilevel Converter (CAMC):** Introduction, General Characteristics of the CAMC, CAMC Three-Phase Inverter, Comparison of the Five-Level Topologies. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating	
Module-4		
Case Study 1: DSTATCOM Built with a Cascade Asymmetric Multilevel Converter: Introduction, Compensation Principles, CAMC Model, Reactive Power and Harmonics Compensation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating	
Module-5		
Case Study 2: Medium-Voltage Motor Drive Built with DCMC: Introduction, Back-to-Back DCMC Converter, Unified Predictive Controller of the Back-to-Back DCMC in an IM Drive Application, Performance Evaluation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analyzing, L_5 - Evaluating, L_6 - Creating	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

18EPE323 MULTILEVEL CONVERTERS FOR INDUSTRIAL APPLICATIONS
(Professional Elective Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Explain the working of medium-voltage power converters and their applications.
- Explain multilevel, symmetric and asymmetric topologies.
- Explain the structure and operation of the diode-clamped multilevel converter, and a multilevel space vector modulation.
- Characterize the balancing boundary of the passive front-end converter.
- Describe the operation and analysis of the flying capacitor multilevel converter.
- Discuss the characteristics topologies of the Cascade Asymmetric Multilevel Controller.
- Explain the working of a distribution static compensator (DSTATCOM) built with CAMC for reactive power and harmonic compensation.
- Evaluate the performance of back-to-back converter in an induction motor drive for several working conditions. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Multilevel Converters for Industrial Applications	Sergio Alberto González, Santiago Andrés Verne, María Inés Valla	CRC Press	2014

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - III			
ADVANCED CONTROL SYSTEMS (Professional Elective Course)			
Course Code	18EPE331	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To impart basic knowledge about digital control through signal conversion, their representation, z – transform, stability analysis in the z – plane, signal reconstruction .etc.
- Development of models of systems in the digital domain, and their implementation.
- To perform state variable method of analysis of digital control systems.
- To impart knowledge of optimal control system analysis in continuous and discrete time domains.
- To impart knowledge about the analysis of nonlinear control systems. ■

Module-1		Teaching Hours
Digital Control: Control System Terminology, Need of Digital control, Configurations of the Basic Digital Control Scheme, Principle of Signal Conversion, Basic Discrete – Time Signals, Time Domain Models for Discrete – Time Systems, The z – Transform, Transfer Function Models, Frequency Response, Stability on the z – Plane and Jury Stability Criterion, Sample and Hold Systems, Sampled Spectra and Aliasing, Reconstruction of Analog Signals, Practical Aspects of the choice of Sampling Rate, Principle of Discretization. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Models of Digital Control Devices and Systems: Introduction, z – Domain Description of Sampled Continuous – time Plants, z – Domain Description of Samples with Dead – Time, Implementation of Digital Controllers, Tunable PID Controllers, Digital Temperature and Position Control Systems, Stepping Motors and their Control. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
State Variable Analysis of Digital Control Systems: Introduction, State Description of Digital Processors, State Description of Sampled continuous – Time Plants, State Description of Systems with Dead Time, Solution of State Difference Equations, Controllability and Observability, Multivariable Systems. **Pole Placement Design and State Observers:** Introduction, Stability Improvement by State Feedback, Necessary and sufficient Conditions for Arbitrary Pole – Placement, State Regulator Design, Design of State Observers, Compensator Design by the Separation Principle, Servo Design – Introduction of the reference Input by Feedforward Control, State Feedback with Integral Control, Digital Control Systems with State Feedback, Deadbeat control by State Feedback and Deadbeat Observers. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Quadratic Optimal Control: Introduction, The Concept of Lyapunov Stability, Lyapunov Functions for Linear Systems, Parameter Optimization and Optimal Control Problems, Quadratic Performance Index, Control Configurations, Optimal State Regulator, Optimal Digital Control Systems, Constrained State Feedback Control. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

18EPE331 ADVANCED CONTROL SYSTEMS
(Professional Elective Course) (continued)

Module-5		Teaching Hours
Nonlinear System Analysis: Introduction, Common nonlinear System Behaviours, Common nonlinearities in Control Systems, Describing Function Fundamentals, Describing Function of Common nonlinearities, Stability Analysis by the Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Evaluate Z transform of a continuous time signal.
- Assess the stability of a system in Z domain.
- Explain the process of reconstructing the analog signal from a digital signal.
- Model the digital systems to analyze them in the digital domain.
- Use state variable representation to design control law and observers for a system in both continuous and discrete time domains.
- Solve optimal control problems.
- Construct Lyapunov functions to evaluate the stability of a system.
- Use describing function, phase plane methods and Lyapunov method to assess the stability of the nonlinear system. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Digital Control and State Variable Methods (Conventional and Intelligent Control Systems)	M Gopal	Mc Graw Hill	3rd Edition, 2008
2	Discrete – Time Control Systems	Katsuhiko Ogata	Pearson	2nd Edition, 2015
3	Digital Control Systems	Benjamin C Kuo	Oxford University Press	2nd Edition, 2007
4	Control System Engineering	I.J. Nagrath M.Gopal	New Age International	5th Edition, 2007

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - III			
POWER QUALITY PROBLEMS AND MITIGATION (Professional Elective Course)			
Course Code	18EPE332	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60
Credits - 04			

Course objectives:

- To give an introduction on power quality (PQ), causes and effects of PQ problems, requirement of PQ improvements, and mitigation aspects of PQ problems.
- To give PQ definitions, terminologies, standards, benchmarks, monitoring requirements through numerical problems.
- To explain passive shunt and series compensation using lossless passive LC components, active shunt compensation using DSTATCOM (distribution static compensators), active series compensation using DVR (dynamic voltage restorer), and combined compensation using UPQC (unified power quality compensator) for mitigation of current-based PQ problems.
- To explain classification, modeling and analysis of various nonlinear loads which cause the power quality problems. ■

Module-1		**Teaching Hours**
Power Quality: Introduction, State of the Art on Power Quality, Classification of Power Quality Problems, Causes of Power Quality Problems, Effects of Power Quality Problems on Users, Classification of Mitigation Techniques for Power Quality Problems. **Power Quality Standards and Monitoring:** Introduction, State of the Art on Power Quality Standards and Monitoring, Power Quality Terminologies, Power Quality Definitions, Power Quality Standards, Power Quality Monitoring, Numerical Examples. **Passive Shunt and Series Compensation:** Introduction, State of the Art on Passive Shunt and Series Compensators, Classification of Passive Shunt and Series Compensators, Principle of Operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators, Modelling, Simulation, and Performance of Passive Shunt and Series Compensators, Numerical Examples. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Active Shunt Compensation: Introduction, State of the Art on DSTATCOMs, Classification of DSTATCOMs, Principle of Operation and Control of DSTATCOMs, Analysis and Design of DSTATCOMs, Modelling, Simulation, and Performance of DSTATCOMs, Numerical Examples. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Active Series Compensation: Introduction, State of the Art on Active Series Compensators, Classification of Active Series Compensators, Principle of Operation and Control of Active Series Compensators, Analysis and Design of Active Series Compensators, Modelling, Simulation, and Performance of Active Series Compensators, Numerical Examples. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Unified Power Quality Compensators: Introduction, State of the Art on Unified Power Quality Compensators, Classification of Unified Power Quality Compensators, Principle of Operation and Control of Unified Power Quality Compensators, Analysis and Design of Unified Power Quality Compensators, Modelling, Simulation, and Performance of UPQCs, Numerical Examples (from 6.01 to 6.10). ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - III		
18EPE332 POWER QUALITY PROBLEMS AND MITIGATION (Professional Elective Course) (continued)		
Module-5		**Teaching Hours**
Unified Power Quality Compensators (continued): Numerical Examples (from 6.11to 20). **Loads That Cause Power Quality Problems:** Introduction, State of the Art on Nonlinear Loads, Classification of Nonlinear Loads, Power Quality Problems Caused by Nonlinear Loads, Analysis of Nonlinear Loads, Modelling, Simulation, and Performance of Nonlinear Loads, Numerical Examples. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain causes, effects of PQ problems and classification of mitigation techniques for PQ problems.
- Explain PQ standards, terminology and monitoring requirements through numerical problems.
- Explain passive shunt and series compensation using lossless passive components.
- Explain the design, operation and modeling of active shunt compensation equipment.
- Explain the design, operation and modeling of active series compensation equipment.
- Explain the design operation and modeling of unified power quality compensators.
- Discuss mitigation of power quality problems due to nonlinear loads. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Modern Tool Usage, Engineers and society, Ethics, Individual and Team work, Communication, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Power Quality Problems and Mitigation Techniques	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad	Wiley	2015

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

MULTI-TERMINAL DC GRIDS (Professional Elective Course)

Course Code	18EPE333	CIE Marks	40
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	SEE Marks	60

Credits - 04

Course objectives:

- To provide the fundamentals of MTDC grids, their network architectures, components and control modes and basics of voltage sourced converters.
- To explain modeling, simulation and analysis of AC- MTDC grids
- To explain the concept of power sharing in MTDC grid, load flow solution and post contingency operation
- To explain protection issues of MTDC grids, including the DC circuit breakers and fault blocking VSC systems and protection strategies. ■

Module-1		Teaching Hours
Fundamentals: Introduction, Rationale behind MTDC Grids, Network Architectures of MTDC Grids, Enabling Technologies and Components of MTDC Grids, Control Modes in MTDC Grid, Challenges for MTDC Grids, Configurations of MTDC Converter Stations, Research Initiatives on MTDC Grids. **Voltage-Sourced Converter (VSC)**: Introduction, Ideal Voltage-Sourced Converter, Practical Voltage-Sourced Converter. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying.	
Module-2		
Voltage-Sourced Converter (continued): Control, Simulation. **Modelling, Analysis, and Simulation of AC–MTDC Grids:** Introduction, MTDC Grid Model. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 – Analysing.	
Module-3		
Modelling, Analysis, and Simulation of AC–MTDC Grids (continued): AC Grid Model, AC–MTDC Load flow Analysis, AC–MTDC Grid Model for Nonlinear Dynamic Simulation, Small-signal Stability Analysis of AC–MTDC Grid, Transient Stability Analysis of AC–MTDC Grid. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 – Analysing.	
Module-4		
Modelling, Analysis, and Simulation of AC–MTDC Grids (continued): Case Study 1: The North Sea Benchmark System, Case Study 2: MTDC Grid Connected to Equivalent AC Systems, Case Study 3: MTDC Grid Connected to Multi-machine AC System. **Autonomous Power Sharing:** Introduction, Steady-state Operating Characteristics, Concept of Power Sharing, Power Sharing in MTDC Grid, AC–MTDC Grid Load flow Solution, Post-contingency Operation, Linear Model, Case Study. ■		**10**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 – Analysing.	
Module-5		
Frequency Support: Introduction, Fundamentals of Frequency Control, Inertial and Primary Frequency Support from Wind Farms, Wind Farms in Secondary Frequency Control (AGC), Modified Droop Control for Frequency Support, AC–MTDC Load Flow Solution, Post-Contingency Operation, Case Study. **Protection of MTDC Grids:** Introduction, Converter Station Protection, DC Cable Fault Response, Fault-blocking Converters, DC Circuit Breakers, Protection Strategies. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

18EPE333 MULTI-TERMINAL DC GRIDS
(Professional Elective Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Explain the fundamentals of MTDC grids, their network architectures, components and control modes
- Differentiate ideal and practical voltage sourced converters.
- Simulate AC- MTDC grids for the analysis.
- Explain the concept of power sharing in MTDC grid, load flow solution and post contingency operation.
- Explain frequency support from wind farms.
- Explain protection issues of MTDC grids, including the DC circuit breakers and fault blocking VSC systems and protection strategies. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Modern Tool Usage, Lifelong Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Multi-Terminal Direct-Current Grids Modelling, Analysis, and Control	Nilanjan Ray Chaudhuri et al	Wiley	2014

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - III			
PROJECT WORK PHASE – 1			
Subject Code	18EPE34	CIE Marks	100
Number of Practical Hours/Week	02	Exam Hours	--
Total Number of Practical Hours	--	SEE Marks	--
Credits - 02			

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson. ■

M.TECH POWER ELECTRONICS (EPE) Outcome Based Education(OBE) and Choice Based Credit System (CBCS) SEMESTER - III			
INTERNSHIP / PROFESSIONAL PRACTICE			
Subject Code	18EPEI35	CIE Marks	40
Number of Practical Hours/Week	--	Exam Hours	03
Total Number of Practical Hours	--	SEE Marks	60
Credits - 06			

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

M.TECH POWER ELECTRONICS (EPE)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

18EPEI35 INTERNSHIP / PROFESSIONAL PRACTICE (continued)

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson. ■

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

IV SEMESRER M.Tech
POWER ELECTRONICS

M.TECH POWER ELECTRONICS (EPE) **Outcome Based Education(OBE) and Choice Based Credit System (CBCS)** **SEMESTER - IV**			
PROJECT WORK PHASE -2			
Subject Code	18EPE41	CIE Marks	40
Number of Practical Hours/Week	04	Exam Hours	03
Total Number of Practical Hours	--	SEE Marks	60
Credits - 20			

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

Continuous Internal Evaluation:
Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.
Project Presentation: 10 marks.
The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.
Question and Answer: 10 marks.
The student shall be evaluated based on the ability in the Question and Answer session for 10 marks. ■

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

*** END ***

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination: 2018-19
M.Tech in VLSI Design & Embedded Systems (EVE)
Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week: Theory	Teaching Hours /Week: Practical/ Field work/ Assignment	Examination: Duration in hours	Examination: CIE Marks	Examination: SEE Marks	Examination: Total Marks	Credits
1	PCC	18ELD11	Advanced Engineering Mathematics	04	--	03	40	60	100	4
2	PCC	18EVE12	ASIC Design	04	--	03	40	60	100	4
3	PCC	18EVE13	Advanced Embedded System	04	--	03	40	60	100	4
4	PCC	18EVE14	VLSI Testing	04	--	03	40	60	100	4
5	PCC	18EVE15	Digital VLSI Design	04	--	03	40	60	100	4
6	PCC	18EVEL16	VLSI & ES Lab-1	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note:- PCC: Professional Core Course

Internship: All the students shall undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. University examination will be conducted during III semester and prescribed credit shall be included in the III semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination: 2018-19
M.Tech in VLSI Design & Embedded Systems (EVE)
Choice Based Credit System (CBCS)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18EVE21	Design of Analog and Mixed mode VLSI Circuits	04	--	03	40	60	100	4
2	PCC	18EVE22	Real Time Operating System	04	--	03	40	60	100	4
3	PCC	18EVE23	System Verilog	04	--	03	40	60	100	4
4	PEC	18XXX24X	Professional Elective 1	04	--	03	40	60	100	4
5	PEC	18XXX25X	Professional Elective 2	04	--	03	40	60	100	4
6	PCC	18EVEL26	VLSI & ES Lab-2	--	04	03	40	60	100	2
7	PCC	18EVE27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note:- PCC: Professional Core Course, PEC: Professional Elective Course

Professional Elective 1		Professional Elective 2	
Course Code Under 18XXX24X	**Course Title**	**Course Code Under 18XXX25X**	**Course Title**
18EVE241	Advances in VLSI Design	18EVE251	Low Power VLSI Design
18EVE242	Nanoelectronics	18EVE252	SoC Design
18EVE243	Static Timing Analysis	18ELD253	Micro Electro Mechanical Systems

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide in any and a senior faculty of the department. Participation in seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be included in the III semester. Internship shall be considered as head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination: 2018-19
M.Tech in VLSI Design & Embedded Systems (EVE)
Choice Based Credit System (CBCS)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18EVE31	CAD of Digital Systems	04	--	03	40	60	100	4
2	PEC	18XXX32X	Professional Elective 3	04	--	03	40	60	100	4
3	PEC	18XXX33X	Professional Elective 4	04	--	03	40	60	100	4
4	Proj	18EVE34	Evaluation of Project Phase -1	--	02	--	100	--	100	2
5	INT	18EVE35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
			TOTAL	**12**	**02**	**12**	**260**	**240**	**500**	**20**

Note:- PCC: Professional Core Course, PEC: Professional Elective Course, Proj: Project, INT: Internship

Professional Elective 3		Professional Elective 4	
Course Code Under 18XXX32X	**Course Title**	**Course Code Under 18XXX33X**	**Course Title**
18ECS321	Advances in Image Processing	18EVE331	VLSI for Signal Processing
18EVE322	CMOS RF Circuit Design	18ESP332	Pattern Recognition & Machine Learning
18EVE323	Embedded Linux System Design And Development	18ECS333	Internet of Things

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfy the internship requirements.

Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination: 2018-19
M.Tech in VLSI Design & Embedded Systems (EVE)
Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Proj	18EVE41	Project Work Phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note: Proj: Project.

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any and a Senior faculty of the department. The CIE marks awarded for Project Work Phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

M.Tech-VLSI & ES-2018- FIRST SEMESTER SYLLABUS

<table>
<tr><td colspan="4">ADVANCED ENGINEERING MATHEMATICS
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – I</td></tr>
<tr><td>Course Code</td><td>18ELD11</td><td>CIE</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• To learn principles of advanced engineering mathematics through linear algebra and calculus of variations.
• To understand probability theory and random process that serve as an essential tool for applications of electronics and communication engineering sciences</td></tr>
<tr><td colspan="3">Modules</td><td>(RBT) Level</td></tr>
<tr><td colspan="4">Module -1</td></tr>
<tr><td colspan="3"><u>Linear Algebra-I</u>
Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions. Matrix form of linear transformations-Illustrative examples (Text Book:1).</td><td>L1,L2</td></tr>
<tr><td colspan="4">Module -2</td></tr>
<tr><td colspan="3"><u>Linear Algebra-II</u>
Computation of eigen values and eigen vectors of real symmetric matrices-Given’s method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process (Text. Book:1).</td><td>L1,L2</td></tr>
<tr><td colspan="4">Module -3</td></tr>
<tr><td colspan="3">Calculus of Variations : -
Concept of functional- Eulers equation. Functional dependent on first and higher order derivatives, Functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries. (Text.Book:2)</td><td>L1,L2</td></tr>
<tr><td colspan="3">Module -4</td><td></td></tr>
<tr><td colspan="3">Probability Theory:-Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions-examples. (Text Book: 3)</td><td>L1,L2</td></tr>
<tr><td colspan="4">Module -5</td></tr>
</table>

Engineering Applications on Random processes:- Classification. Stationary, WSS and ergodic random process. Auto-correlation function-properties, Gaussian random process. (Text Book: 3)	**L1,L2**

Course Outcomes: After studying this course, students will be able to:

1. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
2. Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.
3. Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.
4. Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.
5. Analyze random process through parameter-dependent variables in various random processes.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

<table>
<tr><td colspan="4" align="center"><u>ASIC DESIGN</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER- I</td></tr>
<tr><td>Subject Code</td><td>18EVE12</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• Explain ASIC methodologies and programmable logic cells to implement a function on IC.
• Analyse back-end physical design flow, including partitioning, floor-planning, placement, and routing.
• Gain sufficient theoretical knowledge for carrying out FPGA and ASIC designs.
• Design CAD algorithms and explain how these concepts interact in ASIC design.</td></tr>
<tr><td colspan="3" align="center">Modules</td><td>(RBT) Level</td></tr>
<tr><td colspan="4" align="center">Module -1</td></tr>
<tr><td colspan="3">Introduction to ASICs: Full custom, Semi-custom and Programmable ASICs, ASIC Design flow, ASIC cell libraries.
CMOS Logic: Data path Logic Cells: Data Path Elements, Adders: Carry skip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier (Booth encoding), Data path Operators, I/O cells, Cell Compilers.</td><td>L1,L2</td></tr>
<tr><td colspan="4" align="center">Module -2</td></tr>
<tr><td colspan="3">ASIC Library Design: Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages, library cell design.
Programmable ASIC Logic Cells:
MUX as Boolean function generators, Acted ACT: ACT 1, ACT 2 and ACT 3 Logic Modules, Xilinx LCA: XC3000 CLB, Altera FLEX and MAX, Programmable ASIC I/O Cells: Xilinx and Altera I/O Block.</td><td>L1-L3</td></tr>
<tr><td colspan="4" align="center">Module -3</td></tr>
<tr><td colspan="3">Low-level design entry: Schematic entry: Hierarchical design, The cell library, Names, Schematic Icons & Symbols, Nets, Schematic Entry for ASICs, Connections, vectored instances & buses, Edit in place, attributes, Netlist screener.
ASIC Construction: Physical Design, CAD Tools System partitioning, Estimating ASIC size.
Partitioning: Goals and objectives, Constructive Partitioning, Iterative Partitioning Improvement, KL, FM and Look Ahead algorithms.</td><td>L1-L4</td></tr>
<tr><td colspan="4" align="center">Module -4</td></tr>
</table>

Floor planning and placement: Goals and objectives, Measurement of delay in Floor planning, Floor planning tools, Channel definition, I/O and Power planning and Clock planning. **Placement:** Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Time driven placement methods, Physical Design Flow.	**L1-L3**
Module -5	
Routing: Global Routing: Goals and objectives, Global Routing Methods, Global routing between blocks, Back-annotation. Detailed Routing: Goals and objectives, Measurement of Channel Density, Left-Edge Algorithm, Area-Routing Algorithms, Multilevel routing, Timing –Driven detailed routing, Final routing steps, Special Routing, Circuit extraction and DRC.	**L1-L3**

Course outcomes: After studying this course, students will be able to:

1. Describe the concepts of ASIC design methodology, data path elements, logical effort and FPGA architectures.
2. Analyze the design of FPGAs and ASICs suitable for specific tasks, perform design entry and explain the physical design flow.
3. Design data path elements for ASIC cell libraries and compute optimum path delay.
4. Create floor plan including partition and routing with the use of CAD algorithms.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- Michael John Sebastian Smith, “Application - Specific Integrated Circuits” Addison-Wesley Professional; 2005.

Reference Books:

1. Neil H.E. Weste, David Harris, and Ayan Banerjee, “CMOS VLSI Design: A Circuits and Systems Perspective”, 3rd edition, Addison Wesley/ Pearson education, 2011.
2. Vikram Arkalgud Chandrasetty, “VLSI Design: A Practical Guide for FPGA and ASIC Implementations”, Springer, 2011, ISBN: 978-1-4614-1119-2.
3. Rakesh Chadha, Bhasker J., “An ASIC Low Power Primer”, Springer, ISBN: 978-1-4614-4270-7.

ADVANCED EMBEDDED SYSTEM [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject	**18EVE13**	**CIE**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Describe the hardware software co-design and firmware design approaches
- Explain the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Program ARM CORTEX M3 using the various instructions, for different applications.

Modules	(RBT) Level
Module -1	
Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems (Text 1: Selected Topics from Ch -1, 2, 3).	**L1, L2, L3**
Module -2	
Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Text 1: Selected Topics From Ch-7, 9, 12, 13).	**L1, L2, L3**
Module -3	
ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 2: Ch 1, 2, 3)	**L1, L2, L3**
Module -4	
Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Text 2: Ch-4, 5, 6).	**L1, L2, L3**
Module -5	

Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Text 2: Ch-7, 8, 10).	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

1. Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
2. Explain the hardware software co-design and firmware design approaches.
3. Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
4. Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.
2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.

Reference Book:

James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008.

<table>
<tr><td colspan="4" align="center"><u>VLSI TESTING</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – I</td></tr>
<tr><td>Subject Code</td><td>18EVE14</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
</table>

Course Objectives: This course will enable students to:

- Learn various types of faults and fault modelling.
- Comprehend the need for testing and testable design of digital circuits
- Illustrate methods and algorithms for testing digital combinatorial networks and test pattern generation
- Exemplify methods for testing sequential circuits and memory testing
- Inferring testing methods using Boundary scan, Built-in self test and other advanced topics in digital circuit design.

<table>
<tr><td align="center">Modules</td><td>RBT Level</td></tr>
<tr><td colspan="2" align="center">Module 1</td></tr>
<tr><td>Faults in digital circuits: Failures and Faults, Modeling of faults, Temporary Faults. (Text 1)
Logic Simulation: Applications, Problems in simulation based design verification, types of simulation, The unknown logic values, compiled simulation, event-driven simulation, Delay models, Element evaluation, Hazard detection, Gate-level event-driven Simulation. (Text 2)</td><td>L1,L2</td></tr>
<tr><td colspan="2" align="center">Module 2</td></tr>
<tr><td>Test generation for Combinational Logic circuits: Fault Diagnosis of digital circuits, Test generation techniques for combinational circuits, Detection of multiple faults in Combinational logic circuits. (Text 1)
Testable Combinational logic circuit design: The Read-Muller expansion technique, Three level OR-AND-OR design, Automatic synthesis of testable logic.(Text 1)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="2" align="center">Module 3</td></tr>
<tr><td>Testable Combinational logic circuit design: Testable design of multilevel combinational circuits, Synthesis of random pattern testable combinational circuits, Path delay fault testable combinational logic design, Testable PLA design. (Text 1)
Test generation for Sequential circuits: Testing of sequential circuits as Iterative combinational circuits, state table verification, Test generation based on Circuit Structure, Functional Fault models, test Generation based on Functional Fault models. (Text 1)</td><td>L1,L2,L3</td></tr>
<tr><td colspan="2" align="center">Module 4</td></tr>
<tr><td>Design of testable sequential circuits: Controllability and observability, Ad-Hoc design rules for improving testability, design of diagnosable sequential circuits, the scan-path technique for testable</td><td>L1,L2,L3</td></tr>
</table>

sequential circuit design, Level Sensitive Scan Design(LSSD), Random Access Scan Technique, Partial scan, testable sequential circuit design using Nonscan Techniques, Cross check, Boundary Scan. (Text 1)	
Module 5	
Built-In Self Test: Test pattern generation for BIST, Output response analysis, Circular BIST, BIST Architectures. (Text 1) **Testable Memory Design:** RAM Fault Models, Test algorithms for RAMs, Detection of pattern-sensitive faults, BIST techniques for RAM chips, Test generation and BIST for embedded RAMs. (Text1)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

1. Analyze the need for fault modeling and testing of digital circuits
2. Generate fault lists for digital circuits and compress the tests for efficiency
3. Create tests for digital memories and analyze failures in them
4. Apply boundary scan technique to validate the performance of digital circuits
5. Design built-in self tests for complex digital circuits

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Lala Parag K., Digital Circuit Testing and Testability, New York, Academic Press, 1997.
2. Abramovici M, Breuer M A and Friedman A D, “Digital Systems Testing and Testable Design”, Wiley, 1994.

Reference Books:

1. Vishwani D Agarwal, “Essential of Electronic Testing for Digital, Memory and Mixed Signal Circuits”, Springer, 2002.
2. Wang, Wu and Wen, “VLSI Test Principles and Architectures”, Morgan Kaufmann, 2006.

<table>
<tr><td colspan="4"><u>DIGITAL VLSI DESIGN</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –I</td></tr>
<tr><td>Subject Code</td><td>18EVE15</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• Explain VLSI Design Methodologies
• Learn Static and Dynamic operation principles, analysis and design of inverter circuit.
• Infer state of the art Semiconductors Memory circuits.
• Outline the comprehensive coverage of Methodologies and Design practice that are used to reduce the Power Dissipation of large scale digital circuits.
• Illustrate VLSI and ASIC design</td></tr>
<tr><td colspan="3">Modules</td><td>(RBT) Level</td></tr>
<tr><td colspan="4">Module -1</td></tr>
<tr><td colspan="3">MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects.
MOS Inverters-Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with n_Type MOSFET Load.</td><td>L1, L2</td></tr>
<tr><td colspan="4">Module -2</td></tr>
<tr><td colspan="3">MOS Inverters-Static Characteristics: CMOS Inverter.
MOS Inverters: Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definition, Calculation of Delay Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.</td><td>L2, L3</td></tr>
<tr><td colspan="4">Module -3</td></tr>
<tr><td colspan="3">Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Nonvolatile Memory, Flash Memory, Ferroelectric Random Access Memory (FRAM).</td><td>L1, L2, L3</td></tr>
<tr><td colspan="4">Module -4</td></tr>
</table>

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques,High Performance Dynamic CMOS circuits. **BiCMOS Logic Circuits**: Introduction, Bipolar Junction Transistor (BJT): Structure and Operation, Dynamic Behavior of BJTs, Basic BiCMOS Circuits: Static Behavior, Switching Delay in BiCMOS Logic Circuits, BiCMOS Applications.	**L1,L2, L3**
Module -5	
Chip Input and Output (I/O) Circuits: Introduction, ESD Protection, Input Circuits, Output Circuits and L(di/dt) Noise, On-Chip Clock Generation and Distribution, Latch-Up and Its Prevention. **Design for Manufacturability:** Introduction, Process Variations, Basic Concepts and Definitions, Design of Experiments and Performance Modeling.	**L2, L3**

Course outcomes: After studying this course, students will be able to:
1. Analyse issues of On-chip interconnect Modelling and Interconnect delay calculation.
2. Analyse the Switching Characteristics in Digital Integrated Circuits.
3. Use the Dynamic Logic circuits in state-of-the-art VLSI chips.
4. Study critical issues such as ESD protection, Clock distribution, Clock buffering, and Latch phenomenon
5. Use Bipolar and Bi-CMOS circuits in very high speed design.

Question Paper Pattern
- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:
- Sung Mo Kang & Yosuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, Tata McGraw-Hill, Third Edition.

Reference Books:

1. Neil Weste and K. Eshragian, “Principles of CMOS VLSI Design: A System Perspective”, Second Edition, Pearson Education (Asia) Pvt. Ltd. 2000.
2. Wayne, Wolf, “Modern VLSI Design: System on Silicon” Prentice Hall PTR/Pearson Education, Second Edition, 1998.
3. Douglas A Pucknell & Kamran Eshragian, “Basic VLSI Design” PHI 3rd Edition (original Edition – 1994).

VLSI & ES Lab-1 [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Laboratory Code	**18EVEL16**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE marks**	**60**
Total Number of Lecture Hours	**01Hr Tutorial (Instructions)+ 03 Hours Laboratory**	**Exam Hours**	**03**
CREDITS – 02			

Course objectives: This laboratory course enables students to:

- Learn Verilog Code Programming for the design of digital circuits
- Use FPGA/CPLD board and Logic Analyzer or Chipscope to verify the results.
- Learn physical design for the digital circuits
- Learn Assembly language programming for different applications using ARM- Cortex M3 Kit and Keil uVision- 4 tool.
- Learn C language programming for different applications using ARM-Cortex M3 Kit and Keil uVision-4 tool.

Experiments	**RBT Level**
Part – A: VLSI Digital Design Experiments to be done using 1. CADENCE/SYNOPSIS/MENTOR GRAPHICS/TANNER or any other equivalent Tool 2. FPGA/CPLD Boards with Xilinx or any other equivalent	

ASIC-Digital Design Flow L3

I. Write Verilog Code for the following circuits and their Test Bench for verification, observe the wave technological library (constraints to be given). Do the initial timing verification with gate level simulation.

1. An inverter, Buffer, Transmission gate and basic gates
2. Flip flop - RS, D, JK, MS, T
3. 4-bit counter [Synchronous & Asynchronous counter]

Note: For the set of experiments listed above, students can make the following flow as a study:

- Core Constrained flow
- Creation of I/O pad frame
- Use the created I/O pad frame for Pad constrained design.
- CTS flow Only for designs which have clock

FPGA DIGITAL DESIGN

VLSI Front End Design programs:

Programming can be done using any compiler. Down load the programs on FPGA/CPLD boards and use pattern generator (32 channels and logic analyzer)/Chipscope pro apart from verification by simulation

1. Write Verilog code for the design of 8-bit
   - i. Carry Ripple Adder
   - ii. Carry Look Ahead adder
   - iii. Carry Skip Adder
2. Write Verilog Code for 8-bit
   - i. Array Multiplication (Signed and Unsigned)
   - ii. Booth Multiplication (Radix-4)
3. Write Verilog code for 4/8-bit
   - i. Magnitude Comparator
   - ii. LFSR
   - iii. Parity Generator
   - iv. Universal Shift Register
4. Design a Mealy and Moore Sequence Detector using Verilog to detect Sequence. Eg 11101 (with and without overlap) any sequence can be specified.

Part – B: Experiments to be done using ARM Cortex M3	L1, L2, L3
ARM Cortex M3 Programs - Programming to be done using Keil uVision 4 and download the program on to a M3 evaluation board such as NXP LPC1768 or ATMEL ARM a) Write an Assembly language program to calculate the sum and display the result for the addition of first ten numbers. SUM = 10+9+8+.........+1 b) Write an Assembly language program to store data in RAM c) Write a C program to output the "Hello World" message using UART d) Write a C program to operate a buzzer using Cortex M3 e) Write a C program to display the temperature sensed using Cortex M3. f) Write a C program to control stepper motor using Cortex M3.	

Course outcomes: This laboratory course enable the students to:

1. Understand the features of CAD tool in VLSI design.
2. Design and verify the behavior of digital circuits using digital flow
3. Verify the design using a logic analyzer
4. Analyse physical design
5. Develop Assembly language programs for different applications using ARM- Cortex M3 Kit and Keil uVision-4 tool.
6. Develop C language programs for different applications using ARM-Cortex M3 Kit and Keil uVision-4 tool.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination, one experiment from Part-A and One experiment from Part-B is to be set.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the Procedure part to be made zero.

<table>
<tr><td colspan="5"><u>RESEARCH METHODOLOGY AND IPR</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –I</td></tr>
<tr><td>Course Code</td><td>18RMI17</td><td>CIE Marks</td><td colspan="2">40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>02</td><td>Exam Hours</td><td colspan="2">03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>25</td><td>SEE Marks</td><td colspan="2">60</td></tr>
<tr><td colspan="5">Credits - 02</td></tr>
<tr><td colspan="5">Course objectives:

To give an overview of the research methodology and explain the technique of defining a research problem
To explain the functions of the literature review in research.
To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
To explain various research designs and their characteristics.
To explain the details of sampling designs, and also different methods of data collections.
To explain the art of interpretation and the art of writing research reports.
To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
To discuss leading International Instruments concerning Intellectual Property Rights. ■
</td></tr>
<tr><td colspan="4">Module-1</td><td>Teaching Hours/ RBT Level</td></tr>
<tr><td colspan="4">Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. ■</td><td>05

L1, L2</td></tr>
<tr><td colspan="5">Module-2</td></tr>
<tr><td colspan="4">Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.
Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. ■</td><td>05

L1, L2</td></tr>
<tr><td colspan="5">Module-3</td></tr>
</table>

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. ■	**05** **L1, L2**
Module-4	
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout. **Interpretation and Report Writing (continued):** of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. ■	**05** **L1, L2, L3, L4**
Module-5	
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.■	**05** **L1, L2, L3, L4**

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of interpretation and the art of writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR. ■

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

M.Tech-VLSI & ES-2018-SECOND SEMESTER SYLLABUS

<table>
<tr><td colspan="4">DESIGN OF ANALOG AND MIXED MODE VLSI CIRCUITS
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>18EVE21</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
• Describe basic physics and operation of MOS devices.
• Exemplify single-stage and differential amplifiers and current mirrors
• Describe operational amplifiers
• Learn the design of phase-locked-loops
• Know the role of Data converters in an ever-increasing digital world.</td></tr>
</table>

Modules	RBT Level
Module 1	
Basic MOS Device Physics: General considerations, MOS I/V Characteristics, second order effects, MOS device models. **Single stage Amplifier:** Basic Concepts, Common Source stage (Text 1)	L1, L2
Module 2	
Single stage Amplifier: Source follower, common-gate stage, Cascode Stage, choice of device models. **Differential Amplifiers:** Single ended and differential operation, Basic differential pair, Common mode response, Differential pair with MOS loads, Gilbert cell (Text 1)	L1,L2
Module 3	
Passive and Active Current Mirrors: Basic current mirrors, Cascode Current mirrors, Active Current mirrors. **Operational Amplifiers (part-1):** General Considerations**,** One Stage OP-Amp, Two Stage OP-Amp, Gain boosting (Text 1)	L1,L2,L3
Module 4	
Operational Amplifiers (part-2): Common Mode Feedback, Slew rate, Power Supply Rejection. **Phase Locked Loops:** Simple PLL, Charge pump PLLs, Non-ideal effects in PLLs, Delay-Locked Loops, Applications (Text 1)	L1,L2,L3
Module 5	
Data Converter Architectures: DAC & ADC Specifications, Current Steering DAC, Charge Scaling DAC, Cyclic DAC, Pipeline DAC, Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC (Text 2)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

1. Use efficient analytical tools for quantifying the behaviour of basic circuits by inspection.
2. Design high-performance, stable operational amplifiers with the trade-offs between speed, precision and power dissipation.
3. Design and study the behaviour of phase-locked-loops for the applications.
4. Identify the critical parameters that affect the analog and mixed-signal VLSI circuits' performance
5. Perform calculations in the digital or discrete time domain, more sophisticated data converters to translate the digital data to and from inherently analog world.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", TMH, 2007.
2. R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", Second Edition, Wiley.

Reference Book:

- Phillip E. Allen, Douglas R. Holberg, "CMOS Analog Circuit Design", Second Edition, Oxford University Press.

REAL TIME OPERATING SYSTEM [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	**18EVE22**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable the students to:

- Introduce the fundamental concepts of Real Time Operating Systems and the real time embedded system
- Apply concepts relating to operating systems such as Scheduling techniques, Thread Safe Reentrant Functions, Dynamic priority policies.
- Describe concepts related to Multi resource services like blocking, Deadlock, live lock & soft real-time services.
- Discuss Memory management concepts, Embedded system components, Debugging components and file system components.
- Study programs for multithreaded applications using suitable data structures.

Modules	RBT Level
Module 1	
Real-Time Systems and Resources: Brief history of Real Time Systems, A brief history of Embedded Systems. System Resources, Resource Analysis, Real-Time Service Utility, Scheduler concepts, Real-Time OS, State transition diagram and tables, Thread Safe Reentrant Functions. (Text 1: Selected sections from Chap. 1, 2)	L1,L2,L3
Module 2	
Processing with Real Time Scheduling: Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies with timing diagrams and problems and issues, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies, Alternative to RM policy. (Text 1: Chap. 2,3,7)	L1,L2,L3
Module 3	
Memory and I/O: Worst case execution time, Intermediate I/O, Shared Memory, ECC Memory, Flash file systems. Multi-resource Services, Blocking, Deadlock and live lock, Critical sections to protect shared resources, Missed deadline, QoS, Reliability and Availability, Similarities and differences, Reliable software, Available software. (Text 1: Selected topics from Chap. 4,5,6,7,11)	L1,L2,L3
Module 4	
Firmware Components: The 3 firmware components, RTOS system software mechanisms, Software application components. Debugging Components, Exceptions, assert, Checking return codes, Single-step debugging, Test access ports, Trace Ports. (Text 1: Selected topics	L1,L2,L3

from Chap. 8,9)	
Module 5	
Process and Threads: Process and thread creations, Programs related to semaphores, message queue, shared buffer applications involving inter task/thread communication (Text 2: Chap. 11)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:
1. Develop programs for real time services, firmware and RTOS, using the fundamentals of Real Time Embedded System, real time service utilities, debugging methodologies and optimization techniques.
2. Select the appropriate system resources (CPU, I/O, Memory, Cache, ECC Memory, Microcontroller/FPGA/ASIC to improve the system performance.
3. Apply priority based static and dynamic real time scheduling techniques for the given specifications.
4. Analyze deadlock conditions, shared memory problem, critical section problem, missed deadlines, availability, reliability and QoS.
5. Develop programs for multithreaded applications using suitable techniques and data structure

Question paper pattern:
- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:
1. Sam Siewert, “Real-Time Embedded Systems and Components”, Cengage Learning India Edition, 2007.
2. Dr. K.V.K.K Prasad, Embedded/Real Time Systems, Concepts, Design and Programming, Black Book, Dream Tech Press, New edition, 2010.

Reference Books:
1. James W S Liu, “Real Time System”, Pearson education, 2008.
2. Dream Tech Software Team, “Programming for Embedded Systems”, John Wiley, India Pvt. Ltd., 2008.

SYSTEM VERILOG [As per Choice Based credit System (CBCS) Scheme] SEMESTER – II			
Subject Code	**18EVE23**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Understand digital system verification using object oriented methods
- Learn the System Verilog language for digital system verification.
- Create/build test benches for the basic design/methodology.
- Use constrained random tests for verification
- Understand concepts of functional coverage

Modules	RBT Level
Module 1	
Verification Guidelines: The verification process, basic test bench functionality, directed testing, methodology basics, constrained random stimulus, randomization, functional coverage, test bench components, layered testbench. **Data Types:** Built in Data types, fixed and dynamic arrays, Queues, associative arrays, linked lists, array methods, choosing a storage type, creating new types with type def, creating user defined structures, type conversion, Enumerated types, constants and strings, Expression width.	L1, L2
Module 2	
Procedural Statements and Routines: Procedural statements, Tasks, Functions and void functions, Task and function overview, Routine arguments, returning from a routine, Local data storage, time values. **Converting the test bench and design:** Separating the test bench and design, The interface construct, Stimulus timing, Interface driving and sampling, System Verilog assertions.	L1,L2,L3
Module 3	
Randomization: Introduction, Randomization in System Verilog, Constraint details, Solution probabilities, Valid constraints, In-line constraints, Random number functions, Common randomization problems, Iterative and array constraints, Random control, Random Number Generators.	L1,L2,L3
Module 4	
Threads and Interprocess Communication: Working with threads, Disabling threads, Interprocess communication, Events, semaphores, Mailboxes, Building a test bench with threads and Interprocess Communication.	L1,L2,L3

Module 5	
Functional Coverage: Coverage types, Coverage strategies, Simple coverage example, Anatomy of Cover group and Triggering a Cover group, Data sampling, Cross coverage, Generic Cover groups, Coverage options, Analyzing coverage data, measuring coverage statistics during simulation.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

1. Write test benches for moderately complex digital circuits
2. Use System Verilog language
3. Appreciate functional coverage
4. Apply constrained random tests benches using System Verilog
5. Analyze a verification case and apply System Verilog to verify the design

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- Chris Spear, 'System Verilog for Verification – A guide to learning the Test bench language features', Springer Publications, 2nd Edition, 2010.

Reference Book:

- Stuart Sutherland, Simon Davidmann, Peter Flake, "System Verilog for Design- A guide to using system verilog for Hardware design and modeling", Springer Pulications, 2nd Edition, 2006.
- Stuart Sutherland, Simon Davidmann, Peter Flake, System Verilog for Design Second Edition: A Guide to Using System Verilog for Hardware Design and Modeling, Springer Science & Business Media, 15-Sep-2006

ADVANCES IN VLSI DESIGN
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II

Subject Code	**18EVE241**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Learn circuit-oriented approach towards digital design
- Illustrate the impact of interconnect wiring on the functionality and performance of a digital gate.
- Infer different approaches to digital timing and clocking circuits
- Understand the impact of clock skew on the behaviour of digital synchronous circuits.
- Explain the role of peripheral circuitry such as the decoders, sense amplifiers, drivers and control circuitry in the design of reliable and fast memories .

Modules	RBT Level
Module 1	
Implementation Strategies For Digital ICS: Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Standard Cell, Compiled Cells, Macrocells, Megacells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Pre-wired Arrays, Perspective-The Implementation Platform of the Future.	L1,L2,L3
Module 2	
Coping With Interconnect: Introduction, Capacitive Parasitics, Capacitance and Reliability-Cross Talk, Capacitance and Performance in CMOS, Resistive Parasitics, Resistance and Reliability-Ohmic Voltage Drop, Electromigration, Resistance and Performance-RC Delay, Inductive Parasitics, Inductance and Reliability-Voltage Drop, Inductance and Performance-Transmission Line Effects, Advanced Interconnect Techniques, Reduced-Swing Circuits, Current-Mode Transmission Techniques, Perspective: Networks-on-a-Chip.	L1,L2,L3
Module 3	
Timing Issues In Digital Circuits: Introduction, Timing Classification of Digital Systems, Synchronous Interconnect, Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect, Synchronous Design — An In-depth Perspective, Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques, Latch-Base Technique,	L1,L2,L3

Completion-Signal Generation, Self-Timed Signaling, Practical Examples of Self-Timed Logic, Synchronizers and Arbiters, Synchronizers-Concept and Implementation, Arbiters, Clock Synthesis and Synchronization Using a Phase-Locked Loop, Basic Concept, Building Blocks of a PLL. d Clocking, Self Timed Circuit Design, Self-Timed Logic - An Asynchronous	
Module 4	
Design of testable sequential circuits: Controllability and observability, Ad-Hoc design rules for improving testability, design of diagnosable sequential circuits, the scan-path technique for testable sequential circuit design, Level Sensitive Scan Design(LSSD), Random Access Scan Technique, Partial scan, testable sequential circuit design using Nonscan Techniques, Cross check, Boundary Scan. (Text 1)	L1,L2,L3
Module 5	
Designing Memory and Array Structures: Memory Reliability and Yield, Signal-to-Noise Ratio, Memory yield, Power Dissipation in Memories, Sources of Power Dissipation in Memories, Partitioning of the memory, Addressing the Active Power Dissipation, Dataretention dissipation, Case Studies in Memory Design: The Programmable Logic Array (PLA), A 4 Mbit SRAM, A 1 Gbit NAND Flash Memory, Perspective: Semiconductor Memory Trends and Evolutions.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

1. Apply design automation for complex circuits using the different implementation methodology like custom versus semi-custom, hardwired versus fixed, regular array versus ad-hoc.
2. Use the approaches to minimize the impact of interconnect parasitics on performance, power dissipation and circuit reliability
3. Impose the ordering of the switching events to meet the desired timing constraints using synchronous, clocked approach.
4. Infer the reliability of the memory

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

- Jan M Rabey, Anantha Chandrakasan, Borivoje Nikolic, ―Digital Integrated Circuits-A Design Perspective‖, PHI, 2nd Edition.

Reference Books:

1. M. Smith, ―Application Specific Integrated circuits‖, Addison Wesley, 1997 Wang, Wu and Wen, "VLSI Test Principles and Architectures", Morgan Kaufmann, 2006.
2. H. Veendrick, ―MOS IC‟s: From Basics to ASICs, Wiley-VCH, 1992.

<table>
<tr><td colspan="4"><u>NANOELECTRONICS</u>
[As per Choice Based Credit System (CBCS) scheme] SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>18EVE242</td><td>CIE</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• Enhance basic engineering science and technological knowledge of nanoelectronics .
• Explain basics of top-down and bottom-up fabrication process, devices and systems.
• Describe technologies involved in modern day electronic devices.
• Appreciate the complexities in scaling down the electronic devices in the future.</td></tr>
</table>

Modules	(RBT) Level
Module -1	
Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).	**L1, L2**
Module -2	
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques, spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties(Text1)	**L1,L2,L3**
Module -3	
Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text1). **Carbon Nanostructures:** Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes (Text 2).	**L1, L2, L3**
Module -4	

Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly techniques. **Physical processes:** modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text1).	**L1, L2, L3**
Module -5	
Methods of measuring properties: atomic, crystollography, microscopy, spectroscopy (Text 2). **Applications**: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP's, NEMS, MEMS (Text1).	**L1, L2, L3**

Course outcomes: After studying this course, students will be able to:

1. Know the principles behind Nanoscience engineering and Nanoelectronics.
2. Apply the knowledge to prepare and characterize nanomaterials.
3. Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials.
4. Design the process flow required to fabricate state of the art transistor technology.
5. Analyze the requirements for new materials and device structure in the future tec hnologies.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, “Nanoscale Science and Technology”, John Wiley, 2007.
2. Charles P Poole, Jr, Frank J Owens, “Introduction to Nanotechnology”, John Wiley, Copyright 2006, Reprint 2011.

Reference Book:

Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, “Hand Book of Nanoscience Engineering and Technology”, CRC press, 2003.

STATIC TIMING ANALYSIS [As per Choice Based Credit System (CBCS) scheme] SEMESTER –II			
Subject Code	**18EVE 243**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand timing analyses at various process, environment and interconnect corners.
- Apply the learnt concepts of STA to evaluate the delay of the circuits.
- Understand and analyze the signal integrity issues for the IC.
- Generate the timing analysis report using EDA tool.
- Understand verification and analyze the generated report to identify issues for the violation
- Learn different techniques to meet timing in an IC design.
- Set up the timing analysis environment and perform the timing analysis for various cases.

Modules	**(RBT) Level**
Module -1	
Introduction: Nanometer Designs, What is Static Timing Analysis?. Why Static Timing Analysis?, Crosstalk and Noise, Design Flow, CMOS Digital Designs, FPGA Designs, Asynchronous Designs, STA at Different Design Phases, Limitations of Static Timing Analysis, Power Considerations, Reliability Considerations, **STA Concepts:** CMOS Logic Design, Basic MOS Structure, CMOS Logic Gate, Standard Cells, Modeling of CMOS Cells, Switching Waveform, Propagation Delay, Slew of a Waveform, Skew between Signals, Timing Arcs and Unateness, Min and Max Timing Paths, Clock Domains, Operating Conditions .	**L1-L2**
Module -2	
Standard Cell Library: Pin Capacitance, Timing Modeling, Linear Timing Model, Non-Linear Delay Model, Example of Non-Linear, Delay Model Lookup, Threshold Specifications and Slew Derating Timing Models - Combinational Cells, Delay and Slew Models, Positive or Negative Unate, General Combinational Block, Timing Models - Sequential Cells, Synchronous Checks: Setup and Hold, Example of Setup and Hold Checks, Negative Values in Setup and Hold Checks, Asynchronous Checks, Recovery and Removal Checks Pulse Width Checks, Example of Recovery, Removal and Pulse Width Checks, Propagation Delay, State-Dependent Models XOR, XNOR and Sequential Cells, Interface Timing Model for a Black	**L1**

Box, Advanced Timing Modeling, Receiver Pin Capacitance, Specifying Capacitance at the Pin Level, Specifying Capacitance at the Timing Arc Level, Output Current, Models for Crosstalk Noise Analysis, DC Current, Output Voltage,, Propagated Noise, Noise Models for Two-Stage Cells, Noise Models for Multi-stage and Sequential Cells, Other Noise Models, Power Dissipation Modeling, Active Power, Double Counting Clock Pin Power, Leakage Power, Other Attributes in Cell Library, Area Specification, Function Specification, SDF Condition, Characterization and Operating Conditions, What is the Process Variable, Derating using K-factors, Library Units.	
Module -3	
Interconnect Parasitics: RLC for Interconnect, Wireload Models, Interconnect Trees, Specifying Wireload Models, Representation of Extracted Parasitics, Detailed Standard Parasitic Format, Reduced Standard Parasitic Format, Standard Parasitic Exchange Format, Representing Coupling Capacitances, Hierarchical Methodology, Block Replicated in Layout, Reducing Parasitics for Critical Nets, Reducing Interconnect Resistance, Increasing Wire Spacing, Parasitics for Correlated Nets. **Delay Calculation**: Overview, Delay Calculation Basics, Delay Calculation with Interconnect, Pre-layout Timing, Post-layout Timing, Cell Delay using Effective Capacitance, Interconnect Delay, Elmore Delay, Higher Order Interconnect Delay Estimation, Full Chip Delay Calculation, Slew Merging, Different Slew Thresholds, Different Voltage Domains, Path Delay Calculation, Combinational Path Delay, Path to a Flip-flop, Input to Flip-flop Path, Flip-flop to Flip-flop Path, Multiple Paths, Slack Calculation.	**L1-L4**
Module -4	
Configuring the STA Environment: What is the STA Environment? Specifying Clocks, Clock Uncertainty, Clock Latency, Generated Clocks, Example of Master Clock at Clock Gating Cell Output, Generated Clock using Edge and Edge_shift Options, Generated Clock using Invert Option, Clock Latency for Generated Clocks, Typical Clock Generation Scenario, Constraining Input Paths, Constraining Output Paths, Example A, Example B, Example C, Timing Path Groups, Modeling of External Attributes, Modeling Drive Strengths, Modeling Capacitive Load, Design Rule Checks, Virtual Clocks, Refining the Timing Analysis, Specifying Inactive Signals, Breaking Timing Arcs in Cells, Point-to-Point Specification, Path Segmentation.	**L1-L4**
Module -5	
Timing Verification: Setup Timing Check, Flip-flop to Flip-flop Path, Input to Flip-flop Path, Input Path with Actual Clock, Flip-flop to Output Path, Input to Output Path, Frequency Histogram, Hold Timing Check, Flip-flop to Flip-flop Path, Hold Slack Calculation, Input to Flip-flop Path, Flip-flop to Output Path, Flip-flop to Output Path with Actual Clock, Input to Output Path, Multicycle Paths, Crossing Clock Domains, False Paths, Half-	**L1-L4**

Cycle Paths, Removal Timing Check, Recovery Timing Check, Timing across Clock Domains, Slow to Fast Clock Domains, Fast to Slow Clock Domains, Half-cycle Path - Case 1, Half-cycle Path - Case 2, Fast to Slow Clock Domain, Slow to Fast Clock Domain, Multiple Clocks, Integer Multiples, Non-Integer Multiples, Phase Shifted.	

Course outcomes: After studying this course, students will be able to:

- Evaluate the delay of any given digital circuits.
- Prepare the resources to perform the static timing analysis using EDA tool
- Prepare timing constraints for the design based on the specification.
- Generate the timing analysis report using EDA tool for different checks.
- Perform verification and analyse the generated report to identify critical issues and bottleneck for the violation and suggest the techniques to make the design to meet timing

Question paper pattern:

- The students will have to answer 5 full questions, selecting one full question from each module. Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

It is suggested that the students may be asked to conduct the following experiments to award a part of CIE marks which is reserved for the Other Activities:

In the following experiments, determine the parameters such as slack, critical path, Dynamic power, leakage power, timing and area report. Also, generate Verilog netlist, SDF file and write SDC constraints after synthesis based on the particular experiment.

1. Synthesize 4 bit counter & find the required parameters at 50 MHz (Repeat using Xilinx library also).
2. Synthesize 8 bit Mux and find the required parameters at 25 MHz (Repeat using Xilinx library also).
3. Synthesize synchronous 16 bit save carry adder for 100 MHz and find the required parameters.
4. Synthesize synchronous 16 bit save carry adder for 20 MHz and find the required parameters (Repeat the experiment for 3 Vendor library, Altera library).

5. Compare the area report and timing report as per the vendor and tablet using Pi-chart or Bar chart for expt - 4
6. Synthesize 8 bit multiplier using Xilinx Defence standard / Automotive library to determine the required parameters
7. For the given UART/Traffic signal controller, synthesize using 50 MHZ clock and 100 MHZ clock. Compare the result for both the clocks and determine the required parameters.
8. Compare one of the design through ASIC synthesis and FPGA synthesis to determine the required parameters

Text Book:

J. Bhasker, R Chadha,., “Static Timing Analysis for Nanometer Designs: A Practical Approach”, Springer, 2009.

Reference Books:

1. Sridhar Gangadharan, Sanjay Churiwala, “Constraining Designs for Synthesis and Timing Analysis – A Practical Guide to Synopsis Design Constraints (SDC)”, Springer, 2013.
2. Naresh Maheshwari and Sachin Sapatnekar, "Timing Analysis and Optimization of Sequential Circuits", Springer Science and Business Media, 1999.

<table>
<tr><td colspan="4" align="center"><u>LOW POWER VLSI DESIGN</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –II</td></tr>
<tr><td>Subject Code</td><td>18EVE251</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• Apply State-of-the art approaches to power estimation and reduction.
• Describe the various power reduction and the power estimation methods.
• Explain power dissipation at all layers of design hierarchy from technology, circuit, logic, architecture and system
• Know the basics and advanced techniques in low power design which is a hot topic in today's market where the power plays a major role.
• Practice the low power techniques using current generation design style and process technology.</td></tr>
</table>

Modules	(RBT) Level
Module -1	
Introduction: Need for low power VLSI chips, charging and discharging capacitance, short circuit current in CMOS leakage current, static current, basic principles of low power design, low power figure of merits. **Simulation power analysis:** SPICE circuit simulation, discrete transistor modeling and analysis, gate level logic simulation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. (Text 1)	**L1, L2**
Module -2	
Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. **Circuit:** Transistor and gate sizing, equivalent pin ordering, network restructuring and reorganization, special latches and flip flops, low power digital cell library, adjustable device threshold voltage. (Text 1)	**L1, L2, L3**
Module -3	
Logic: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic (Text 1). **Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network (Text 2).	**L1, L2, L3**
Module -4	

Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation (Text 1). **Low power arithmetic components:** Introduction, circuit design style, adders, multipliers, division (Text 2).	**L1- L4**
Module -5	
Low power memory design: Introduction, sources and reductions of power dissipation in memory subsystem, sources of power dissipation in DRAM and SRAM (Text 2). **Algorithm & Architectural Level Methodologies**: Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis (Text 2). **Advanced Techniques**: Adiabatic computation, pass transistor, Asynchronous circuits (Text 1).	**L1-L4**

Course outcomes: After studying this course, students will be able to:

1. Identify the sources of power dissipation in CMOS circuits.
2. Perform power analysis using simulation based approaches and probabilistic analysis.
3. Use optimization and trade-off techniques that involve power dissipation of digital circuits.
4. Make the power design a reality by making power dimension an integral part of the desigUse practical low power design techniques and their analysis at various levels of design abstraction and analyse how these are being captured in the latest design automation environments. n process
5. Use practical low power design techniques and their analysis at various levels of design abstraction and analyse how these are being captured in the latest design automation environments.
6. Use practical low power design techniques and their analysis at various levels of design abstraction and analyse how these are being captured in the latest design automation environments.

Question paper pattern:

- The students will have to answer 5 full questions, selecting one full question from each module. Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, Kluwer Academic, 1998.
2. Jan M.Rabaey, Massoud Pedram, “Low Power Design Methodologies”, Kluwer Academic, 2010.

Reference Books:

1. Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley, 2000
2. A.P.Chandrasekaran and R.W.Broadersen, “Low power digital CMOS design”, Kluwer Academic,1995.
3. A Bellamour and M I Elmasri, “Low power VLSI CMOS circuit design”, Kluwer Academic,1995.

<table>
<tr><td colspan="4" align="center"><u>SoC DESIGN</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>18EVE252</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50
(10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
• Describe the ARM processor architecture and user-level assembly language programming
• Appreciate what a high-level language (in this case, C) really needs and how those needs are met by the ARM instruction set.
• raises the issues involved in debugging systems which use embedded
• processor cores and in the production testing of board-level systems.
• Learn the concept of memory hierarchy, discussing the principles
• of memory management and caches.</td></tr>
</table>

Modules	RBT Level
Module 1	
ARM Organization and Implementation:3-stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface. **The ARM Instruction Set :**Introduction, Exceptions, Conditional execution, Branch and Branch with Link (B, BL),Branch, Branch with Link and eXchange (BX, BLX),Software Interrupt (SWI),Data processing instructions, Multiply instructions, Count leading zeros (CLZ - architecture v5T only), Single word and unsigned byte data transfer instruction, Half-word and signed byte data transfer instructions,Multiple register transfer instructions, Swap memory and register instructions (SWP), Status register to general register transfer instructions, General register to status register transfer instructions, Coprocessor instructions, Coprocessor data operations, Coprocessor data transfers, Coprocessor register transfers, Breakpoint instruction (BRK - architecture v5T only), Unused instruction space, Memory faults, ARM architecture variants.	L1,L2
Module 2	
Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment. **Architectural Support for System Development:** The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA), The ARM reference peripheral specification, Hardware	L1,L2

system prototyping tools, The ARMulator, The JTAG boundary scan test architecture, The ARM debug architecture, Embedded Trace, Signal processing support.	
Module 3	
ARM Processor Cores: ARM7TDMI, ARM8,ARM9TDMI, ARM10TDMI,Discussion,Example and exercises. **Memory Hierarchy:** Memory size and speed, On-chip memory, Caches, Cache design - an example, Memory management, Examples and exercises.	L1,L2
Module 4	
Architectural Support for Operating Systems: An introduction to operating systems, The ARM system control coprocessor, CP15 protection unit registers, ARM protection unit,CP15 MMU registers, ARM MMU architecture, Synchronization, Context switching, Input/ Output, Example and exercises. **ARM CPU Cores:** The ARM710T, ARM720T and ARM740T, The ARM810, The Strong ARM SA-110, The ARM920T and ARM940T, The ARM946E-S and ARM966E-S, The ARM1020E, Discussion, Example and exercises.	L1,L2
Module 5	
Embedded ARM Applications: The VLSI Ruby II Advanced Communication Processor, The VLSI ISDN Subscriber Processor, The One C™VWS22100 GSM chip, The Ericsson-VLSI Bluetooth Baseband Controller, The ARM7500 and ARM7500FE, The ARM7100 364, The SA-1100 368, Examples and exercises. **The AMULET Asynchronous ARM Processors:** Self-timed design 375, AMULET1 377, AMULET2 381, AMULET2e 384,AMULET3 387, The DRACO telecommunications controller 390, A self-timed future? 396, Example and exercises.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

1. Apply the 3- and 5-stage pipeline ARM processor cores and analyse the implementation issues.
2. Use the concepts and methodologies employed in designing a System-on-chip (SoC) based around a microprocessor core and in designing the microprocessor core itself.
3. Understand how SoCs and microprocessors are designed and used, and why a modern processor is designed the way that it is.
4. Use integrated ARM CPU cores (including StrongARM) that incorporate full support for memory management.
5. Analyze the requirements of a modern operating system and use the ARM architecture to address the same.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- Steve Furber, “ARM System-On-Chip Architecture”, Addison Wesley, 2nd edition.

References Books:

1. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.
2. Sudeep Pasricha and Nikil Dutt, "On-Chip Communication Architectures: System on Chip Interconnect”, Morgan Kaufmann, Publishers © 2008.
3. Michael Keating, Pierre Bricaud, “Reuse Methodology Manual for System on Chip designs”, Kluwer Accademic Publishers, 2nd edition, 2008.

MICRO ELECTRO MECHANICAL SYSTEMS [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	**18ELD253**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Know an overview of microsystems, their fabrication and application areas.
- Teach working principles of several MEMS devices.
- Develop mathematical and analytical models of MEMS devices
- Know methods to fabricate MEMS devices
- Expose the students to various application areas where MEMS devices can be used.

Modules	**RBT Level**
Module 1	
Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.	L1, L2
Module 2	
Working Principles of Microsystems: Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. **Engineering Science for Microsystems Design and Fabrication:** Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.	L1, L2
Module 3	
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.	L1,L2,L3
Module 4	
Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of	L1,L2,L3

Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	
Module 5	
Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro-manufacturing. **Microsystem Design:** Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:
1. Understand the technologies related to Micro Electro Mechanical Systems.
2. Describe the design and fabrication processes involved with MEMS devices.
3. Analyse the MEMS devices and develop suitable mathematical models
4. Understand the various application areas for MEMS devices

Question paper pattern:
- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, John Wiley & Sons, 2008. ISBN: 978-0-470-08301-7

Reference Books:

1. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Micro electromechanical Systems (MEMS), Cenage Learning.

<table>
<tr><td colspan="4"><u>VLSI & ES Lab-2</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II</td></tr>
<tr><td>Laboratory Code</td><td>18EVEL26</td><td>IA Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>01Hr Tutorial (Instructions) + 03 Hours Laboratory</td><td>Exam Mark</td><td>60</td></tr>
<tr><td></td><td></td><td>Exam Hour</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 02</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:

• Learn the CAD tool and the flow of the Full Custom IC design cycle.
• Learn running DRC, LVS and Parasitic Extraction of the various designs.
• Create various components like inverter, differential amplifier and use the same in the design of operational amplifier, R-2R based DAC and ADC.
• Understand the suitability of different techniques of IPC and task switching in a multithreaded application.
• Study and implement different types of data structures required to implement inter task communication.
• Implement Inter task communication using an appropriate data structure.</td></tr>
</table>

Experiments	**(RBT) Level**
PART A: VLSI Design. **Experiments to be conducted using suitable CAD tool** 1. Design an **Inverter** with given specifications*, completing the design flow mentioned below: a. Draw the schematic and verify the following i) DC Analysis ii) Transient Analysis b. Draw the Layout and verify the DRC, ERC c. Check for XX d. Extract RC and back annotate the same and verify the Design e. Verify & Optimize for Time, Power and Area to the given constraint***	**L2,L3,L4**

2.Design the following circuits with given specifications*, completing the design flow mentioned below: a. Draw the schematic and verify the following i) DC Analysis ii) AC Analysis iii) Transient Analysis b. Draw the Layout and verify the DRC, ERC, LVS c. Check for XX d. Extract RC and back annotate the same and verify the Design i) Single Stage differential amplifier ii) Common source amplifier iii) Design an op-amp with given specification* using differential amplifier Common source amplifier in library** iv) Design a 4 bit R-2R based DAC for the given specification**	
3. Design an Integrator using OPAMP (First Order)	
4. Design a Differentiator using OPAMP (First Order)	
5. Design and characterize a basic Sigma delta ADC from the available designs.	
PART B: RTOS programs using C language in LINUX OS. 1. Develop programs to (a) create child process and display it's id and (b) Execute child process function using switch structure 2. Develop and test program for a multithreaded application, where communication is through a buffer for the conversion of lowercase text to uppercase text, using semaphore concept. 3. Develop and test program for a multithreaded application, where communication is through shared memory for the conversion of lowercase text to uppercase text. 4. Develop program for inter-thread communication using message queue. Data is to be input from the keyboard for the chosen application 5. Create 'n' number of child threads. Each thread prints the message "I'm in thread number …" and sleeps for 50 ms and then quits. The main thread waits for complete execution of all the child threads and then quits. Compile and execute in Linux. 6. Implement the usage of anonymous pipe with 512 bytes for data sharing between parent and child processes using handle inheritance mechanism	**L1, L2, L3**

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Design, implement and analyse analog, digital and mixed mode circuits
- Learn the various issues in Mixed signal designs basically data converters.
- Acquire hands-on skills of using CAD tools in VLSI design.
- Appreciate the design process in VLSI through a mini-project on the design of a CMOS sub-system.
- Select a suitable task switching technique in a multithreaded application.
- Implement different techniques of message passing and Inter task communication.
- Implement different data structures such as pipes, queues and buffers in multithreaded programming.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination, two questions using different tool to be set.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

M.Tech-VLSI & ES-2018- THIRD SEMESTER SYLLABUS

CAD of DIGITAL SYSTEMS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	**18EVE31**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits –03			

Course objectives: This course will enable students to:

- Use graph theory in physical design
- Learn various optimization methods
- Understand different techniques for placement and routing

Modules	RBT Levels
Module-1	
Introduction to Design Methodologies: The VLSI Design Problem, The Design Domains, Design Actions, Design Methods and Technologies. **VLSI Design Automation tools**: Algorithmic and System Design, Structural and Logic Design, Transistor-level Design, Layout Design, Verification Methods, Design Management Tools. **Algorithmic graph theory and computational complexity:** Terminology, Data Structures for the Representation of Graphs, Computational Complexity, Examples of Graph Algorithms. **Tractable and intractable problems:** Decision Problems, Complexity Classes, NP-completeness and NP-hardness, Consequences.	L1, L2
Module-2	
General purpose methods for combinational optimization: Backtracking and Branch-and-bound, Dynamic Programming, Integer Linear Programming, Local Search, Simulated Annealing, Tabu Search, Genetic Algorithms, A Few Final Remarks on General-purpose Methods. **Layout compaction:** Design Rules, Symbolic Layout, Problem Formulation, Algorithms for Constraint-graph Compaction, Other Issues.	L2,L3
Module-3	
Placement and partitioning: Circuit Representation, Wire-length Estimation, Types of Placement Problem, Placement Algorithm, Partitioning. **Floor planning:** Floorplanning Concepts, Shape Functions and Floorplan Sizing.	L2,L3
Module-4	

Routing: Types of Local Routing Problems, Area Routing, Channel Routing, Introduction to Global Routing, Algorithms for Global Routing. **Simulation:** General Remarks on VlSl Simulation, Gate-level Modeling and Simulation, Switch-level Modeling and Simulation.	L2,L3
Module-5	
Logic Synthesis and Verification: Introduction to Combinational Logic Synthesis, Binary-decision Diagrams, Two-level Logic Synthesis **High level synthesis:** Hardware Models for High Level Synthesis, Internal Representation of the Input Algorithm, Allocation, Assignment and Scheduling, Some Scheduling Algorithm, Some Aspects of the Assignment Problem, High-level Transformations.	L3,L4

Course Outcomes: After studying this course, students will be able to:

1. Solve graph theoretic problems.
2. Evaluate the computational complexity of an algorithm
3. Write algorithms for VLSI Automation
4. Simulate and synthesize digital circuits using VLSI automation tools.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- S H Gerez, " Algorithms for VLSI Design Automation", Wiley, India, 2nd edition

Reference Books:

- N.A. Sherwani, "Algorithms for VLSI Physical Design Automation". Springer International edition, 3rd edition.

<table>
<tr><td colspan="4" align="center"><u>ADVANCES IN IMAGE PROCESSING</u>
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – III</td></tr>
<tr><td>Subject Code</td><td>18ECS321</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours Per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
1. Acquire fundamental knowledge in understanding the representation of the digital image and its properties
2. Equip with some pre-processing techniques required to enhance the image for further analysis purpose.
3. Select the region of interest in the image using segmentation techniques.
4. Represent the image based on its shape and edge information.
5. Describe the objects present in the image based on its properties and structure.</td></tr>
</table>

Modules	**RBT Level**
Module 1	
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.	L1
Module 2	
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.	L1, L2
Module 3	
Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.	L1, L2, L3
Module 4	
Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.	L1, L2, L3
Module 5	
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and	L1, L2, L3

watersheds.

Course Outcomes: After studying this course, students will be able to:

- Understand the representation of the digital image and its properties
- Apply pre-processing techniques required to enhance the image for its further analysis.
- Use segmentation techniques to select the region of interest in the image for analysis
- Represent the image based on its shape and edge information.
- Describe the objects present in the image based on its properties and structure.
- Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", Cengage Learning, 2013, ISBN: 978-81-315-1883-0

Reference Books:

1. Geoff Doughertry, Digital Image Processing for Medical Applications, Cambridge university Press, 2010
2. S.Jayaraman, S Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, 2011.

CMOS RF CIRCUIT DESIGN [As per Choice Based credit System (CBCS) Scheme SEMESTER – III			
Subject Code	**18EVE322**	**IA Marks**	**40**
Number of Lecture Hours/Week	**04**	**Exam marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Learn basic concepts in RF and microwave design emphasizing the effects of nonlinearity and noise.
- Appreciate communication system, multiple access and wireless standards necessary for RF circuit design.
- Deal with transceiver architecture, various receiver and transmitter designs, their merits and demerits
- Understand the design of RF building blocks such as Low Noise Amplifiers, Mixers, Oscillators and PLLs

Modules	RBT Level
Module 1	
Introduction to RF Design, Wireless Technology and Basic Concepts: A wireless world, RF design is challenging, The big picture. General considerations, Effects of Nonlinearity, Noise, Sensitivity and dynamic range, Passive impedance transformation. Scattering parameters, Analysis of nonlinear dynamic systems, conversion of gains and distortion	L1,L2,L3
Module 2	
Communication Concepts: General concepts, analog modulation, digital modulation, spectral re-growth, coherent and non-coherent detection, Mobile RF communications, Multiple access techniques, Wireless standards, Appendix 1: Differential phase shift keying.	L1,L2,L3
Module 3	
Transceiver Architecture: General considerations, Receiver architecture, Transmitter architectures, Direct conversion and two-step transmitters, RF testing for heterodyne, Homodyne, Image reject, Direct IF and sub sampled receivers.	L1,L2,L3
Module 4	
Low Noise Amplifiers and Mixers: General considerations, Problem of input matching, LNA topologies: common-source stage with inductive load, common-source stage with resistive feedback. Mixers-General considerations, passive down conversion mixers, Various mixers- working and implementation.	L1,L2,L3
Module 5	
VCO and PLLs- Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Quadrature and single sideband generators. Radio	L1,L2,L3

frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Power Amplifier design	

Course Outcomes: After studying this course, students will be able to:

1. Analyse the effect of nonlinearity and noise in RF and microwave design.
2. Exemplify the approaches taken in actual RF products.
3. Minimize the number of off-chip components required to design mixers, Low-Noise Amplifiers, VCO and PLLs.
4. Explain various receivers and transmitter topologies with their merits and drawbacks.
5. Demonstrate how the system requirements define the parameters of the circuits and the impact on the performance

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.

The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- B. Razavi, "RF Microelectronics", PHI, second edition.

Reference Books:

1.R. Jacob Baker, H.W. Li, D.E. Boyce "**CMOS Circuit Design, layout and Simulation**", PHI 1998.
2. Thomas H. Lee "**Design of CMOS RF Integrated Circuits**" Cambridge University press 1998.
3. Y.P. Tsividis, "**Mixed Analog and Digital Devices and Technology**", TMH 1996

EMBEDDED LINUX SYSTEM DESIGN AND DEVELOPMENT [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	**18EVE323**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits –03			

Course objectives: This course will enable students to:

- Understand transition roadmap from a traditional RTOS to embedded Linux.
- Explain the steps involved in building a GNU cross-platform tool chain
- Explains boot loader architecture, system memory map, both hardware and software memory maps, interrupt management, the PCI subsystem, timers, UART, and power management.
- Explains the MTD subsystem architecture for accessing flash devices, discusses various embedded file systems
- Learn various embedded drivers such as the Serial driver, Ethernet driver, I2C subsystem, and USB gadgets.

Modules	RBT Levels
Module-1	
Introduction: History of Embedded Linux, Why Embedded Linux, Embedded Linux Versus Desktop Linux, Frequently Asked Questions, Embedded Linux Distributions, Porting Roadmap. **Getting Started**: Architecture of Embedded Linux, Linux Kernel Architecture, User Space, Linux Start-Up Sequence, GNU Cross-Platform Tool chain.	L1, L2
Module-2	
Board Support Package: Inserting BSP in Kernel Build Procedure, Memory Map, Interrupt Management, The PCI Subsystem, Timers, UART, Power Management.	L2,L3
Module-3	
Embedded Storage: Flash Map, MTD—Memory Technology Device, MTD Architecture, Sample MTD Driver for NOR Flash, The Flash-Mapping Drivers, MTD Block and Character Devices, Mtdutils Package, Embedded File Systems, Optimizing Storage Space, Tuning Kernel Memory.	L2,L3
Module-4	
Embedded Drivers : Linux Serial Driver, Ethernet Driver , I2C Subsystem on Linux, USB Gadgets, Watchdog Timer, Kernel Modules**.**	L2,L3
Module-5	
Porting Applications: Architectural Comparison, Application Porting Roadmap, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver.	L2,L4

Course Outcomes: After studying this course, students will be able to:

- Understand the embedded Linux development environment.
- Understand and create Linux BSP for a hardware platform.
- Understand the Linux model for embedded storage and write drivers and applications for the same.
- Understand various embedded Linux drivers such as serial, I2C, and so on.
- Port applications to embedded Linux from a traditional RTOS.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- P.Raghvan,Amol Lad,Sriram Neelakandan, “Embedded Linux System Design And Development”, Auerbach Publications,Taylor & Francis Group, 2006 .

Reference Book:

- Karim Yaghmour, Jon Masters, Gilad Ben-Yossef, and Philippe Gerum, “Building Embedded Linux Systems” O’Reilly publications, 2nd edition.

VLSI DESIGN FOR SIGNAL PROCESSING [As per Choice Based credit System (CBCS) Scheme SEMESTER – III			
Subject Code	**18EVE331**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Learn several high-level architectural transformations that can be used to design families of architectures for a given algorithm.
- Deal with high-level algorithm transformations such as strength reduction, look-ahead and relaxed look-ahead.

Modules	**RBT Level**
Module 1	
Introduction to DSP Systems: Typical DSP Algorithms, DSP Application Demands and Scaled CMOS Technologies, Representations of DSP Algorithms. **Iteration Bounds:** Data flow graph Representations, loop bound and Iteration bound. Algorithms for Computing Iteration Bound, Iteration Bound of multi rate data flow graphs.	L1, L2
Module 2	
Pipelining and Parallel Processing: pipelining of FIR Digital Filters, parallel processing, Pipelining and parallel processing for low power. **Retiming:** Definition and Properties, Solving Systems of Inequalities, Retiming Techniques.	L1,L2,L3
Module 3	
Unfolding: An Algorithm for Unfolding, Properties of Unfolding, Critical path, Unfolding and Retiming, Application of Unfolding. **Folding:** Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding of Multirate Systems.	L1,L2,L3
Module 4	
Systolic Architecture Design: systolic array design Methodology, FIR systolic array, Selection of Scheduling Vector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design for space representation containing Delays. **Fast convolution**: Cook-Toom Algorithm, Winograd Algorithm, Iterated convolution, cyclic convolution Design of fast convolution Algorithm by Inspection.	L1,L2,L3
Module 5	
Pipelined and Parallel Recursive and Adaptive Filter: Pipeline	L1,L2,L3

Interleaving in Digital Filter, first order IIR digital Filter, Higher order IIR digital Filter, parallel processing for IIR filter, Combined pipelining and parallel processing for IIR Filter, Low power IIR Filter Design Using Pipelining and parallel processing, pipelined adaptive digital filter.	

Course Outcomes: After studying this course, students will be able to:

1. Illustrate the use of various DSP algorithms and addresses their representation using block diagrams, signal flow graphs and data-flow graphs
2. Use pipelining and parallel processing in design of high-speed /low-power applications
3. Apply unfolding in the design of parallel architecture
4. Evaluate the use of look-ahead techniques in parallel and pipelined IIR Digital filters.
5. Develop an algorithm or architecture or circuit design for DSP applications

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- Keshab K.Parthi, "VLSI Digital Signal Processing systems, Design and implementation ", Wiley 1999.

Reference Books:

1. Mohammed Isamail and Terri Fiez, "Analog VLSI Signal and Information Processing ", Mc Graw-Hill,1994.
2. S.Y. Kung, H.J. White House, T. Kailath, " VLSI and Modern Signal Processing ", Prentice Hall, 1985.
3. Jose E. France, Yannis Tsividis, " Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing ", Prentice Hall, 1994.
4. Lars Wanhammar, “DSP Integrated Circuits”, Academic Press Series in Engineering, 1st Edition.

PATTERN RECOGNITION and MACHINE LEARNING **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – III**			
Course Code	**18ESP332**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			
Course objectives: The objective of the course is to discusses main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems. Special emphasis will be given to regression, classification, regularization, feature selection and density estimation in supervised mode of learning.			

Modules	**RBT Levels**
Module-1	
Introduction: Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory **Distributions:** Binary and Multinomial Variables, The Gaussian Distribution, The Exponential Family, Nonparametric Methods. **(Ch.: 1,2)**	**L1,L2**
Module-2	
Supervised Learning **Linear Regression Models:** Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison **Classification & Linear Discriminant Analysis:** Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Mode **Ch. :3,4)**	**L1,L2,L3**
Module-3	
Supervised Learning **Kernels:** Dual Representations, Constructing Kernels, Radial Basis Function Network, Gaussian Processes **Support Vector Machines:** Maximum Margin Classifiers, Relevance Vector Machines **Neural Networks:** Feed-forward Network, Network Training, Error Backpropagation **(Ch:5,6,7)**	**L1,L2,L3**
Module-4	
Unsupervised Learning: **Mixture Models:** K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures, Alternative View of EM. **Dimensionality Reduction:** Principal Component Analysis, Factor/Component Analysis, Probabilistic PCA, Kernel PCA, Nonlinear Latent Variable Models **(Ch.: 9,12)**	**L1,L2,L3**
Module-5	

Probabilistic Graphical Models: Bayesian Networks, Conditional Independence, Markov Random Fields, Inference in Graphical Models, Markov Model, Hidden Markov Models **(Ch.:8,13)**	**L1,L2,L3**

Course Outcomes: At the end of this course, students will be able to
1. Identify areas where Pattern Recognition and Machine Learning can offer a solution.
2. Describe the strength and limitations of some techniques used in computational Machine Learning for classification, regression and density estimation problems.
3. Describe and model data.
4. Solve problems in Regression and Classification.

Question paper pattern:
- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:
1. Pattern Recognition and Machine Learning. Christopher Bishop. Springer, 2006

<table>
<tr><td colspan="4" align="center"><u>INTERNET of THINGS</u>
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III</td></tr>
<tr><td>Course Code</td><td>18ECS333</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">Credits – 04</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to:
• Introduce concept of IOT and its applications in today’s scenario.
• Understand IOT content generation and transport through networks
• Understand the devices employed for IOT data acquisition and communication access technologies
• Introduce some use cases of IOT</td></tr>
</table>

Module-1	RBT
What is IOT Genesis, Digitization, Impact, Connected Roadways, Buildings, Challenges **IOT Network Architecture and Design** Drivers behind new network Architectures, Comparing IOT Architectures, M2M architecture, IOT world forum standard, IOT Reference Model, Simplified IOT Architecture.	**L1, L2**
Module-2	
IOT Network Architecture and Design Core IOT Functional Stack, Layer1(Sensors and Actuators), Layer 2(Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IOT Network management. Layer 3(Applications and Analytics) – Analytics vs Control, Data vs Network Analytics IOT Data Management and Compute Stack	**L2,L3**
Module-3	
Engineering IOT Networks Things in IOT – Sensors, Actuators, MEMS and smart objects. Sensor networks, WSN, Communication protocols for WSN Communications Criteria, Range Frequency bands, power consumption, Topology, Constrained Devices, Constrained Node Networks IOT Access Technologies, IEEE 802.15.4 Competitive Technologies – Overview only of IEEE 802.15.4g, 4e, IEEE 1901.2a Standard Alliances – LTE Cat0, Cat-M, NB-IOT	**L2,L3**
Module-4	

Engineering IOT Networks IP as IOT network layer, Key Advantages, Adoption, Optimization, Constrained Nodes, Constrained Networks, IP versions, Optimizing IP for IOT. Application Protocols for IOT – Transport Layer, Application Transport layer, Background only of SCADA, Generic web based protocols, IOT Application Layer Data and Analytics for IOT – Introduction, Structured and Unstructured data, IOT Data Analytics overview and Challenges.	**L3,L4**
Module-5	
IOT in Industry (Three Use cases) IOT Strategy for Connected manufacturing, Architecture for Connected Factory Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary substation grid block and automation. Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart street lighting.	**L3,L4**

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Course Outcomes: After studying this course, students will be able to:

1. Understand the basic concepts IOT Architecture and devices employed.
2. Analyze the sensor data generated and map it to IOT protocol stack for transport.
3. Apply communications knowledge to facilitate transport of IOT data over various available communications media.
4. Design a use case for a typical application in real life ranging from sensing devices to analyzing the data available on a server to perform tasks on the device.

Text Book:

- CISCO, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743

Reference Book:

- Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547

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CONTENTS

Definitions of Keywords

The following are the definitions/descriptions that have been followed for the different terms used in the Regulations of Master of Business Administration (MBA) Programme:

1. **Programme:** Is an educational programme in Business Administration leading to award of Degree. It involves events/activities, comprising of lectures/ tutorials/ laboratory work/ field work, outreach activities/ project work/ vocational training/ viva/ seminars/ internship/ assignments/ presentations/ self-study/ quiz etc, or a combination of some of these.
2. **Branch:** Meansspecialization or discipline of MBA.
3. **Semester:** Refers to one of the two sessions of an academic year (vide: serial number 4), each session being of sixteen weeks duration (with working days greater than or equal to ninety).The odd semester may be scheduled from August and even semester from February of the year.
4. **Academic Year:**Refers to the sessions of two consecutive semesters (odd followed by an even) including periods of vacation.
5. **Course:** Refers to usually referred to as 'papers' and is a component of a programme. All Courses need not carry the same weight. The Courses should define learning objectives and learning outcomes. A Course may be designed to comprise lectures/ tutorials/ laboratory work/ field work/ outreach activities/project work/ vocational training/ viva/ seminars/ term papers/assignments/ presentations/ self-study/quiz etc. or a combination of some of these.
6. **Credit:** Refers to a unit by which the Course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of lecture or two hours of laboratory/practical Courses/ tutorials/ fieldwork per week etc.
7. **Audit Courses:** Means Knowledge/ Skill enhancing Courses without the benefit of a grade or credit for a Course.
8. **Choice Based Credit System (CBCS):** Refers to customizing the Course work, through Core, Elective and soft skill Courses, to provide necessary support for the students to achieve their goals.

9. **Course Registration:** Refers to formal registration for the Courses of a semester (Credits) by every student under the supervision of a Faculty Advisor (also called Mentor, Counselor etc.) in each Semester for the Institution to maintain proper record.
10. **Course Evaluation:** Means Continuous Internal Evaluation (CIE) and Semester End Examinations (SEE) to constitute the major evaluations prescribed for each Course. CIE and SEEto carry 40 % and 60 % respectively, to enable each Course to be evaluated for 100 marks, irrespective of its Credits.
11. **Continuous Internal Evaluation (CIE):** Refers to evaluation of students achievement in the learning process. CIE shall be by the course instructor and includes tests, homework, problem solving, oral examination, group discussion, quiz, mini-project, outreach activities and seminar throughout the semester, with weightage for the different components being fixed at the University level.
12. **Semester end examinations (SEE):** Refers to examination conducted at the University level covering the entire course syllabus. SEE is also termed as university examination.
13. **First Attempt:** Refers to a student who has completed all formalities and has become eligible to attend the SEE and has attended at least one head of passing, such attempt shall be considered as first attempt.
14. **Credit Based System (CBS):** Refers to quantification of course work, after a student completes teaching – learning process, followed by passing in both CIE and SEE. Under CBS, the requirement for awarding degree is prescribed in terms of total number of credits to be earned by the students.
15. **Credit Representation:** Refers to Credit Values for different academic activities considered, as per the Table.1. Credits for seminar, project phases, project viva–voce and internship shall be as specified in the Scheme of Teaching and Examination.

Table 1: Credit Values

Theory/Lectures (L) (hours/week/Semester)	Tutorials (T) (hours/week/Semester)	Laboratory/Practical (P) (hours/week/Semester)	Credits (L:T:P)	Total Credits
4	0	0	4:0:0	4
3	0	0	3:0:0	3
2	2	0	2:1:0	3
2	0	2	2:0:1	3
2	2	2	2:1:1	4
0	0	6	0:0:3	3

16. **Letter Grade:** It is an index of the performance of students in a said Course. Grades are denoted by letters S, A, B, C, D, E and F.

17. **Grading:** Grade refers to qualitative measure of achievement of a student in each Course, based on the percentage of marks secured in (CIE plus SEE). Grading is done by Absolute Grading [Refer: 18OMB6.0]. The rubic attached to letter grades are as follows:

    S – Outstanding, A – Excellent, B – Very Good, C – Good, D – Above Average, E – Average and F – Fail.

18. **Grade Point (GP):** Refers to a numerical weightage allotted to each letter grade on a 10-point scale as under.

Letter Grade and corresponding Grade Points on a typical 10 – Point scale							
Letter Grade	S	A	B	C	D	E	F
Grade Point	10	09	08	07	06	04	00

19. **Passing Standards:** Refers to passing a Course only when getting GP greater than or equal to 04 (as per serial number 18).

20. **Credit Point:** Is the product of Grade Point (GP) and number of credits for a Course i.e.

    Credt points (CrP)=GP×Credits for the Course.

21. **Semester Grade Point Average (SGPA):** Refers to a measure of academic performance of student/s in a semester. It is the ratio of total credit points secured by a student in various Courses of a semester and the total Course credits taken during that semester. [Refer:18OMB6.0]

22. **Cumulative Grade Point Average (CGPA):** Is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points earned by a student in various Courses in all semesters and the sum of the total credits of all Courses in all the semesters. It is expressed up to two decimal places. [Refer: 18OMB6.0]

23. **Grade Card:** Refers to the certificate showing the grades earned by a student. A grade card shall be issued to all the registered students after every semester end examination. The grade card will display the Programme details (Course code, title, number of credits, grades secured) along with SGPA of that semester and CGPA earned till that semester.

24. **University:** Visvesvaraya Technological University (VTU), Belagavi.

18OMB1.0	**Title, Duration and Credits of the Programme of Study**
18OMB1.1	The Programme shall be called Master of Business Administration (Subject of Specialization) abbreviated as MBA (Subject of Specialization).
18OMB1.2	The Programme shall be a full time programme extended over a period of two academic year duration divided into four semesters and each semester shall be of 16 weeks duration.
18OMB1.3	**Maximum Duration for Programme Completion:** A candidate shall be allowed a maximum duration of 4 years from the first semester of admission to become eligible for the award of the Degree, failing which he/she may discontinue the program or register once again as a fresh candidate to I semester.
18OMB1.4	**Prescribed Number of Credits for the Programme:** The number of credits to be completed for the award of degree shall be 100.
18OMB1.5	The Calendar of events in respect of the Programme shall be notified by the University in advance.
18OMB2.0	**Eligibility for Admission (As per the Government orders issued from time to time)**
18OMB2.1	Admission to MBA Program shall be open to the candidates who have passed recognized Bachelor's Degree of minimum of 3 years duration or equivalent examination and obtained an aggregate minimum of 50% marks taken together in all the subjects including languages in all the years of the Degree Examination and 45% of marks in case of SC, ST and Category-I of Karnataka candidates. (Reservation is applicable only for Karnataka Candidates).

18OMB2.2	**For admissions under PGCET qualification and Roaster system of Government of Karnataka:** There shall be an Entrance Examination (PGCET) for admission to the MBA programme. A candidate seeking admission to MBA Programme offered in any of the Engineering Colleges affiliated to VTU shall appear for this Examination. For admission under Government quota, ranks obtained in PGCET entrance examination, conducted by Karnataka Examination Authority (KEA), shall be considered. **For admissions under Management Quota:** The candidates should have appeared for theEntrance Examination conducted by KEA (PGCET)/Karnataka Management Aptitude Test (KMAT) or appeared and qualified under any approved entrance examination conducted by the authority recognized by Government of Karnataka/VTU /any other University of Karnataka state. Further, there shall be an Admissions Committee for the MBA Program consisting of the Principal of the College as the Chairman, Head of the concerned Department and one senior staff member of the concerned Department. The Admissions Committee conducts the interview and selects the candidates for admission.
18OMB2.3	(i) The candidates from Universities other than the Universities of Karnataka shall have to obtain Eligibility Certificate from the VTU to seek admission to MBA program in any of the college affiliated to VTU. (ii) The candidates from foreign countries shall have to obtain Eligibility Certificate from the VTU to seek admission to MBA program in any of the college affiliated to VTU. Further, they have to produce equivalence certificate from the Association of Indian Universities.
18OMB2.4	The intake under various categories (regular, SC/ST and category I) shall be as sanctioned by the AICTE, State Government and VTU, from time to time.

18OMB2.5	**Admission to vacant seats:** Seats remaining vacant (unfilled), after the completion of PG admission process by Karnataka Examination Authority, shall be filled by the Institution by inviting applications through Press notification. The seats shall be filled by Candidates preferably who have PGCET score. In the absence of such Candidates, admission shall be based on merit in the entrance test conducted at the Institution level. An Admissions Committee, consisting of the Principal of the College, Head of the concerned Department and the subject experts, shall be in charge of admissions.
18OMB3.0	**Courses**
18OMB3.1	The curriculum of the Programme shall be any combination of following type of courses: i) Professional Core Courses (PC) - relevant to the chosen specialization/ branch [May be split into Hard (no choice) and Soft (with choice), if required]. The core course is to be compulsorily studied by a student and is mandatory to complete the requirements of a programme in a said discipline of study. ii) Professional Electives Courses (PE) - relevant to the chosen specialization/ branch: these are the courses, which can be chosen from the pool of papers. It shall be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student skills. iii) Open Electives Courses (OE) - from other technical and/ or emerging specialization areas. iv) Project Work, Seminar. v) Audit Courses (AC): (a) The Audit course can be any credit course offered by the program to which the Candidate is admitted (other than the courses considered for completing the prescribed program credits). (b) The students interested in audit courses can register for one audit course at a time during II to IV semester.

	Students who have registered to audit courses, considered on par with students registered to the same course for credit, have to satisfy attendance and CIE requirements. However, they need not have to appear for SEE. (c) Registration for any audit course, in writing, shall be completed at the beginning of each semester. The Institution should intimate the Registrar (Evaluation) about the registration at the beginning of the semester and obtain a formal approval for inclusion of the audit course/s in the Grade cards/ Transcripts issued to the students. vi) Professional training/Internship (referred to as Internship): Preferably at an industry/ R and D organization/IT company/ Government organization/Business organization of significant repute for a specified period mentioned in Scheme of Teaching and Examination.
18OMB3.2	A candidate shall exercise his /her option in respect of the electives and register for the same before the beginning of the concerned semester. The candidate may be permitted to opt for change of elective subject within 10 days from the date of commencement of the semester as per the calendar of the University.
18OMB3.3	The minimum number of students to be registered for an Elective to be offered shall not be less than ten. However, the above condition shall not be applicable when the class strength is less than ten.
18OMB4.0	**Internship**
18OMB4.1	**Internship:** The student shall undergo Internship/Organization study as per the Scheme of Teaching and Examination. 1. The internship shall be carried out in any industry/R&D Organization/Research Institute/Institute of national and international repute Business organization/ recognized national and international Professional Bodies, Societies or Organizations.

	2. The Department/college shall nominate a faculty to facilitate, guide and supervise students under internship. 3. The students shall report the progress of the internship to the internal guide in regular intervals and seek his/her advise. 4. The Internship shall be completed during the period specified in Scheme of Teaching and Examination. 5. After completion of Internship, students shall submit a report to the Head of the Department with the approval of both internal and external guides. 6. There will be 40 marks for CIE (Seminar: 20, Internship/ Organization study report: 20) and 60 marks for Viva – Voce conducted during SEE. [To be read along with 18OMB 8.1 and 9.3] 7. The internal guide shall award the CIE marks for seminar and internship report after evaluation. He/she will also be the internal examiner for Viva – Voce conducted during SEE. 8. The external guide from the industry shall be an examiner for the viva voce on Internship. Viva-Voce on internship shall be conducted at the college and the date of Viva-Voce shall be fixed in consultation with the external Guide. The Examiners shall jointly award the Viva - Voce marks. 9. (i) In case the external Guide is not available or expresses his inability to conduct viva voce, the Chief Superintendent shall be permitted to make alternate arrangement. The examiner, in the order of preference, shall be an industry person or a faculty of another institution chosen from the list of University examiners. The same shall be intimated to the concerned BOE Chairperson. (ii) In case the external Guide accepts to conduct viva-voce examination from his/her workplace, it shall be arranged via Video/web conferencing/ Webinar. The external Examiner shall send the signed marks list, soon after the examination, via email/any electronic media.

	10. The students are permitted to carry out the internship anywhere in India or abroad. The University will not provide any kind of Financial Assistance to any student for internship.
18OMB4.2	**Failing to undergo Internship:** Internship is one of the head of passing. Completion of Internship is mandatory. If any student fails to undergo/complete the Internship, he/she shall be considered as fail in that Course and the prescribed credits shall not be awarded in that Course. The student, however, can submit the project dissertation and appear for viva voce. The student shall be eligible for the internship credits only after satisfying the conditions prescribed for the same during the subsequent academic year. The reappearance shall be considered as an attempt.
18OMB5.0	**Project**
18OMB5.1	**Project work and Dissertation:** Each candidate shall carry out the project work independently as per Scheme of Teaching and Examinations under the guidance of one of the faculty members of the Department in the Institution of study. If the project is of inter-disciplinary nature, a co-guide shall be taken from the other concerned department. The topic and title of the dissertation shall be chosen by the candidate in consultation with the guide and co-guide, if any, during the III semester itself. The subject and topic of the dissertation shall be from the major field of studies of the candidate. Modification of only the title but not the field of work may be permitted at the time of final submission of dissertation report during IV semester. If dissertation has to be carried out in any industry/R&D labs/business organizations, outside the campus, permission shall be taken from the Principal to that effect. The Principal, shall submit a list showing the name of the student, University Seat Number, title of the

	project, name/s of the guide/co-guide at the time of submission of project report to the University.
18OMB5.2	Project is one of the head of passing. The candidate shall submit a soft copy (CD) of the dissertation work to the University. The CD should contain the entire Dissertation in monolithic form as a PDF file (not separate chapters). The Guide, after checking the report for completeness shall upload the Dissertation along with name, University Seat Number, address, mobile number of the candidate, etc., as prescribed in form available on online Dissertation evaluation portal.
18OMB5.3	**Plagiarism Check** Once the Guide uploads the dissertation, the same shall be linked for plagiarism check. The allowable plagiarism index is less than or equal to 25%. If the check indicates a plagiarism index greater than 25%: * For the first time, the candidate has to resubmit the dissertation, to the Registrar (Evaluation), Regional Center/Head Office, VTU along with the penal fees of Rs. 2000/- (RupeesTwo thousand only). * For the second time, the candidate has to resubmit the dissertation along with the penal fees of Rs. 4000/- (Rupees four thousand only). * If the dissertation is rejected again during second resubmission with reference to plagiarism index, the candidate shall redo the project and submit after a semester's time subject to provisions of 18OMB1.5.
18OMB5.4	The dissertation shall be sent through email for evaluation to two examiners - one internal examiner (guide/co-guide) and one external examiner (first) appointed by the University. The evaluation of the dissertation shall be made independently by each examiner.
18OMB5.5	Examiners shall evaluate the dissertation normally within a period of not more than two weeks from the

	date of receipt of dissertation through email.
18OMB5.6	The examiners shall independently submit the marks through the specified link.
18OMB5.7	Average of the marks awarded by the two Examiners shall be the final evaluation marks for the Dissertation.
18OMB5.8	(a) Viva-voce examination of the candidate shall be conducted as per 18OMB5.10, if the dissertation work and the reports are accepted by the external examiner (first). (b) If the external examiner (first) finds that the dissertation work and the report are not up to the expected standard and the minimum passing marks cannot be awarded, the dissertation shall not be accepted for SEE. The external examiner (first) can recommend for modifications/suggestions of dissertation or totally reject the dissertation. The examiner shall offer suggestions for improvement of the dissertation for resubmission or list the reasons for rejection of the dissertation. (c) The resubmitted Dissertation incorporating the modifications/suggestions [as per 18OMB5.8 (b)] of the external examiner (first) and satisfying the provision 18OMB5.3 shall be sent again to the external examiner (first) for evaluation. If the dissertation and the report are accepted by the external examiner (first), Viva-voce examination of the candidate shall be conducted as per 18OMB5.10. (d) In case of rejection of Dissertation by the external examiner (first), the same will be sent to a Second Examiner (external) approved by the University. The decision oftheSecond Examiner (external) is final. If the dissertation and the report are accepted by the Second Examiner (external), Viva-voce examination of the candidate shall be conducted as per 18OMB5.10. If the Second Examiner (external) rejects the dissertation and the report, the candidate shall have to carry out the

	dissertation work once again and submit the dissertation subject to provisions of 18OMB1.5. In such cases of rejection, the candidate shall redo the entire procedure starting from the submission of Dissertation in soft copy. (e) In case of rejection of Dissertation, with reasons, by the external examiner (first) [as per 18OMB5.8 (b)], the same will be sent to a Second Examiner (external) [not necessarily the same examiner considered under 18OMB5.8 (d)] approved by the University. The decision of the Second Examiner (external) is final. If the dissertation and the report are accepted by the Second Examiner (external), Viva-voce examination of the candidate shall be conducted as per 18OMB5.10. If the Second Examiner (external) rejects the dissertation and the report, the candidate shall have to carry out the dissertation work once again and submit the dissertation subject to provisions of 18OMB1.5. In such cases of rejection, the candidate shall redo the entire procedure starting from the submission of Dissertation in soft copy.
18OMB5.9	The candidate, whose Dissertation is rejected, can rework on the same topic or choose another topic of dissertation under the same Guide or new Guide if necessary. In such an event, the report shall be submitted within four years from the date of admission to the Programme.
18OMB5.10	Viva-voce examination of the candidate shall be conducted by the external examiner and internal examiner/ guide. Internal examiner as per the direction of the University shall have to arrive at a mutually convenient date for the conduct of viva-voce examination of the concerned candidate with an intimation to the Registrar (Evaluation). In case one of the examiners expresses his/her inability to attend the viva-voce, the Registrar (Evaluation) shall
	appoint a substitute examiner in his/her place.
18OMB5.11	The relative weights for the evaluation of dissertation

	and the performance at the viva voce shall be as per the scheme of teaching & examination.
18OMB5.12	The marks awarded by both the Examiners at the viva voce Examination shall be sent jointly to the University immediately after the examination.
18OMB5.13	Examination fee as fixed from time to time by the University for evaluation of dissertation report and conduct of viva voce shall be remitted through the Head of the Institution as per the instructions of Registrar (Evaluation) from time to time.
18OMB5.14	The candidates who fail to submit the dissertation work within the stipulated time have to submit the same at the time of next ensuing examination.
18OMB6.0	**Computation of SGPA and CGPA**
18OMB6.1	(i) The University adopts absolute grading system wherein the marks are converted to grades, and every semester results will be declared with semester grade point average (SGPA) and Cumulative Grade Point Average (CGPA). The CGPA will be calculated for every semester, except for the first semester. (ii) The grading system with the letter grades and the assigned range of marks under **absolute grading system are as given below:**

Level	Outstanding	Excellent	Very Good	Good	Above Average	Average	Fail
Letter Grade	S	A	B	C	D	E	F
Grade Points	10	9	8	7	6	4	00
Percentage of Marks Scored in a Course	≥ 90	<90 ≥ 80	< 80 ≥ 70	< 70 ≥ 60	< 60 ≥ 55	< 55 ≥ 50	< 50
	(90 -100)	(80 - 89)	(70 - 79)	(60 - 69)	(55 - 59)	(50- 54)	(0 - 49)

(iii) A student obtaining Grade F in a Course shall be considered fail and is required to reappear in subsequent SEE. Whatever the letter grade secured by the student during his /her reappearance shall be retained. However the number of attempts taken to clear a Course shall be indicated in the grade cards/ transcripts.

18OMB6.2	**Computation of SGPA and CGPA** The following expressions shall be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) respectively:
SGPA=	(? [CourseCredits Grade Points] for all the Courses in that Semester) ――― (? [Course Credits] for all the Courses in that Semester)
CGPA =	(∑[CourseCredits × Grade Points] for all Courses excluding @ those with F grades until that Semester) ――― ∑ [Course Credits]for all Courses excluding those with F grades until that semester

(a) SGPA and CGPA Calculations: An Illustrative Example for one academic year

Semester (Odd :I, Even: II)	Course Number	Credits	Grade	Grade Points	Credit Points	SGPA, CGPA
I	XX101	5:0:0 = 5	B	8	$5 \times 8 = 40$	
I	XX102	3:2:0 = 5	Absent(F)	0	$5 \times 0 = 00$	
I	XX103	3:0:0 = 3	A	9	$3 \times 9 = 27$	$\text{SGPA} = \frac{117}{25}$
I	XX104	0:1:1 = 2	F	0	$2 \times 0 = 00$	$= 4.68$
I	XX105	4:1:0 = 5	D	6	$5 \times 6 = 30$	
I	XX106	5:0:0 = 5	E	4	$5 \times 4 = 20$	
	Total	25 (18*)	Total		117	
(18*): Total credits of the semester excluding the credits of the courses under F grade. Considered for the calculation of CGPA of the two consecutive semesters under consideration.						
II	XX107	3:1:1 = 5	C	7	$5 \times 7 = 35$	$\text{SGPA} = \frac{157}{25}$
II	XX108	4:0:0 = 4	B	8	$4 \times 8 = 32$	
II	XX109	3:0:0 = 3	D	6	$3 \times 6 = 18$	$= 4.68$
II	XX110	4:1:0 = 5	E	4	$5 \times 4 = 20$	
II	XX111	2:1:1 = 4	A	9	$4 \times 9 = 36$	CGPA
II	XX112	2:0:0 = 2	F	0	$2 \times 0 = 00$	$= \frac{(117 + 157)}{18 + 23}$
II	XX113	0:2:0 = 2	B	8	$2 \times 8 = 16$	
	Total	25 (23*)		Total	157	$= 274/41 = 6.68$
(23*): Total credits of the semester excluding the credits of the courses under F grade. Considered for the calculation of CGPA of the two consecutive semesters under consideration.						
If the Student secures letter grades as detailed below after reappearance to SEE, then the SGPA and CGPA shall be calculated as indicated below.						
I	XX102	3:2:0 = 5	D	6	$5 \times 6 = 30$	SGPA (I Semester) $= \frac{117 + 30 + 14}{25}$
I	XX104	0:1:1 = 2	C	7	$2 \times 7 = 14$	$= 161/25 = 6.44$
II	XX112	2:0:0 = 2	D	6	$2 \times 6 = 12$	SGPA (I Semester) $= (157 + 12)/25 = 169/25 = 6.76$

CGPA at the end of the academic year after passing all the Courses of the two consecutive semesters under consideration $= \frac{6.44 \times 25 + 6.76 \times 25}{50} = 6.60$?

(b) CGPA Calculation of the Programme:An Illustrative Example				
Semester	I	II	III	IV
Credits of the semester	24	24	28	24
SGPA	7.00	8.50	9.20	6.86

$$\text{CGPA} = \frac{(24 \times 7.00 + 24 \times 8.50 + 28 \times 9.20 + 24 \times 6.86)}{100} = 7.94$$?

18OMB6.3	**Grade Card:** Based on the secured letter grades, grade points, SGPA and CGPA, a grade card for each semester and a consolidated grade card indicating the performance in all semesters shall be issued. ?
18OMB7.0	**Conversions of Grades into Percentage and Class Equivalence**
18OMB7.1	**Conversions of Grades into Percentage** Conversion formula for the conversion of CGPA into percentage is given below: Percentage of marks secured, P = [CGPA Earned - 0.75] × 10 **Illustration for a CGPA of 8.20:** P = [CGPA Earned 8.2 - 0.75]× 10 = 74.5 %
18OMB7.2	**Class Equivalence:** After the conversion of final CGPA into percentage of marks (P), a graduating student is reckoned to have passed in (i) First Class with Distinction (FCD) if P =70% (ii) First Class (FC) if P =60% but <70% and (iii) Second Class (SC) if P < 60%.
18OMB8.0	**Continuous Internal Evaluation and Semester End Evaluation**
18OMB8.1	There shall be a maximum of 40 CIE Marks in each theory. A candidate shall obtain not less than 50% of the maximum marks prescribed for the CIE of each Theory course/ Internship /Project/Dissertation. [To be read along with 18OMB8.8]

18OMB8.2	CIE Marks shall be based on a) Tests (for 25Marks) and b) Assignments, Quiz, Simulation, Experimentation, Mini project, oral examination, field work etc., (for 15 Marks)conducted in respective courses.
18OMB8.3	The CIE marks in a theory course, for 25 marks, shall be based on two tests covering the entire syllabus. An additional test may be conducted for the needy students to provide an opportunity to improve their CIE Marks before the end of the semester. The CIE marks shall be the average of the marks scored in at least two of the above tests.
18OMB8.4	The candidates shall write the Tests in Blue Book/s. The Blue book/s and other documents relating to award of CIE marks under 18OMB8.2 (b) shall be preserved by the Principal / Head of the Department for at least six months from the date of announcement of University results and made available for verification at the directions of the Registrar (Evaluation).
18OMB8.5	Every page of the CIE marks list shall bear the signatures of the concerned Teacher, Head of the Department and the Principal.
18OMB8.6	The CIE marks list shall be displayed on the Notice Board and corrections, if any, shall be incorporated before submitting to the University.
18OMB8.7	The CIE marks shall be sent to the university by the Principals well in advance before the commencement of Semester End Examinations. No corrections of the CIE marks shall be entertained after the submission of marks list to the University.
18OMB8.8	Candidates obtaining less than 50% of the CIE marks in any course (Theory/Internship/Project) shall not be eligible to appear for the University examination in that course/s. In such cases, the Head of the Department shall arrange for the improvement of CIE marks in the course when offered in the subsequent semester subject to the provision of 18OMB1.5.

18OMB8 9 `	**Semester End Evaluation** : There shall be a University examination at the end of each semester . Setting Theory Question Papers and Evaluation: Question papers in theory courses shall be set by the Examiners appointed by the University.
18OMB8.10	There shall be double valuation of theory papers. The theory Answer booklets shall be valued independently by two examiners appointed by the University.
18OMB8.11	If the difference between the marks awarded by the two Examiners is not more than 15 per cent of the maximum marks, the marks awarded to the candidate shall be the average of two evaluations.
18OMB8.12	If the difference between the marks awarded by the two Examiners is more than 15 per cent of the maximum marks, the answer booklet shall be evaluated by a third Examiner appointed by the University. The average of the marks of nearest two valuations shall be considered as the marks secured by the candidate. In case, if one of the three marks falls exactly midway between the other two, then the highest two marks shall be taken for averaging.
18OMB9.0	**Eligibility for Passing and Award of Degree**
18OMB9.1	(1) A student who obtains any grade S to E shall be considered as pass and if a student secures F grade in any of the head of passing he/she has to reappear in that head for the SEE. (2) A student shall be declared successful at the end of the Programme for the award of Degree only on obtaining CGPA = 5.00, with none of the Coursesremaining with F Grade. (3) In case, the CGPA fall below 5.00, the student shall be permitted to appear again for SEE for required number of courses and times, subjectto the provision of 18OMB1.5, to make up CGPA = 5.0. The student should reject the SEE results of the previous attempt and obtain written permission from The Registrar (Evaluation) to reappear in the subsequent SEE.

18OMB9.2	For a pass in a theory course, the student shall secure minimum of 40 % of the maximum marks prescribed in the Semester End Examination and 50 % of marks in CIE and 50 % in the aggregate of CIE and SEE marks. The Minimum Passing Grade in a course is E.
18OMB9.3	To a pass in Internship/ Project/Dissertation/Viva-voce examination, a student shall secure a minimum of 50 % of the maximum marks prescribed for the SEE in Internship/ Project/Dissertation/Viva-voce. The Minimum Passing Grade in a course is E.
18OMB9.4	IV semester students having backlog courses are permitted to upload the dissertation report and to appear for SEE. The IV semester grade card shall be released only when the student completes all the backlog courses and become eligible for the award of degree. [To be read along with 18OMB11.2].
18OMB9.5	A candidate may at his/her desire reject his/her latest semester, except the IV semester, results of University examination in respect to all courses of that semester. Rejection shall be permitted only once during the entire Programme. The CIE marks of the rejected semester shall remain the same. Rejection of results of the University examination including CIE marks is not permitted.
18OMB9.6	If the rejection of the University examination results of the semester happens to be of an odd semester, the candidate can take admission to the immediate next even semester. However, if the rejection of the University result is of even semester, the candidate cannot take admission to the next odd semester.
18OMB9 7	Application for rejection shall be submitted to the Registrar E(valuation)through the Principal of the college , within thirty days from the date of announcement of results .
18OMB9.8	A candidate, who opts for rejection of results of a semester shall be eligible for the award of class and distinction, but shall not be eligible for the award of rank.

18OMB9.9	**Eligibility for Award of Degree:** A student shall be declared to have completed the degree of MBA, provided the student has undergone the stipulated course work as per the regulations and has earned the prescribed Credits, as per the Scheme of Teaching and Examination, of the programme.
18OMB10.0	**Attendance Requirement**
18OMB10.1	**Registration and Enrolment:** i) Except for the first semester, registration for a semester will be done during a specified week before the semester end examination of the previous semester. ii) The registration sheet shall have the Candidate details, course name and code, number of credits and category (core/elective/audit) for each course of that semester. iii) The Faculty Adviser, assigned by the Head of the Department, will counsel the students in planning their courses of study and provide guidance, motivation, emotional support, and enable the mentees to reach the desired professional and career goals.
18OMB10.2	Courses of each semester shall be treated as a separate unit for calculation of the attendance.
18OMB 10.3	The candidate has to put in a minimum attendance of 85% in each course with a provision to condone 10 % of the attendance by the Vice-Chancellor on the specific recommendation of the Principal of the college where the candidate is studying, based on medical grounds, participation in University/ State/ National/ International level sports and cultural activities, seminars, workshops, paper presentation etc., of significant value. The necessary documents in support are to be submitted along with recommendations to condone the shortage.
18OMB10.4	In case of late admission, approved by competent authority (Karnataka Examination Authority/VTU), to I semester of the programme the attendance shall be reckoned from the date of admission to the programme.

18OMB10.5	A candidate, who does not satisfy the attendance requirement (in one or more Courses) as mentioned in 18OMB10.3 shall not be eligible to appear for the SEE of that semester and shall not be permitted to take admission to next higher semester. The candidate shall be required to repeat that semester during the subsequent year.
18OMB10.6	Principals of the concerned colleges shall notify regularly, the list of candidates who fall short of attendance.
18OMB10.7	The list of the candidates falling short of attendance shall be sent to the University at least one week prior to the commencement of the examination.
18OMB11.0	**Promotion and Eligibility**
18OMB11.1	**Promotion:** There shall be no restriction for promotion from an odd semester to the next even semester, provided the student has fulfilled the attendance requirement.
18OMB11 2	(a) Candidates ,with a maximum of four backlog courses of first year shall be eligible for taking admission to second year (III semester) . (b) Each credit course shall be treated as a head of passing.
18OMB11.3	The Mandatory non – credit courses, if any, shall not be considered for the Eligibility criterion prescribed for promotion, award of Class, calculation of SGPA and CGPA. However, a pass in the above courses is mandatory before the completion of Degree.
18OMB12.0	**Temporary Discontinuation/Break in the Program**
18OMB12.1	(a) If a candidate, for any reason, temporarily discontinues the Programme or take a break from programme during any semester, he/she may be permitted to continue in the programme by registering to the same semester of the prevailing scheme. The candidate shall complete all the remaining course work subject to the provision 18OMB1.5. Also the Candidates may have to complete additional course/s, if any, as per the decision of concerned Board of Studies and

	approval of Dean, Faculty of Engineering, on establishing equivalence between two schemes. A Grade card shall be issued to that effect. Additional course/s shall not be considered for the eligibility criterion prescribed for promotion. However, based on the individual cases, it is considered to decide the SGPA and CGPA to admit the student for the award of degree.Such candidate shall not be eligible for the award of rank. (b) Candidates who takes admission to any semester of the existing scheme from another scheme, as a repeater/fresher because of various reasons have to complete additional course/s, if any, as per the decision of concerned Board of Studies and approval of Dean, Faculty of Engineering, on establishing equivalence between two schemes. A Grade card shall be issued to that effect. Additional course/s shall not be considered for the eligibility criterion prescribed for promotion. However, based on the individual cases, it is considered to decide the SGPA and CGPA to admit the student for the award of degree. Such candidate shall not be eligible for the award of rank.
18OMB13.0	**Award of Prizes, Medals and Ranks**
18OMB13.1	For the award of Prizes and Medals, the conditions stipulated by the Donor shall be considered subject to the provisions of the statutes framed by the University for such awards.
18OMB13.2	(1) For award of rank in a Specialization of MBA, the CGPA secured by the student on completion of the programme is considered. (2) A student shall be eligible for a rank at the time of award of MBA, provided the student i) Is not a repeater in any semester ii) Has not rejected the results of any semester. iii) Has passed I to IV semester in all the courses in first attempt only (3) The total number of ranks awarded shall be 10 % of total number of students appeared in IV semester

	of the programmesubject to a maximum of 10 ranks. **Illustration:** a) If 150 students appeared for the IV semester, the number of ranks to be declared will be 10. b) If 84 students appeared for the IV semester, the number of ranks to be declared will be 08. (c) In case of fractional number of ranks, it is rounded to higher integer only when the first decimal place value is greater than or equal to 5.
18OMB13.3	Ranks are awarded based on the merit of the students as determined by CGPA. If two or more students get the same CGPA, the tie shall be resolved by considering the number of times a student has obtained higher SGPA. If it is not resolved even at this stage, the number of times a student has obtained higher grades like S, A, B etc., shall be taken into account to decide the order of the rank.
18OMB14.0	**Applicability and Power to Modify**
18OMB14 1	The regulations governing the Degree of MBA of Visvesvaraya Technological University shall be binding on all concerned.
18OMB14.2	i) Notwithstanding anything contained in the foregoing, the University shall have the power to issue directions/ orders to address any difficulty. ii) Nothing in the foregoing may be construed as limiting the power of the University to ammed, modify or repeal any or all of the above. Programme shall be called Master Of Business Administration (Subject of Specialization), abbreviated as MBA. (Subject of Specialization) Programme.

MBA Program Structure and Credits			
Year	Particulars	Credits	Total Credits
I	I Semester	24	48
	II Semester	24	
II	III Semester	24	52
	Internship (III Semester)	4	
	IV Semester	18	
	Project Work(IV Semester)	6	
	Total	**100**	**100**

PROGRAMME OUTCOMES STUDENT WILL BE ABLE CO (POS)

PO1. Acquire Sufficient theoretical knowledge and are enabled to apply them to solve practical problems in business and other organizations / institutions of importance.

PO2. Apply Effective communication skills with a high degree of lateral and critical thinking that enhances learn ability, developed for being continuously employable.

PO3. Demonstrate leadership qualities, ethically sound, enabled with decision making skills that reflect a high degree of social consciousness

PO4. Recognise the need for sustained research orientation to comprehend a growingly complex, economic, legal and ethical environment

PO5. Possess self-sustaining entrepreneurship qualities that encourages calculated risk taking.

SCHEME OF TEACHING AND EXAMINATION

I Semester

Subject Code	Title of the Subject	Course Category	Teaching hours per week			Duration of Exam hours	Marks for		Total Marks	Credits
			Lecture	Practical Component	Total Hours		CIE	SEE		
18MBA11	Management & Organizational Behavior	Core	4	-	4	3	40	60	100	4
18MBA12	Managerial Economics	Core	4	-	4	3	40	60	100	4
18MBA13	Accounting for Managers	Core	4	-	4	3	40	60	100	4
18MBA14	Business Statistics & Analytics	Core	4	-	4	3	40	60	100	4
18MBA15	Marketing Management	Core	4	-	4	3	40	60	100	4
18MBA16	Managerial Communications	Core	4	-	4	3	40	60	100	4
		Total	**24**	**-**	**24**	**-**	**240**	**360**	**600**	**24**

Note:
1.Each course content has indicative case studies which can be dealt in the class by the course instructor. In addition to this the course instructor may use an extra casefrom Harvard/Case Centre. The student cannot assume the same cases will be part of the question paper.
2.One Industrial Visit per Semester is Mandatory. The Department shall insist on report submi ssion by each student and shall maintain this as a documentary proof. Theformat of the report shall be prescribed by the department.
3. Course instructors are free to set the Course outcome and map with the Programme Outcome, subsequently attainment level may be calculated.

II Semester

Subject Code	Title of the Subject	Course Category	Teaching hours per week			Duration of Examination Hours	Marks for		Total Marks	Credits
			Lecture	Practical Component	Total		CIE	SEE		
18MBA21	Human Resource Management	Core	4	-	4	3	40	60	100	4
18MBA22	Financial Management	Core	4	-	4	3	40	60	100	4
18MBA23	Research Methodology	Core	4	-	4	3	40	60	100	4
18MBA24	Legal and Business Environment	Core	4	-	4	3	40	60	100	4
18MBA25	Strategic Management	Core	4	-	4	3	40	60	100	4
18MBA26	Entrepreneurship Development	Core	4	-	4	3	40	60	100	4
		Total	**24**	**-**	**24**	**-**	**240**	**360**	**600**	**24**

Note:
1.Each course content has indicative case studies which can be dealt in the class by the course instructor. In addition to this the course instructor may use an extra casefrom Harvard/Case Centre. The student cannot assume the same cases will be part of the question paper.
2.One Industrial Visit per Semester is Mandatory. The Department shall insist on report submi ssion by each student and shall maintain this as a documentary proof. Theformat of the report shall be prescribed by the department.
3. Course instructors are free to set the Course outcome and map with the Programme Outcome, subsequently attainment level may be calculated.

III Semester (Core Specialization)

Subject Code			Course Category	Teaching hours per week			Duration of Examination hours	Marks for		Total Marks	Credits
Marketing	Finance	Human Resource		Lecture	Practical Component	Total		CIE	SEE		
18MBAMM301 Consumer Behavior	18MBAFM301 Banking and Financial Services	18MBAHR301 Recruitment & Selection	Elective	3	2	5	3	40	60	100	4
18MBAMM302 Retail Management	18MBAFM302 Investment Management	18MBAHR302 HR Analytics	Elective	3	2	5	3	40	60	100	4
18MBAMM303 Services Marketing	18MBAFM303 Direct Taxation	18MBAHR303 Compensation & Reward System	Elective	3	2	5	3	40	60	100	4
18MBAMM304 Marketing Research& Analytics	18MBAFM304 Advanced Financial Management	18MBAHR304 Learning & Development	Elective	3	2	5	3	40	60	100	4
18MBAMM305 Business Marketing	18MBAFM305 Cost Management	18MBAHR305 Industrial Relations & Legislations	Elective	3	2	5	3	40	60	100	4
18MBAMM306 Supply Chain Management	18MBAFM306 Project Appraisal Planning & Control	18MBAHR306 Conflict & Negotiation Management	Elective	3	2	5	3	40	60	100	4
18MBAOS307 OrganizationStudy			Core	0	8	8	--	40	60	100	4
Industrial Visit			Core	--	--	--	--	--	--	--	--
			Total	18	20	38	--	280	420	700	28

Note:

1.Each Course has a theory component of 3hrs (3credits) and a Practical component of 2hrs (1credit). The Time-Table allotment for each course should be (3+2) = 5hours.

2.For the practical component, it is mandatory to maintain a practical record.

3. 20% of marks should be allocated for application oriented questions in the SEE Question Paper, based on practical component.

4.Organization Study (Four Weeks) will be carried out by students after second semester during vacation and the report submitted by the students will be assessed internally during the third semester.

5.One Industrial Visit per Semester is Mandatory. The Department shall insist on report submission by each student and shall maintain this as a documentary proof. Theformat of the report shall be prescribed by the department.

6.Course instructors are free to set the Course outcome and map with the Programme Outcome, subsequently attainment level may be calculated.

Rubrics for Organization Study			Rubrics for Viva voce Examination	
	Particulars	Marks	Aspects	Marks
CIE	Assessment by the Guide- Interaction with the student	20	Communication skill	5
	Report Evaluation by the Guide	20	Understanding the Industry	5
SEE	Viva-Voce Examination to be conducted by the Guide and an External examiner from the Industry/Institute	60	Understanding the Corporate Functions/Company profile	10
	Total	100	Mckensy's 7S framework and Porter's Five Force Model	10
			SWOT analysis	10
			Financial statement analysis	10
			Learning experience	5
			Overall presentation	5
			Total	60

III Semester (Dual Specialization)

Subject Code			Course Category	Teaching hours per week			Duration of Examinationhours	Marks for		Total Marks	Credits
Marketing & Finance	Finance & HR	HR & Marketing		Lecture	Practical Component	Total		CIE	SEE		
18MBAMM301 Consumer Behavior	18MBAFM301 Banking and FinancialServices	18MBAHR301 Recruitment & Selection	Elective	3	2	5	3	40	60	100	4
18MBAMM302 Retail Management	18MBAFM302 Investment Management	18MBAHR302 HR Analytics	Elective	3	2	5	3	40	60	100	4
18MBAMM303 Services Marketing	18MBAFM303 Direct Taxation	18MBAHR303 Compensation & Reward System	Elective	3	2	5	3	40	60	100	4
18MBAFM301 Banking and FinancialServices	18MBAHR301 Recruitment & Selection	18MBAMM301 Consumer Behavior	Elective	3	2	5	3	40	60	100	4
18MBAFM302 Investment Management	18MBAHR302 HR Analytics	18MBAMM302 Retail Management	Elective	3	2	5	3	40	60	100	4
18MBAFM303 Direct Taxation	18MBAHR303 Compensation & Reward System	18MBAMM303 Services Marketing	Elective	3	2	5	3	40	60	100	4
18MBAOS307 Organization study			Core	--	8	8	--	40	60	100	4
Industrial Visit			Core	--	--	--	--	--	--	--	--
			Total	18	20	38	-	280	420	700	28

Note:

1.Each Course has a theory component of 3hrs (3credits) and a Practical component of 2hrs (1credit). The Time-Table allotment for each course should be (3+2) = 5hours.

2.For the practical component, it is mandatory to maintain a practical record.

3. 20% of marks should be allocated for application oriented questions in the SEE Question Paper, based on practical component.

4.Organization Study (Four Weeks) will be carried out by students after second semester during vacation and the report submitted by the students will be assessed internally during the third semester.

5.One Industrial Visit per Semester is Mandatory. The Department shall insist on report submission by each student and shall maintain this as a documentary proof. Theformat of the report shall be prescribed by the department.

6.Course instructors are free to set the Course outcome and map with the Programme Outcome, subsequently attainment level may be calculated.

Rubrics for Organization Study			Rubrics for Viva voce Examination	
	Particulars	Marks	Aspects	Marks
CIE	Assessment by the Guide- Interaction with the student	20	Communication skill	5
	Report Evaluation by the Guide	20	Understanding the Industry	5
SEE	Viva-Voce Examination to be conducted by the Guide and an External examiner from the Industry/Institute	60	Understanding the Corporate Functions/Company profile	10
	Total	100	Mckensy's 7S framework and Porter's Five Force Model	10
			SWOT analysis	10
			Financial statement analysis	10
			Learning experience	5
			Overall presentation	5
			Total	60

IV Semester (Core Specialization)

Subject Code: Marketing	Subject Code: Finance	Subject Code: Human Resource	Course Category	Teaching hours per week: Lecture	Teaching hours per week: Practical Component	Teaching hours per week: Total	Duration of Examination hours	Marks for: CIE	Marks for: SEE	Total Marks	Credits
18MBAMM401 Sales Management	18MBAFM401 Mergers, Acquisitions & Corporate Restructuring	18MBAHR401 Public Relations	Elective	3	--	3	3	40	60	100	3
18MBAMM402 Integrated Marketing Communication	18MBAFM402 Risk Management and Insurance	18MBAHR402 Organizational Leadership	Elective	3	--	3	3	40	60	100	3
18MBAMM403 Digital and Social Media Marketing	18MBAFM403 Indirect Taxation	18MBAHR403 International Human Resource Management	Elective	3	--	3	3	40	60	100	3
18MBAMM404 Strategic Brand Management	18MBAFM404 International Financial Management	18MBAHR404 Organization Change and Development	Elective	3	--	3	3	40	60	100	3
18MBAMM405 Rural Marketing	18MBAFM405 Financial Derivatives	18MBAHR405 Strategic Talent Management	Elective	3	--	3	3	40	60	100	3
18MBAMM406 International Marketing Management	18MBAFM406 Corporate Valuation	18MBAHR406 Personal Growth & Interpersonal Effectiveness	Elective	3	--	3	3	40	60	100	3
18MBAPR407 Project Work			Core	0	12	12	--	40	60	100	6
Industrial Visit			Core	--	--	--	--	--	--	--	--
		Total		**18**	**12**	**30**	--	**280**	**420**	**700**	**24**

Note:
1.Course instructors are free to set the Course outcome and map with the Programme Outcome, subsequently attainment level may be calculated.
2. Project work(Six Weeks) will be carried out after third semester and shall be evaluated during fourth semester.

IV Semester (Dual Specialization)

Subject Code: Marketing & Finance	Subject Code: Finance & HR	Subject Code: HR & Marketing	Course Category	Teaching hours per week: Lecture	Teaching hours per week: Practical Component	Teaching hours per week: Total	Duration of Examination hours	Marks for: CIE	Marks for: SEE	Total Marks	Credits
18MBAMM401 Sales Management	18MBAFM401 Mergers, Acquisitions& Corporate Restructuring	18MBAHR401 Public Relations	Elective	3	--	3	3	40	60	100	3
18MBAMM402 Integrated Marketing Communication	18MBAFM402 Risk Management and Insurance	18MBAHR402 Organizational Leadership	Elective	3	--	3	3	40	60	100	3
18MBAMM403 Digital and Social Media Marketing	18MBAFM403 Indirect Taxation	18MBAHR403 International Human Resource Management	Elective	3	--	3	3	40	60	100	3
18MBAFM401 Mergers, Acquisitions & Corporate Restructuring	18MBAHR401 Public Relations	18MBAMM401 Sales Management	Elective	3	--	3	3	40	60	100	3
18MBAFM402 Risk Management and Insurance	18MBAHR402 Organizational Leadership	18MBAMM402 Integrated Marketing Communication	Elective	3	--	3	3	40	60	100	3
18MBAFM403 Indirect Taxation	18MBAHR403 International Human Resource Management	18MBAMM403 Digital and Social Media Marketing	Elective	3	--	3	3	40	60	100	3
18MBAPR407Project Work			Core	--	12	12	--	40	60	100	6
Industrial Visit			Core	--	--	--	--	--	--	--	--
		Total		**18**	**12**	**30**	-	**280**	**420**	**700**	**24**

Note:
1.Course instructors are free to set the Course outcome and map with the Programme Outcome, subsequently attainment level may be calculated.
2. Project work(Six Weeks) will be carried out after third semester and shall be evaluated during fourth semester.

I SEMESTER
MANAGEMENT AND ORGANIGATIONAL BEHAVIOR

Semester	**I**	**CIE Marks**	**: 40**
Course Code	**18MBA11**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**4-0-0**	**Exam Hours**	**: 03**
	Credits : 04		

COURSE OBJECTIVES:
1. To make students understand fundamental concepts and principles of management, including the basic roles, skills, and functions of management
2. To make students knowledgeable of historical development, theoretical aspects and practice applications of managerial process
3. To understand the basic concepts and theories underlying individual behavior besides developing better insights into one's own self.
4. To make students aware of Individual behavior in groups, dynamics of groups, team building and interpersonal effectiveness besides developing a better awareness of how they can be better facilitators for building effective teams as leaders themselves

PART A - PRINCIPLES OF MANAGEMENT
Unit 1:
Introduction: Management: Introduction, Definition of management, Nature, Purpose and Functions, Levels and types of managers, managerial roles, skills for managers, evolution of management thought, Fayol's fourteen principles of management, Recent trends in management.

Unit 2:
Planning and Organizing:

Planning: Meaning, Nature of Planning, Planning Process, Objectives, MBO, Strategies, level of strategies, policies, methods and programs, Planning Premises, Decision-making, Process of decision-making, Types of decisions, Techniques in decision-making.

Organizing: Organization structure, Formal and informal organizations, Functional, divisional, geographical, customer based and matrix organizations, tram based structures, virtual organizations, boundary less organizations. Principles of organizations-chain of command, span of control, delegation, decentralization, and empowerment.

Case Study: Principles of Management, Cengagelearning , William , Manjunath , Sandhya

Unit 3:
Controlling: Meaning, importance of controlling, controlling process, types of control, factors influencing control effectiveness.

RECOMMENDED BOOKS
- Management and Organizational Behaviors, Chuck Williams, James Cambell, Manjunath &Sandhya Cengage Publications, 2018
- Essentials of Management-Koontz, 8/e, McGraw Hill
- Management: Text and Cases-VSP Rao, Excel Books

REFERENCE BOOKS:
- Masters of Management Thought – Mahanand Charati & M M Munshi, Sapna Book House, Bangalore, 2015.
- Principles and practices of Management, KiranNerkar, Vilas Chopde, Dreamtech Press, 2011
- Management Theory & practice – Chandan J. S, Vikas Publishing House.

PART B - ORGANIZATIONAL BEHAVIOUR
Unit 4:
Introduction: Organizational Behaviour: Introduction, definition, fundamental principles of OB, contributing disciplines, challenges and opportunities. Evolution & Organizational Behavior in India.

Case study: Organizational Behavior by Steven L McShane, Mary Ann Von Glinow and Radha R Sharma, TaTa McGraw Hill companies, Fouth Edition, Pg-6.

Unit 5:
Foundations of Individual Behaviour : Individual behaviour: Foundations of individual behaviour. Ability: Intellectual abilities, Physical ability, the role of disabilities.

Personality: Meaning, formation, determinants, traits of personality, big five and MBTI, personality attributes influencing OB.

Perception: Meaning,Process of perception, factors influencing perception, link between perception and individual decision-making.

Attitude: Meaning,Formation, components of attitudes, relation between attitude and behaviour.

Unit 6:
Motivation: Meaning, theories of motivation-needs theory, two factor theory, Theory X and Y, application of motivational theories.

Leadership: Meaning, styles of leadership, leadership theories, trait theory, behavioural theories, managerial grid, situational theories.

Case Study: "Nuts and Bolts", Principles of Management, Cengagelearning , William , Manjunath , Sandhya Page no 531-532.

PRACTICAL COMPONENTS:
- Studying organizational structures of any 10 companies and classifying them into different types of organizations which are

studied in Unit 2 and justifying why such structures are chosen by those organizations.

- Preparing the leadership profiles of any 5 business leaders and studying their leadership qualities and behaviors with respects to the trait, behavioural and contingency theories studied.
- Identifying any five job profiles and listing the various types, abilities required for those jobs and also the personality traits/attributes required for the jobs identified.

Note: Faculty can either identify the organizations/ leaders/job profile or students can be allowed to choose the same.

COURSE OUTCOMES:

1. Comprehend & correlate all the management functions which are happening around with fundamental concepts and principles of management.
2. Understand the overview of management, theory of management and practical applications of the same.
3. Effectively use their skills for self-grooming, working in groups and to achieve organizational goals .
4. Demonstrate their acumen in applying managerial and behavioral concept in real world/situation.
5. Understand and demonstrate their exposure on recent trends in management.

RECOMMENDED BOOKS:

- Organizational behaviour, Stephen P Robbins, Timothy A. Judge, NeharikaVohra, 14th Edition, Pearson, 2012.
- Introduction to OrganisationalBehaviour – Michael Butler, Jaico Publishing House.
- Organizational Behaviour - Anada Das Gupta, Biztantra, 2011.

REFERENCE BOOKS:

- Organizational Behaviour - Fred Luthans, 12/e, McGraw Hill International, 2011.
- Management and Organizational Behaviour - Laurie J Mullins, Pearson education.
- Organizational Behaviour, Aquinas P. G, Excel Books.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			
CO3			X	X	
CO4					X
CO5			X		

MANAGERIAL ECONOMICS

Semester	**I**	**CIE Marks**	**: 40**
Course Code	**18MBA12**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**4-0-0**	**Exam Hours**	**: 03**
	Credits : 04		

Course Objectives:

1. To introduce the fundamentals, tools and theories of managerial economics.
2. To provide an understanding of the application of Economics in Business.
3. To learn the basic economic concepts.
4. To have an understanding of Demand, Production, Cost, Profit and Market competitions with reference to a firm and industry.

Introduction to Economics

Unit 1:

Managerial Economics: Meaning, Nature, Scope, & Significance, Uses of Managerial Economics, Role and Responsibilities of Managerial Economist, Relationship of Managerial Economics with Statistics, Accounting and Operations Research, The Basic process of decision making.

Fundamental Concepts of Managerial Economic

Unit 2:

Opportunity Costs, Incremental Principle, Time perspective, Discounting and Equi-Marginal principles, Theory of the Firm: Firm and Industry, Forms of Ownership, Objectives of the firm, alternate objectives of firm. Managerial theories: Baumol's Model, Marris's Hypothesis, Williamson's Model. Behavioral theories: Simon's Satisficing Model, Cyert and March Model, Agency theory.

Case Study: Dabur India Limited: Growing Big and Global.

Source: Managerial Economics – Geethika, Ghosh & Choudhury, 2/e, McGraw Hill. 2011. Pp 64-65.

Demand analysis

Unit 3:

Law of Demand, Exceptions to the Law of Demand, Elasticity of Demand –Classification of Price, Income & Cross elasticity, Advertising and promotional elasticity of demand. Uses of elasticity of demand for Managerial decision making, Measurement of elasticity of demand. Law of supply, Elasticity of supply, Demand forecasting: Meaning & Significance, Methods of demand forecasting. (No problems)

Cost Analysis & Production analysis

Unit 4:

Concepts, Types of cost, Cost curves, Cost – Output Relationship in the short run and in the long run, LAC curve. Concepts, production function with one variable input - Law of Variable Proportions. Production function with 2 variable inputs and Laws of returns to scale, Indifference Curves, ISO-Quants & ISO-Cost line, Least cost combination factor, Economies of scale, Diseconomies of scale. Technological progress and production function

Case Study: Automobile Industry in India: New Production paradigm.

Source: Managerial Economics – Geethika, Ghosh&Choudhury, 2/e, McGraw Hill. 2011. Pp 234-236.

Market structure and pricing practices

Unit 5:

Perfect Competition, Features, Determination of price under perfect competition, Monopoly: Features, Pricing under monopoly, Price Discrimination. Monopolistic Competition: Features, Pricing Under monopolistic competition, Product differentiation. Oligopoly: Features, Kinked demand Curve, Cartels, Price leadership.

Descriptive Pricing Approaches: Full cost pricing, Product line pricing, Product life cycle pricing, Pricing Strategies: Price Skimming, Penetration Pricing, Loss leader pricing, Peak Load pricing.

Case Study: David Fights Goliath: The Nirma Story.

Source: Managerial Economics – Geethika, Ghosh & Choudhury, 2/e, McGraw Hill. 2011. Pp 349-351.

Unit 6: Profits

Profits: Determinants of Short-Term & Long Term Profits, Measurement of Profit.

Break Even Analysis – Meaning, Assumptions, Determination of BEA, Limitations, Uses of BEA in Managerial decisions.

PRACTICAL COMPONENTS:

- Assessment of Demand Elasticity – Price, Income, Cross, Advertising.
- Demand Forecasting
- Preparing a Project proposal for a Business Venture.

COURSE OUTCOMES:

1. The student will understand the application of Economic Principles in Management decision making.
2. The student will learn the micro economic concepts and apply them for effective functioning of a Firm and Industry.
3. The Student will be able to understand, assess and forecast Demand.
4. The student will apply the concepts of production and cost for optimization of production.

5. The student will design Competitive strategies like pricing, product differentiation etc. and marketing according to the market structure.
6. The student will be able to identify, assess profits and apply BEP for decision making.

RECOMMENDED BOOKS:

- Managerial Economics – Geethika, Ghosh & Choudhury, 2/e, McGraw Hill. 2011
- Managerial Economics – Dominick Salvotore, 7/e, Oxford Publishers, 2010.
- Managerial Economics – R. Panneerselvam, P. Sivasankaran, P. Senthilkumar, Cengage,2018.

REFERENCE BOOKS:

- Managerial Economics – Samuelson & Marks, 5/e, Wiley, 2009.
- Managerial Economics – Hirschey, 2/e, Cengage Learning, 2010.
- Managerial Economics: Case Study solutions – Kaushal H, 1/e, Macmillan, 2011.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X			X	
CO3	X				X
CO4					X
CO5				X	
CO6				X	

ACCOUNTING FOR MANAGERS

Semester	I	CIE Marks	: 40
Course Code	18MBA13	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. Explain fundamental accounting concepts, the elements of financial statements, and basic accounting vocabulary.
2. Explain and use the accounting equation in basic financial analysis and explain how the equation is related to the financial statements.
3. Prepare basic entries for business transactions and present the data in an accurate and meaningful manner.
4. Prepare basic financial statements and explain the articulation between the basic statements.
5. To analyze a company's financial statements and come to a reasoned conclusion about the financial situation of the company.

Unit 1:

Introduction to Accounting: Need and Types of Accounting, Users of Accounting, concepts and conventions of Accounting, Relation of Accounting with other disciplines, Capital and Revenue Expenditure and Receipt, Accounting Equation.

Case study: Problem on Accounting Equation .

Unit 2:

Preparation of books of Accounts: Journals, ledgers 3 column cash book and trial balance, Depreciation- Straight line and Written down Value Methods.

Case Study on Change of Method of Depreciation.

Unit 3:

Preparation of Financial Statements: Preparation of final accounts of sole traders in horizontal form, Preparation of final accounts of companies in vertical form as per Companies Act of 2013 (Basic problems of Final Accounts), Window dressing.

Case Study problem on Final Accounts of Company and Firm.

Unit 4:

Analysis of Financial Statements: Ratio Analysis, Preparation of financial statements using ratios, Preparation of Cash flow Statement (only indirect method).

Case Study on Ratio analysis.

Unit 5:

Emerging issues in Accounting: Human Resource Accounting, Forensic Accounting, Sustainability Reporting. Accounting Standards and IFRS: Nature and significance.

Unit 6:

Fundamentals of Taxation: Basic concepts of Direct & Indirect Tax. Heads of Income, Deductions u/s 80C, Rate of Income Tax of current assessment Year for Individuals only (only theory) .

PRACTICAL COMPONENTS:

- Collecting Annual reports of the companies and analyzing the financial statements using different techniques and presenting the same in the class.
- Analyzing the companies' cash flow statements and presenting the same in the class.
- Exposing the students to usage of accounting software's (Preferably Tally).
- Filling up of ITR forms.
- Identify the sustainability report of a company and study the contents.

COURSE OUTCOME:

1. Demonstrate theoretical knowledge and its application in real time accounting.
2. Demonstrate knowledge regarding accounting principles and its application.
3. Capable of preparing financial statement of sole trading concerns and companies.
4. Independently undertake financial statement analysis and take decisions.
5. Comprehend emerging trends in accounting and taxation.

RECOMMENDED BOOKS:

- Financial Accounting: A Managerial Perspective, Narayanaswamy R, 5/e , PHI, 2014.
- A Text book of Accounting For Management, Maheswari S. N,Maheswari Sharad K. Maheswari , 2/e, Vikas Publishing house (P) Ltd.
- Financial Accounting, Tulsian P. C, 1/e, Pearson Education.

REFERENCE BOOKS:

- Financial Accounting for Management: An Analytical Perspective,

Ambrish Gupta, 4/e, Pearson Education.

- Introduction to Financial Statement Analysis, Ashish K Bhattacharya, Elsevier India.
- Financial Accounting – Raman B. S,Vol I & Vol II, 1/e, United Publishers, 2009.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X				
CO3		X			
CO4		X			
CO5				X	X

BUSINESS STATISTICS & ANALYTICS

Semester	**I**	**CIE Marks**	**: 40**
Course Code	**18MBA14**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**4-0-0**	**Exam Hours**	**: 03**
	Credits : 04		

Course Objectives:

1. To make the students learn about the applications of statistical tools and techniques in decision making.
2. To emphasize the need for statistics and decision models in solving business problems.
3. To enhance the knowledge on descriptive and inferential statistics.
4. To familiarize the students with analytical package MS Excel.
5. To develop analytical skills in students in order to comprehend and practice data analysis at different levels.

Unit 1:

Introduction to Statistics: Meaning and Definition, functions, scope and limitations, Collection and presentation of data, frequency distribution, measures of central tendency - Mean, Median, Mode, Geometric mean, Harmonic mean.

Measures of dispersion: Range – Quartile Deviation – Mean Deviation - Standard Deviation – Variance-Coefficient of Variance - Comparison of various measures of Dispersion.

Unit 2:

Correlation and Regression: Scatter Diagram, Karl Pearson correlation, Spearman's Rank correlation(one way table only), simple and multiple regression(problems on simple regression only).

Unit 3:

Probability Distribution: Concept and definition - Rules of probability – Random variables – Concept of probability distribution – Theoretical probability distributions: Binomial, Poisson, Normal and Exponential – Baye's theorem (No derivation) (Problems only on Binomial, Poisson and Normal).

Unit 4:

Time Series Analysis: Introduction - Objectives Of Studying Time Series Analysis - Variations In Time Series - Methods Of Estimating Trend: Freehand Method - Moving Average Method - Semi-Average Method -

Least Square Method. Methods of Estimating Seasonal Index: Method Of Simple Averages - Ratio To Trend Method - Ratio To Moving Average Method.

Unit 5:

Linear Programming: structure, advantages, disadvantages, formulation of LPP, solution using Graphical method. Transportation problem: basic feasible solution using NWCM, LCM, and VAM unbalanced, restricted and maximization problems.

Unit 6:

Project Management: Introduction – Basic difference between PERT & CPM – Network components and precedence relationships – Critical path analysis – Project scheduling – Project time-cost trade off – Resource allocation, Concept of project crashing.

PRACTICAL COMPONENT :(Student-Centered Learning)

- Students are expected to have a basic excel classes.
- Students should be able to relate the concepts which can highly enhance an application scenario in your profession.
- Student should demonstrate the application of the techniques covered in this course.

COURSE OUTCOMES:

1. Facilitate objective solutions in business decision making under subjective conditions.
2. Demonstrate different statistical techniques in business/real-life situations.
3. Understand the importance of probability in decision making.
4. Understand the need and application of analytics.
5. Understand and apply various data analysis functions for business problems.

RECOMMENDED BOOKS:

- Business Statistics and Analytics – Pannerselvam, Nagesh, Senthilkumar, Cengage Learning, 2018.
- BStat: A South Asian Perspective with Course Mate – Keller & Arora Cengage Learning, 2016.
- Quantitative Methods for Business, Anderson, Sweeney and Williams, Thomson, 2005 ISBN 981-240-641-7.

REFERENCE BOOKS:

- Statistical Method s – Dr S. P Gupta, Sulthan Chand & sons, fourth Edition, ISBN 81-8054298-X.
- Fundamentals of Statistics, S.C Gupta, 6th edition, Himalaya Publishing House, 2007, ISBN, 978-81-8318-755-8.
- Analyzing Multivariate Data, James Lattin, Douglas Carroll and Paul Green, Thomson Learning, 2003, ISBN 0-534-34974-9.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X			X	X
CO2		X	X	X	
CO3			X	X	X
CO4				X	
CO5		X			

MARKETING MANAGEMENT

Semester	I	CIE Marks	: 40
Course Code	18MBA15	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. Make students have an understanding of the fundamental concepts of marketing & the environment in which marketing system operates.
2. To analyze the motives influencing buying behaviour & Describe major bases for segment marketing, target marketing, and market positioning.
3. Identify a Conceptual framework, covering basic elements of the marketing mix.
4. To understand fundamental premise underlying market driven strategies.

Unit 1:

Introduction to Marketing: Introduction, Definitions of market and marketing, Selling Vs marketing, The Exchange Process, Elements of Marketing Concept, Functions of Marketing, Old Concept or Product-oriented Concept, New or Modern or Customer- oriented Concept, Marketing Myopia, Marketing Environment analysis, (Micro and Macro), Marketing in the 21st century opportunities, challenges & Ethics.

Unit 2 :

Buyer Behavior Analysis: Meaning and Characteristics, Importance, Factors Influencing Consumer Behaviour, Consumer Purchase Decision Process, Buying Roles, Buying Motives. The black box model of consumer behaviour. B2B marketing Vs Consumer Marketing.

Case Study on " Barista Lavazza", Marketing Management, Arun Kumar & Meenakshi N, 2/e, Vikas, 2012.Pg 33-34.

Unit 3 :

Market Segmentation, Targeting & Positioning (STP): Concept of Market Segmentation, Benefits, Requisites of Effective Segmentation, Bases for Segmenting Consumer Markets, Market Segmentation Strategies.

Targeting - Bases for identifying target Customer target Marketing strategies, Positioning - Meaning, Product Differentiation Strategies, Tasks involved in Positioning. Branding - Concept of Branding, Types, Brand Equity, Branding strategies.

Case Study on " Marketing of Tata's Nano in India ", Marketing in India: Text and Cases- Neelamegham S, 4/e, Vikas. Pg 335-354.

Unit 4:

Managing the Product: Concept, product hierarchy, product line, product mix, product mix strategies, Product life cycle and its strategies, New Product Development, packing as a marketing tool, Role of labeling in packing. Services Marketing & its Characteristics.

Case Study on " American Express ", Marketing Management: A South Asian Perspective–Kotler, Keller, Koshy & Jha, 14/e, Pearson Education, 2012. Pg 257-259 .

Unit-5:

Pricing decisions: Significance of pricing, factor influencing pricing (Internal factor and External factor), objectives, Pricing Strategies-Value based, Cost based, Market based, Competitor based, Pricing Procedure.

Marketing Channels: Meaning, Purpose, Factors Affecting Channel Choice, Channel Design, Channel Management Decision, Channel Conflict, Designing a physical Distribution System, Network Marketing.

Unit 6:

Promotion Strategy: Integrated Marketing Communications (IMC)-communication objectives, steps in developing effective communication, Stages in designing message. Advertising: Advertising Objectives, Advertising Budget, Advertising Copy, AIDA model, Traditional Vs Modern Media- Online and Mobile Advertising, Social Media for Advertising.

Sales Promotion: Tools and Techniques of sales promotion, Push-pull strategies of promotion. Personal selling: Steps/process involved in Personal Selling. Publicity/Public Relation-word of mouth, sponsorships. Database marketing: Basic concepts of e-commerce, e-marketing, m-Commerce, m-marketing, e-networking, CRM, MkIS.

Marketing Planning: Meaning, Steps involved in Marketing planning. Marketing Audit- Meaning, components of Marketing Audit. Marketing Strategic Planning Process.

Case Study on " Facebook ", Marketing Management: A South Asian Perspective–Kotler, Keller, Koshy & Jha, 14/e, Pearson Education, 2012. Pg 503-504.

PRACTICAL COMPONENTS:

- Marketing Games and quiz for Students.
- Analyze Product Life Cycle of few Products like-Electronic goods, Computers etc.
- Study Packaging strategies used by FMCG companies.
- Understand Marketing strategies, plans used by automobile, cosmetic, FMCG companies etc.

COURSE OUTCOME:

1. Develop an ability to assess the impact of the environment on marketing function.
2. To formulate marketing strategies that incorporate psychological and sociological factors which influence buying.
3. Explain how companies identify attractive market segments, differentiate and position their products for maximum competitive advantage in the market place.
4. Build marketing strategies based on product, price, place and promotion objectives.
5. Synthesize ideas into a viable marketing plan.

RECOMMENDED BOOKS

- Marketing Management: A South Asian Perspective–Kotler, Keller, Koshy & Jha, 14/e, Pearson Education, 2012.
- Marketing- Lamb, Hair, Mc Danniel, 7/e, Cengage Learning 2012.
- Marketing Management, Tapan Panda, 2/e, Excel Publication.

REFERENCE BOOKS

- Marketing Management, Arun Kumar & Meenakshi N, 2/e, Vikas, 2012.
- Marketing in India: Text and Cases- Neelamegham S, 4/e, Vikas.
- Fundamentals of Marketing Management, Etzel M.J BJ Walker & William J. Stanton, 14/e, TMH, 2012.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO 3	PO4	PO5
1	X			X	
2		X	X		
3		X			
4					X
5					X

MANAGERIAL COMMUNICATION

Semester	I	CIE Marks	: 40
Course Code	18MBA16	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

Course Objective:

1. To enable the students to become aware of their communication skills and sensitize them to their potential to become successful managers.
2. To enable learners with the mechanics of writing and also help them to draft business letters in English precisely and effectively.
3. To introduce the students to some of the practices in managerial communication those are in vogue.
4. To prepare students to develop the art of business communication with emphasis on analysing business situations.
5. To train Students towards drafting business proposals.

Unit 1:

Introduction: Meaning & Definition, Role, Classification – Purpose of communication – Communication Process – Characteristics of successful communication – Importance of communication in management – Communication structure in organization – Communication in conflict resolution – Communication in crisis. Communication and negotiation –Communication in a cross-cultural setting.

Unit 2:

Oral Communication: Meaning – Principles of successful oral communication – Barriers to communication – Conversation control –Reflection and Empathy: two sides of effective oral communication. Modes of Oral Communication – Listening as a Communication Skill, Non-verbal communication.

Unit 3:

Written Communication: Purpose of writing – Clarity in writing – Principles of effective writing – Approaching the writing process systematically: The 3X3 writing process for business communication: Pre writing – Writing – Revising – Specific writing features – Coherence – Electronic writing process.

Unit 4:

Business Letters and Reports: Introduction to business letters – Types of Business Letters – Writing routine and persuasive letters – Positive and Negative messages Writing Reports: Purpose, Kinds and Objectives of reports – Organization & Preparing reports, short and long reports Writing

Proposals: Structure & preparation – Writing memos Media Management: The press release – Press conference – Media interviews

Group Communication: Meetings – Planning meetings – objectives – participants – timing – venue of meetings.

Meeting Documentation: Notice, Agenda, and Resolution & Minutes

Unit 5:

Presentation skills: What is a presentation – Elements of presentation – Designing & Delivering Business Presentations – Advanced Visual Support for managers.

Case Methods of learning: Understanding the case method of learning.

Negotiation skills: What is negotiation – Nature and need for negotiation – Factors affecting negotiation – Stages of negotiation process – Negotiation strategies.

Unit 6:

Employment communication: Introduction – Composing Application Messages – Writing CVs – Group discussions – Interview skills

Impact of Technological Advancement on Business Communication– Technology-enabled Communication-Communication networks– Intranet–Internet–E-mails–SMS– teleconferencing – videoconferencing.

Note: Course Instructors are free to set their own cases or use cases from Harvard /Case centre.

PRACTICAL COMPONENTS:

- Make students enact and analyze the non-verbal cues.
- Demonstrating using Communication Equipments like Fax, Telex, Intercoms, etc.
- Demonstrating Video conferencing & teleconferencing in the class.
- Conduct a mock meeting of students in the class identifying an issue of their concern. The students should prepare notice, agenda and minutes of the meeting.
- Each student to give presentation of 5 minutes (this can be spread throughout the semester) and to be evaluated by the faculty.
- Organize a mock press conference addressing to the launch of new product by an organization.
- Students should be given an assignment to draft a proposal to undertake research project.

COURSE OUTCOMES:

1. The students will be aware of their communication skills and know their potential to become successful managers.

2. The students will get enabled with the mechanics of writing and can compose the business letters in English precisely and effectively.
3. The students will be introduced to the managerial communication practices in business those are in vogue.
4. Students will get trained in the art of business communication with emphasis on analysing business situations.
5. Students will get exposure in drafting business proposals to meet the challenges of competitive environment.

RECOMMENDED BOOKS:

- Business Communication: Concepts, Cases And Applications – Chaturvedi P. D, & Mukesh Chaturvedi ,2/e.
- Pearson Education,2011.
- Business Communication: Process and Product – Mary Ellen Guffey, 3/e, Cengage Learning, 2002.
- *Communicating in Business with CourseMate- Ober/Newman-Latest Edition-2018.
- Business Communication – Lesikar, Flatley, Rentz & Pande, 11/e, TMH, 2010.

REFERENCE BOOKS:

- Effective Technical Communication – Ashraf Rizvi M, TMH, 2005.
- Business Communication – Sehgal M. K & Khetrapal V, Excel Books.
- Business Communication – Krizan, Merrier, Jones, 8/e, Cengage Learning, 2012.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X		X	
CO3		X	X		
CO4					
CO5					X

II SEMESTER
HUMAN RESOURCE MANAGEMENT

Semester	II	CIE Marks	: 40
Course Code	18MBA21	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

COURSE OBJECTIVES:
- To understand the HRM concepts and theory.
- To obtain an overview of various HRM functions and practices.
- To gain an insight into the basic statutory provisions.

Unit 1:
Human Resource Management: Introduction, meaning, nature, scope of HRM - Importance and Evolution of the concept of HRM - Major functions of HRM - Principles of HRM.
Case Study on " Enterprise Builds on People", Human Resource Management, Angelo S Denis / Ricky W Griffin / Anita Sarkar, Cengage Learning, Page 22-23.

Unit 2:
Job Analysis: Meaning, process of Job Analysis, methods of collecting job analysis data, Job Description and Job Specification, Role Analysis.
Human Resource Planning: Objectives, Importance and process of Human Resource Planning, Effective HRP.

Unit 3:
Recruitment: Definition, Constraints and Challenges, Sources and Methods of Recruitment, Recent trends and Approaches to recruitment.
Selection: Definition and Process of Selection.
Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation.
Case Study on " Jayram's Dilemma", Human Resource Management, Angelo S Denis / Ricky W Griffin / Anita Sarkar, Cengage Learning, Page 123.

Unit 4:
Training and development: Training v/s development, Systematic Approach to Training, Training Methods; one the job and off the job.
Case Study on " Training Program at ABC Cement", Human Resource Management, Angelo S Denis / Ricky W Griffin / Anita Sarkar, Cengage Learning, Page 140.

Unit 5:
Performance Appraisal : Concept of Performance Appraisal, the Performance Appraisal Process, Methods of Performance Appraisal.
Employee Turnover & Employee Retention: Meaning, Strategies to manage employee turnover, Employee retention strategies.
Compensation: Meaning of Job Evaluation, Objectives of Compensation Planning, components of compensation, Compensation Pay Structure in India.

Unit 6:
Employee Welfare: Introduction, Types of Welfare Facilities and Statutory Provisions in India.
Employee Grievances: Employee Grievance procedure, Grievances Management in Indian Industry.
Discipline: Meaning, approaches to discipline, essential of a good disciplinary system, managing difficult employees.

PRACTICAL COMPONENTS:
- Give a case and ask the students to prepare the recruitment advertisement for a newspaper.
- Expose students to standard selection tests followed in various sectors.
- Exploring training and development practices.
- Exploring performance appraisal practices in various sectors.
- Exploring employee separation practices.
- Give a job analysis case and ask the students to prepare job description and job specification.
- Ask the students to prepare an appointment letter for the post of office manager of a company known to you.

COURSE OUTCOME:
1. Understanding of HRM functions, principles, Job analysis that facilitates students to design a job description and job specification for various levels of employees.
2. Synthesize knowledge on effectiveness of recruitment process, sources & understanding of systematic selection procedure.
3. Identify the various training methods and design a training program.
4. Understand the concept of performance appraisal process in an organization.
5. List out the regulations governing employee benefit practices.

RECOMMENDED BOOKS:

- Human Resources Management: A South Asian Perspective, Denski/Griffin/Sarkar- Cengage Learning, 2012.
- Human Resource Management – Rao V. S. P, Excel BOOKS, 2010.

- Human Resource Management – Dr. T.P RenukaMurthy HPH.

REFERENCE BOOKS:

- Human Resource Management - John M. Ivancevich, 10/e, McGraw Hill.
- Human Resource Management in practice - Srinivas R. Kandula, PHI, 2009
- Managing Human Resources - Luis R Gomez-Mejia, David B. Balkin, Robert L. Cardy,6/e, PHI, 2010.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1		X			
CO2		X			
CO3					X
CO4	X				
CO5			X	X	

FINANCIAL MANAGEMENT

Semester	**II**	**CIE Marks**	**: 40**
Course Code	**18MBA22**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**4-0-0**	**Exam Hours**	**: 03**
	Credits : 04		

Course Objectives:

1. To familiarize the students with basic concepts of financial management and financial system.
2. To understand concept of time value of money and its uses.
3. To evaluate the investment proposals.
4. To analyze capital structure and dividend decision.
5. To understand the management of working capital in an organization.

Unit 1:

Financial management – Introduction to financial management, objectives of financial management. Changing role of finance managers. Interface of Financial Management with other functional areas.

Emerging Issues in financial management: Risk management, Behavioral finance and financial engineering.

Introduction to Financial System. Financial markets, Financial Instruments, Financial institutions and financial services. Introduction to derivatives.

Unit 2:

Time value of money –Future value of single cash flow & annuity, present value of single cash flow, annuity & perpetuity. Simple interest & Compound interest, Capital recovery & loan amortization. (Theory & Problem).

Case Study on Loan amortization.

Unit 3:

Sources of Financing: Shares, Debentures, Term loans, Lease financing, Hybrid financing, Venture Capital, Angel investing and private equity, Warrants and convertibles (Theory Only).

Cost of Capital: Basic concepts. Cost of debenture capital, cost of preferential capital, cost of term loans, cost of equity capital (Dividend discounting and CAPM model) - Cost of retained earnings - Determination of Weighted average cost of capital (WACC) and Marginal cost of capital. (Theory & Problem).

Case Study on WACC.

Unit 4:

Investment decisions – Capital budgeting process, Investment evaluation

techniques – Net present value, Internal rate of return, Modified internal rate of return, Profitability index, Payback period, discounted payback period, accounting rate of return (Theory & Problem). Capital rationing; Risk analysis in capital budgeting (Theory only).
Case Study on replacement of capital project.

Unit 5:

Working capital management – factors influencing working capital requirements - Current asset policy and current asset finance policy- Determination of operating cycle and cash cycle - Estimation of working capital requirements of a firm. (Does not include Cash, Inventory & Receivables Management).
Case study on Working Capital Determination.

Unit 6:

Capital structure and dividend decisions – Planning the capital structure. (No capital structure theories to be covered) Leverages, EBIT and EPS analysis. ROI & ROE analysis. Capital structure policy. Dividend policy – Factors affecting the dividend policy - Dividend Policies- Stable Dividend, Stable Payout (No dividend theories to be covered).
Case Study on EBIT-EPS analysis & Leverages.

PRACTICAL COMPONENTS:

- Study the different financial services offered by a bank.
- Identifying the small or medium sized companies and understanding the Investment evaluation techniques used by them.
- Using the annual reports of selected companies, students can study the working capital management employed by them. Students can also compare the working capital management of companies in the same sector.
- Students can choose the companies that have gone for stock split and Bonus issue in the last few years and study the impact of the same on the stock price.

COURSE OUTCOME:

1. Understand the basic financial concepts.
2. Apply time value of money.
3. Evaluate the investment decisions.
4. Analyze the capital structure and dividend decisions.
5. Estimate working capital requirements.

RECOMMENDED BOOKS:

- Financial Management -Prasanna Chandra, 9/e, TMH.
- Financial Management,Khan M. Y.& Jain P. K, 7/e, TMH.

- Financial Management ,I M Pandey, 11th Edition, Vikas Publishing House.

REFERENCE BOOKS:

- Principles of corporate finance, Brealey and Myers, 9/e,TMH.
- Financial Management,Rathod,Babitha Thimmaiah,Harish Babu, HPH.
- Fundamentals of Financial Management,Brigham & Houston, 10/e, Cengage Learning.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			
CO3			X		
CO4			X	X	
CO5			X		

RESEARCH METHODOLOGY

Semester	II	CIE Marks	: 40
Course Code	18MBA23	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To understand the basic components of research design.
2. To Gain an insight into the applications of research methods.
3. To equip students with various research analytical tools used in business research.

Unit 1:

Business Research – Meaning, types, process of research- management problem, defining the research problem, formulating the research Hypothesis, developing the research proposals, research design formulation, sampling design, planning and collecting the data for research, data analysis and interpretation. Research Application in business decisions, Features of good research study.

Case Study 1: Business Research Methods: S.N.Murthy & U.Bhojanna. Excel Books-page 458.

Unit 2:

Business Research Design: Meaning and significance - Types: Exploratory and Conclusive Research Design.

Exploratory Research: Meaning, purpose, methods- Literature search, experience survey, focus groups and comprehensive case methods.

Conclusive Research Design - Descriptive Research - Meaning, Types – Cross sectional studies and longitudinal studies.

Experimental Research Design – Meaning and classification of experimental designs- formal and informal, Pre experimental design, Quasi-experimental design, True experimental design, statistical experimental design.

Case Study 2: Business Research Methods: S.N.Murthy & U.Bhojanna. Excel Books-page 455.

Unit 3:

Sampling: Concepts- Types of Sampling - Probability Sampling – simple random sampling, systematic sampling, stratified random sampling, cluster sampling -Non Probability Sampling –convenience sampling- judgemental sampling, snowball sampling- quota sampling - Errors in sampling.

Case Study 3: Business Research Methods: S.N.Murthy & U.Bhojanna. Excel Books-page 461.

Unit 4:

Data Collection: Primary and Secondary data Primary data collection methods - Observations, survey, Interview and Questionnaire, Qualitative Techniques of data collection, Questionnaire design – Meaning - process of designing questionnaire. Secondary data -Sources – advantages and disadvantages.

Case Study 4: Business Research Methods: S.N.Murthy &U.Bhojanna. Excel Books-page 457.

Measurement and Scaling Techniques: Basic measurement scales-Nominal scale, Ordinal scale, Interval scale, Ratio scale. Attitude measurement scale - Likert's Scale, Semantic Differential Scale, Thurstone scale, Multi-Dimensional Scaling.

Case Study 5: Business Research Methods: S.N.Murthy & U.Bhojanna. Excel Books-page 452 & 463.

Unit 5:

Hypothesis - types, characteristics, source, formulation of hypotheses, errors in hypotheses. Parametric and Non-Parametric Tests- t-test, z-test, f-test, u-test, K-W Test (problems on all tests) Statistical analysis- Bivariate and Multivariate Analysis- ANOVA-one-way and two-way classification (theory only).

Case Study 6: Business Research Methods: S.N.Murthy & U.Bhojanna. Excel Books-page 301.

Unit 6:

Data Analysis and Report Writing: Editing, Coding, Classification, Tabulation, Validation Analysis and Interpretation- Report writing and presentation of results: Importance of report writing, types of research report, report structure, guidelines for effective documentation.

Case Study 7: Business Research Methods: S.N.Murthy & U.Bhojanna. Excel Books-page 470.

PRACTICAL COMPONENTS:

- To identify research problem and collect relevant literatures for data analysis.
- To write the research design by using Exploratory and Descriptive Research methods.
- To prepare the questionnaire on brand awareness, effectiveness of training in public sector organization, Investors attitude towards Mutual funds in any financial institutions.
- To conduct Market survey and to investigate consumer perception towards any FMCG.
- To demonstrate Report writing and Presentation methods.

COURSE OUTCOME:

1. Understand various research approaches, techniques and strategies in the appropriate in business.
2. Apply a range of quantitative / qualitative research techniques to business and day to day management problems.
3. Demonstrate knowledge and understanding of data analysis, interpretation and report writing.
4. Develop necessary critical thinking skills in order to evaluate different research approaches in Business.

RECOMMENDED BOOKS

- Business Research Methods: A South-Asian Perspective with course Mate William G.Zikmund/Barry J.Babin/Jon C.Carr/AtanuAdhikari/Mitch Griffin, Cengage learning.
- Business Research Methods: S.N.Murthy&U.Bhojanna. Excel Books.
- Business Research Methods. Donald R. Cooper & Pamela s Schindler, 9/e, TMH /2007.

REFERENCE BOOKS

- Research Methodology – C.R.Kothari, Vishwa Prakashan.
- Research Methods – M MMunshi& K Gayathri Reddy, Himalaya Publishing House, 2015.
- Marketing Research- Naresh K Malhotrs- 5th Edition, Pearson Education /PHI 2007.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			
CO3			X		
CO4					X

LEGAL AND BUSINESS ENVIRONMENT

Semester	II	CIE Marks	: 40
Course Code	18MBA24	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To provide insights into the core concepts of incorporation of company.
2. To understand various policies and procedures of the company Act.
3. To gain insights into various procedure of Investigation &Winding up of Companies.

Part-A (Legal Environment)

Unit I:

Indian Contract Act, 1872-Meaning of contract, agreement, essential elements of a valid contract. Law of agency-meaning, creation and termination of agency.

Unit 2 : `

Corporate Incorporation and Management

Definition of company, characteristics, types of company, lifting of corporate veil (i) Incorporation of company (ii) Memorandum and Articles of Association (iii) Doctrine of Ultra Vires (iv) Doctrine of Indoor Management and constructive notices Management - (i) Directors: Appointment, Removal, Position, Powers and Duties of Directors. (ii) Auditor and audit Committee: Its Role. Directors – qualification and Appointment, Liabilities and duties.

Mini case Presentation and Discussion on Saloman v/s A Soloman & Company Ltd.

Unit 3:

Oppression, Mismanagement and Investigation:

(i) Prospectus, membership and shareholding in an company.(ii) Prevention of Oppression (iii) Prevention of Mismanagement (iv) Role & Powers of the Company Law Board (v) Role & Powers of Central Government. Meeting : (i) Types of Meetings (ii) Procedure of calling for a meeting (iii) Company's resolutions and its kinds, proxies.

Corporate Liquidation: (i). Winding up of Companies (ii). Mode of winding up of the companies (iii). Compulsory Winding up under the Order of the Tribunal (iv). Voluntary winding up (v). Contributories (vi). Payment of liabilities.

Mini case Presentation and Discussion on Rule in Foss v. Harbottle.

PRACTICAL COMPONENTS:

- Students to collect analyze and discuss MOA, AOA & Prospectus of a company.
- Students to produce a report on the working of reputed agency including its formation, nature of relations with the outside world and such other issues of relevance.

COURSE OUTCOME:

1. Students should get clear idea about the concept of incorporation of company, its relevance, characteristics, types of company, lifting of corporate.
2. Student to acquire knowledge about conducting meeting, duties of directors and Investigation of the company.
3. To give the students an insight on Winding up of the companies , Mode of winding up of the companies.

RECOMMENDED BOOKS:

- Elements of Mercantile law, Sultanchand publications, 34th Edition, 2014
- Legal & Business Environment, Racvindra Kumar & Renukamurthy, Cengage learning, 2018.
- Saleem Sheikh & William Rees, Corporate Governance & Corporate Control, Cavendish Publishing Ltd., 1995.

REFERENCES BOOKS:

- Charles Wild & Stuart Weinstein Smith and Keenan, Company Law, Pearson Longman, 2009 2. Institute of Company Secretaries of India, Companies Act 2013, CCH Wolter Kluver Business, 2013.
- Lexis Nexis, Corporate Laws 2013 (Palmtop Edition) 4. C.A. Kamal Garg, Bharat's Corporate and Allied Laws, 2013. Taxmann, Companies Act 2013.

CO – PO MAPPING.

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2			X		X
CO3			X		X

Part-B (Business Environment)

Course Objectives:

1. To provide an understanding about the Macro Economic Environment of Business.
2. To have an understanding of the basic macro-economic concepts.
3. To study the various economic policies of our country.

Unit-4

Indian Business environment: Nature and Scope, Structure of the Business Environment – Internal and External environment. Political and Legal Environment, Economic Environment, Socio – Cultural Environment, Global environment: WTO and global relations.

Basic economic Concepts: Open and Closed Economies, Primary, secondary and Tertiary sectors and their contribution to the economy. SWOT Analysis for the Indian economy. Measuring the Economy: Measuring GDP and GDP Growth rate, Components of GDP, Business Cycle- Features, and Phases.

Unit-5

Industrial Policies and Structure: Planning- Problems in industrial development during the plan period, Classification of industries based on ownership. Industrial policies, Industrial strategy for the future, New Industrial policy 1991.

Structure of Indian Industry: Public and Private Sector Enterprises, Objectives of PSUs, Performance and shortcomings. Private Sector– growth, problems and prospects. SSI – Role in Indian Economy. Startups and their current state in India.Privatisation-Problems and prospects, Disinvestments in Indian public sector Units since 1991.

Case Study : Privatization of Airport and Airline Industry, Source: Business Environment: Text and cases – Justin Paul, 2/e, McGraw Hill. 2008. Pp 166-168.

Unit-6

Economic policies: Fiscal Policy: Objectives, Instruments, Union Budget, Taxes, Role of Government.

Monetary Policy: Money, Measures of money supply, Monetary system inIndia, Tools for credit control. Structure of the Banking system, RBI and its functions, Banking structure reforms –Narasimham committee recommendations.

India Foreign Trade Policy: Objectives, Features, Policy of 2015-2020- salient features.

PRACTICAL COMPONENTS:

- Students are expected to give a report on how the economic environment has affected the performance of any five large Indian Business Houses.

- Students are expected to analyze the major economic and financial indicators such as GDP, Inflation, CPI, BSE, NSE, Currency, Gold rate, Oil barrel price etc., for a particular period of time and submit the report on the same.

COURSE OUTCOMES:

1. To student will have an understanding of the macro environment of Business and various macroeconomic concepts.
2. The student will understand the industrial policies of the past and the present and the evolution over time, and how Indian Industrial structure evolved over time.
3. The student will be exposed to various economic policies of the country and the state of economy.

RECOMMENDED BOOKS:

- Economic Environment of Business –Misra S. K &Puri V. K. , 6/e, Himalaya publishing house, 2010.
- Business Environment :Text and Cases - Justin Paul, 3/e, McGrawHill, 2011.
- Business Environment - Fernando, 1/e, Pearson, 2011.

REFERENCE BOOKS:

- Principles of Macro Economics –Mankiw, 4/e, Cengage Learning,2011.
- Macro Economics – Andrew. B. Abel, & Ben S. Bernanke, 7/e,Pearson Education, 2011.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2			X		X
CO3			X		X

STRATEGIC MANAGEMENT

Semester	II	CIE Marks	: 40
Course Code	18MBA25	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To provide insights into the core concepts of strategic management.
2. To evaluate various business strategies in dynamic market environments.
3. To gain insights into various strategic management models.

Unit 1:

Meaning and Nature of Strategic Management, its Importance and relevance and . Characteristics of Strategic Management, The Strategic Management Process. Relationship between a Company ' s Strategy and its Business Model.

Minicase Presentation and Discussion: Business model of Amul and KMF , Suggested questions for case presentation: a. Discuss competitive strategy of Amul b. what are the difference between Amul business model and KMF.

Unit 2:

Strategy Formulation- Understand strategic management process business definition & Organization values that build mission statement. Describe strategic vision, mission, goals, long term objectives, short term objectives and discuss their value to the strategic management process. Balanced Score card.

Minicase Presentation and Discussion: Shanghai GM , Suggested questions for case presentation: a. Introducing China's auto industry, including opportunities & threats b. Why joint venture with SAIC? c. What makes Shanghai GM successful? d. Lessons learnt to other Western MNEs.

Unit 3:

Analyzing a Company' s External Environment – The Strategically relevant components of a Company's External Environment – Industry Analysis - what factors are driving industry change and its impact - Porter's dominant economic feature - Competitive Environment Analysis - Porter's Five Forces model – Key Success Factors concept and implementation.

Mini-Case Presentations and Discussions: Jet Blue Airlines Suggested topics for case presentation and discussion: a. Analyzing the general (national/global) environment b. Assessing five forces of the industry c. Identifying opportunities & threats of the industry d. Jet Blue's capability analysis.

Unit 4:
Analyzing a company's resources and competitive position – Analysis of a Company's present strategies - SWOT Analysis – Value Chain Analysis - Benchmarking . Generic Competitive Strategic – Low cost provider Strategy - Differentiation Strategy - Best cost provider Strategy - Focused Strategy - Strategic Alliance and Collaborative Partnerships - Mergers and Acquisition Strategic - Outsourcing Strategic - International Business level.
Minicase presentation and discussion: Wal-Mart Stores Inc. Suggested topics for case presentation and discussion: a. what competitive strategy does the firm use? Why? b. How does the firm achieve competitive advantages via four-building blocks (quality, innovation, efficiency and customer responsiveness)? c. Any evidence or efforts about value-chain activities? d. Recommendations?

Unit:5
Business planning in different environment - Entrepreneurial level Business planning – Multistage wealth creation model for entrepreneurs – Planning for large and diversified companies – brief overview of Innovation, integration, Diversification, Turnaround Strategic – GE nine cell planning gird and BCG matrix.
Minicase Presentation and Discussion: Siemens's Global Development Strategy Suggested topics for presentation and discussion: 1. Why does Siemens need global coordination and integration? 2. How did Siemens coordinate and orchestrate project development and operations dispersed in various regions? 3. Do you think that different foreign subsidiaries should vary in their autonomy and corporate support, why and how? 4. Takeaway lessons and your recommendations.

Unit:6 Strategy Implementation
Organizational design, structures and controls. Importance of integrating strategy implementation and strategy formulation. Organizational structures used to implement different business level strategies. Organizational structures used to implement different corporate level strategy. How corporate culture promotes implementation of strategy, types of control systems.
Minicase presentation and discussion: Infosys Pvt ltd. Suggested topics for case presentation and discussion: a. Discuss strategy formulation and implementation of recent year.

PRACTICAL COMPONENTS
- Analyzing the Mission and Vision statements of selected Indian companies.
- Applying Michael Porter's model to an industry (Retail, Telecom, Infrastructure, FMCG, Insurance, Banking etc.
- Pick a successful growing company. Do a web-search of all news related to that company over a one-year period.. Analyze the news items to understand and write down the company's strategy and execution efficiency.
- Pick a company that has performed very badly compared to its competitors. Collect information on why the company failed. What were the issues in strategy and execution that were responsible for the company's failure in the market; Analyze the internal and external factors.
- Map out GE 9-cell matrix and BCG matrix for some companies and compare them.
- Conduct SWOT analysis of companies around your campus.

COURSE OUTCOME:
1. Students should get clear idea about the concept of Strategic Management, its relevance, Characteristics, process nature and purpose.
2. Student to acquire an understanding of how firms successfully institutionalize a strategy and create an organizational structure for domestic and overseas operations and gain competitive advantage.
3. To give the students an insight on strategy at different levels of an organization to gain competitive advantage.
4. To help students understand the strategic drive in multinational firms and their decisions in different markets.
5. To enable the students to gain knowledge of strategy implementation and the control measures for effective decision-making.

RECOMMENDED BOOKS:
- Crafting and executing Strategy. A Thompson Jr, Margaret A. and John E Gamble. Mc Graw Hill Publication, New Delhi.
- Strategic Management – Hitt & Manikutti, Cengage learning,2018.
- Strategic Management – Fred R David, PHI Learing Private Ltd, New Delhi.

REFERENCE BOOKS:
- Strategy and the Business Landscape – Pankaj Ghemawat.
- Strategic Management – Competitiveness and Globalization: Michael A. Hitt, Duane Ireland, Robert E. Hokinson, : South Western, Thomson Learning.
- Crafting and Executing Strategy, Arthur Thompson, A.J.Strickland, Arun Jain, Mc Grawhill.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			
CO3			X	X	
CO4					X
CO5			X		

ENTREPRENEURSHIP DEVELOPMENT

Semester	II	CIE Marks	: 40
Course Code	18MBA26	SEE Marks	: 60
Teaching Hours / week (L:T:P)	4-0-0	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To develop and strengthen entrepreneurial quality and motivation in students.
2. To impart basic entrepreneurial skills and understandings to run a business efficiently and effectively.
3. To provide insights to students on entrepreneurship opportunities, sources of funding and institutions supporting entrepreneurs.
4. To understand the contribution of the entrepreneurs towards Rural, Society and Socio Economic Development of the country.

Unit 1:

Entrepreneur & Entrepreneurship: Meaning of entrepreneur - Evolution of the concept - Functions of an Entrepreneur - Types of Entrepreneur - Intrapreneur- an emerging class - Concept of Entrepreneurship - Evolution of Entrepreneurship - Development of Entrepreneurship - Entrepreneurial Culture - Stages in entrepreneurial process.

Unit 2:

Business Planning Process: Meaning of business plan - Business plan process - Advantages of business planning - Marketing plan - Production/operations plan - Organization plan - Financial plan - Final Project Report with Feasibility Study - preparing a model project report for starting a new venture.

Unit 3:

Institutions supporting Entrepreneurs: Small industry financing developing countries - A brief overview of financial institutions in India - Central level and state level institutions - SIDBI - NABARD - IDBI - SIDCO - Indian Institute of Entrepreneurship - DIC - Single Window - Latest Industrial Policy of Government of India.

Unit 4:

Family Business: Importance of family business - Types - History - Responsibilities and rights of shareholders of a family business - Succession in family business - Pitfalls of the family business - strategies for improving the capability of family business - improving family business performance.

Unit 5:

International Entrepreneurship Opportunities: The nature of international entrepreneurship - Importance of international business to the firm - International versus domestic entrepreneurship - Stages of economic development - Entrepreneurship entry into international business - exporting - Direct foreign investment - barriers to international trade.

Unit 6:

Informal Risk Capital and Venture Capital: Informal risk capital market - venture capital - nature and overview - venture capital process - locating venture capitalists - approaching venture capitalists.

Social Entrepreneurship: Social enterprise-need - types - characteristics and benefits of social enterprises-Social entrepreneurship - Rural entrepreneurship-need and problems of rural entrepreneurship - challenges and opportunities-Role of government. Make in India, Smart India, Digitalized India.

Case studies in Entrepreneurship Development.

PRACTICAL COMPONENTS:

- Make a business plan for your intended business - talk to bankers to find out what they look for in a business plan - modify accordingly and present it in the class.
- Analyze the performance of listed family firms. How is their performance compared to the performance of other firms? Does a family firm successfully manage to create wealth for non-family investors?
- Interview a local entrepreneur to find out his/her major motivations to start a business - which of the skills and characteristics do you find in the entrepreneur?
- Study a local for-profit business and try to list out the positive social impacts of the business.
- Visit a trade show and try to compare the marketing activities of various stalls in that show - make a list of good practices you come across in the show.
- Choose an NGO in your locality. Interview the founder and present the case in class on the motivations - challenges - ecosystem support and their impacts - arrive at possible solutions and convey back to NGO.

COURSE OUTCOMES:

1. Display keen interest and orientation towards entrepreneurship, entrepreneurial opportunities in order to setup a business.
2. As an entrepreneur learn to think creatively and understand the components in developing a Business plan.
3. Become aware about various sources of funding and institutions supporting entrepreneurs.

4. Gain consciousness towards social entrepreneurship and rural entrepreneurship opportunities.

RECOMMENDED BOOKS:

- Entrepreneurship- A South-Asian Perspective, D.F.Kuratko, T.V.Rao – Cengage Learning -2018.
- Entrepreneurship Development-Small Business Enterprise- Poornima Charantimath Pearson Education - 2007.
- Entrepreneurship- Rober D Hisrich - Michael P Peters - Dean A Shepherd - 6/e - The McGraw-Hill companies - 2007.

REFERENCE BOOKS:

- Entrepreneurship Theory at crossroads - Mathew J Manimala - 2/e - Biztantra - 2007.
- Entrepreneurship - Rajiv Roy - 2/e - Oxford University Press 2011.
- Entrepreneurship-Principles and Practices - Kurakto - 7/e - Thomson Publication - 2007.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			X
CO3				X	
CO4			X		

MARKETING SPECIALISATION
III SEMESTER
CONSUMER BEHAVIOR

Semester	III	CIE Marks	: 40
Course Code	18MBAMM301	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To understand the concept of consumer behaviour, decision making by consumers, behavioural variables and its influences on consumer behaviour.
2. To comprehend the social and cultural dimensions of consumer behaviour.
3. To provide an insight of the psychological and behavioural concepts of consumers.

Unit 1:

Introduction to the study of Consumer Behaviour: Meaning & Definition of Consumer Behaviour, Difference between Consumer & Customer, Nature & characteristics of Indian Consumers, Consumerism: meaning, Consumer Movement in India, Rights & Responsibilities of consumers in India, Benefits of consumerism.

Unit 2:

Models of Consumer Behaviour: Input-Process-Output Model, Nicosia Model, Howard Sheth Model, Engel-Kollat-Blackwell Models of Consumer Behaviour, Internal Influences, External Influences.

Consumer Decision Making: Consumer Buying Decision Process, Levels of Consumer Decision Making – Four views of consumer decision making. On-line Decision Making: Meaning & Process/Stages.

Situational Influences- Nature of Situational Influence, Situational Characteristics and consumption behaviour.

Part 1

Unit 3:

Individual Influences on Consumer Behaviour and CRM

A) Motivation: Basics of Motivation, Needs, Goals, Positive & Negative Motivation, Rational Vs Emotional motives, Motivation Process, Arousal of motives, Selection of goals. Motivation Theories and Marketing Strategy - Maslow's Hierarchy of Needs, McGuire's Psychological Motives.

B) Personality: Basics of Personality, Theories of Personality and Marketing Strategy (Freudian Theory, Neo-Freudian Theory, Trait Theory), Applications of Personality concepts in Marketing, Personality and understanding consumer diversity, Brand Personality, Self and Self-Image.

C) Perception: Basics of Perception & Marketing implications, Elements of Perception, Dynamics of Perception, Influence of perception on CB, Consumer Imagery, Perceived price, Perceived quality, price/quality relationship, Perceived Risk, Types of risk, How to consumers' handle risk.

Part 2

Unit 4:

Individual Influences on Consumer Behaviour

A) Learning: Elements of Consumer Learning, Marketing Applications of Behavioural Learning Theories, Classical Conditioning – Pavlovian Model, Neo-Pavlovian Model, Instrumental Conditioning.

B) Attitude: Basics of attitude, the nature of attitude, Models of Attitude and Marketing Implication, (Tri-component Model of attitude, Multi attribute attitude models. Elaboration Likelihood Model).

C) Persuasive Communication: Communications strategy, Target Audience, Media Strategy, Message strategies, Message structure and presentation.

Unit 5:

External Influences on Consumer Behaviour

Social Class: Social Class Basics, What is Social Class? (Social class & Social status, the dynamics of status consumption, Features of Social Class, Five Social-Class Categories in India.

Culture: Basics, Meaning, Characteristics, Factors affecting culture, Role of customs, values and beliefs in Consumer Behaviour. Subculture: Meaning, Subculture division and consumption pattern in India, Types of subcultures. Cross Culture - Cross-cultural consumer analysis - Cross-cultural marketing strategy: Cross-cultural marketing problems in India, Strategies to overcome cross-cultural problems.

Groups: Meaning and Nature of Groups, Types Family: The changing structure of family, Family decision making and consumption related roles, Dynamics of husband-wife decision making, The family life cycle & marketing strategy, Traditional family life cycle & marketing implications, Reference Groups: Understanding the power & benefits of reference groups, Factors that affect reference group influence, Types of reference group, Reference Group Appeals.

Unit 6:

Consumer Influence and Diffusion of Innovations

Opinion Leadership: Dynamics of opinion leadership process, Measurement of opinion leadership, Market Mavens, Opinion Leadership & Marketing Strategy, Creation of Opinion Leaders.

Diffusion of Innovations: Diffusion Process, Adoption Process: Stages, categories of adopters, Post Purchase Processes.

Customer Relationship Management- Meaning & Significance of CRM, Types of CRM Strategies for building relationship marketing, e-CRM, Meaning, Importance of e-CRM, Difference Between CRM & e-CRM.

PRACTICAL COMPONENT:

- Students can go to malls and unorganized retail outlets and observe the behaviour of consumers of different demographic segments while buying different category of goods. The students need to present the findings / observations followed with a group discussion.
- Students have to prepare a questionnaire and conduct the survey on consumer buying behaviour and present the findings in the class.
- Find three advertisements that appeal to the need for power, affiliation and achievement. Discuss their effectiveness. Rewrite these for persons in different levels of Maslow's Hierarchy?
- Meet your friends and conduct a survey to find what are the important factors in their purchase of mobiles, shoes, bags etc.
- Conduct a study on advertisements regarding a specific product and find out how consumer deal with the information overload?

COURSE OUTCOMES:

The student should be able to:

1. Explain the background and concepts vital for understanding Consumer Behaviour.
2. Identify the role of variables that determines Consumer Behaviour in Social & cultural domain.
3. Identifying the psychological and behavioural practices adopted by organizations to enhance the Consumer Behaviour.

RECOMMENDED BOOKS:

- Consumer Behavior - Leon Schiff man, LesslieKanuk, 10/e, Pearson, Latest edition.
- Consumer Behaviou: A Managerial Perspective, Dr. Dheeraj Sharma, Jagdish N Sheth, Banwari Mittal,1/e, Cengage Learning.

REFERENCE BOOKS:

- Consumer Behavior in Indian Perspective – Suja Nair, Himalaya Publications, 2015
- Consumer Behavior: Building Marketing Strategy – Del I. Hawkins, & Others, 11/e, TMH,
- Consumer Behavior- Satish K. Batra& S H HKazmi, Excel Books.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X	X		
CO3	X				X

RETAIL MANAGEMENT

Semester	III	CIE Marks	: 40
Course Code	18MBAMM302	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To develop an understanding of the contemporary retail management, issues, strategies and trends.
2. To highlight the importance of retailing and its role in the success of modern business.
3. To acclimatize with the insights of retailing, key activities and relationships.

Unit 1:

Introduction and Perspectives on Retailing World of Retailing, Retail management, introduction, meaning, characteristics, emergence of organizations of retailing - Types of Retailers (Retail Formats) - Multichannel Retailing -Customer Buying Behaviour, Historical Perspective, role of retailing, trends in retailing, FDI in Retail - Problems of Indian Retailing - Current Scenario.

Unit 2:

Theories of Retailing: Wheel of retailing, The Retail Accordion, Melting Pot Theory, Polarization theory.

Unit 3:

Retailing strategy for Setting up Retail organization and planning: Retail Market Strategy - Financial Strategy - Site & Locations (Size and space allocation, location strategy, factors Affecting the location of Retail, Retail location Research and Techniques, Objectives of Good store Design.) – Human Resource Management, Information Systems and supply chain management & Logistics. Retail Pricing and Promotion: Factors influencing retail pricing, Retail pricing strategies, Retail promotion strategies.

Unit 4:

Store Management and Visual Merchandising: Store Management: Responsibilities of Store Manager, Store Security, Parking Space Problem at Retail Centres, Store Record and Accounting System, Coding System, Material Handling in Stores, Management of Modern retails –Store Layout, design: Types of Layouts, role of Visual Merchandiser, Visual Merchandising Techniques, Controlling Costs and Reducing Inventories Loss, Exteriors, Interiors Customer Service, Planning Merchandise

Assortments -Buying systems -Buying merchandise and Retail Communication Mix.

Unit 5:

Relationship Marketing & International Retailing: Management & Evaluation of Relationships in Retailing, Retail Research in Retailing: Importance of Research in Retailing, Trends in Retail Research, Areas of Retail Research. Customer Audits, Brand Management in retailing, Internationalization of Retailing and Evolution of International Retailing, Motives of International Retailing, International Retail Environment – Socio-Cultural, Economic, Political, Legal, Technological and issues in international retailing.

Unit 6:

Retail Audit and ethics in Retailing Undertaking an audit, responding to a retail Audit, problems in conducting a retail audit. Ethics in retailing, social responsibility and consumerism .

PRACTICAL COMPONENTS:

- Interview a salesperson in a retail store and write a brief report about what they like and dislike about their jobs, their salary, travelling allowances, sales quotas, why they chose a sales career, and what does it take to succeed in this profession.
- Go to a kirana store and a supermarket and compare the following: a) store arrangement b) No of brands carried c) pricing policies – are discounts given? d) Service – personal or impersonal? Etc.
- Go to at least three kirana stores in your neighbourhood (around 2 kms) and discuss with them the importance of location, pricing, credit policy, etc. What percentages of goods are sold ‘loose’ in each locality and compare this with the approximate income range of the customers? What are the retailer’s losses when a customer defaults in payment? Does he make up for it by increasing his prices to other customers?
- Ask your friends if they would buy certain goods like groceries, vegetables, socks, mobile, pens etc from the roadside vendor as against a regular shop. Group the products into low risk and high risk ones. Does this buying behavior also depend on the personality of the individual doing the buying? Or the one doing the selling?
- Student can make a presentation on any product or the services of student choice, covering selling strategies and one day work exposure towards merchandising in any big retail outlets of respective places where institute is operating. Rural colleges can send the students to the city nearby to observe the merchandising planning in retail outlets and to make a small report.

COURSE OUTCOMES:

The student should be able to:

1. Find out the contemporary retail management, issues, and strategies.
2. Evaluate the recent trends in retailing and its impact in the success of modern business.
3. Relate store management and visual merchandising practices for effective retailing.

RECOMMENDED BOOKS:

- Retail Management - Levy & Weitz, 8/e, TMH, 2012.
- Retail Management - Chetan Bajaj, Oxford University press.
- Retailing, James R Carver, Patrick m Dunne, Robert F Lusch, 8/e.

REFERENCE BOOKS:

- Integrated Retail Management - James R. Ogden & Denise Trodden, Biztantra, Latest Edition.
- Retail Marketing Management - Dravid Gilbert, 2/e, Pearson Education
- Retail Management: A Strategic Approach - Barry Berman, Joel R. Evans, Pearson.
- Retail Management, Global perspective, Dr. Harjith Singh, 3rd Revised Edition, S.Chand.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3		X			X

SERVICES MARKETING

Semester	III	CIE Marks	: 40
Course Code	18MBAMM303	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To acquaint the students with the characteristics of services and their marketing implications.
2. To discuss and conceptualize the service quality, productivity in services, role of personnel in service marketing and to manage changes in the environment.
3. To familiarize the students with the GAPS model and strategizing towards closing the GAPS for effective services marketing.

Unit 1:

Introduction to services: Concepts, contribution and reasons for the growth of services sector, difference in goods and service in marketing, characteristics of services, concept of service marketing triangle, service marketing mix, GAP models of service quality.

Consumer behaviour in services: Search, Experience and Credence property, consumer expectation of services, two levels of expectation, Zone of tolerance, Factors influencing customer expectation of services.

Customer perception of services-Factors that influence customer perception of service, Service encounters, Customer satisfaction, Strategies for influencing customer perception.

Unit 2:

Understanding customer expectation through market research: Key reasons for GAP 1,using marketing research to understand customer expectation, Types of service research, Building customer relationship through retention strategies –Relationship marketing, Evaluation Of customer relationships, Benefits of customer relationship, levels of retention strategies, Market segmentation-Basis & targeting in services.

Unit 3:

Customer defined service standards: “Hard” & “Soft” standards, challenges of matching supply & demand in capacity, four common types of constraints facing services, optimum v/s maximum use of capacity, strategies for matching capacity & demand.

Yield management-balancing capacity utilization, pricing. Waiting line strategies- four basic Waiting line strategies.

Leadership &Measurement system for market driven service performance-key reasons for GAP-2 service leadership- Creation of service vision and implementation, Service quality as profit strategy, Role of service quality In offensive and defensive marketing.

Unit 4:

Employee role in service designing: Boundary spanning roles, Emotional labour, Source of conflict, Quality- productivity trade off, Strategies for closing GAP 3.

Customer's role in service delivery-Importance of customer & customer's role in service delivery, Strategies for enhancing-Customer participation, Delivery through intermediaries-Key intermediaries for service delivery, Intermediary control strategies.

Unit 5:

Role of marketing communication- Key reasons for GAP 4 involving communication, four categories of strategies to match service promises with delivery.

Pricing of services- Role of price and value in provider GAP 4, Role of non-monitory cost, Price as an indicator of service quality –Approaches to pricing services, pricing strategies.

Unit 6:

Physical evidence in services: Importance of Physical Evidence, Elements of Physical Evidence, Physical Evidence Strategies, Guidelines for Physical Evidence.

Service scapes: Types of service scapes-Objective and Goals of services capes Role of services capes, Approaches for understanding service scapes effects, Frame work for understanding services capes & its effect on behaviour-Guidance for physical evidence strategies.

PRACTICAL COMPONENT:

- Ask students to choose a service industry of their choice at the beginning of the semester
- Ask them to do an in-depth study of the industry and give a presentation at the end of the every Module relating the concepts to the particular industry(GAPS).
- Students can prepare service blueprints for any service of their choice.
- Identify any existing services, locate loopholes in the design and suggest modifications.
- Visit a service industry and analyze the role of customers in service delivery.

COURSE OUTCOMES:

The student should be able to:

1. Develop an understanding about the various concepts and importance of Services Marketing.
2. Enhance knowledge about emerging issues and trends in the service sector.
3. Learn to implement service strategies to meet new challenges.

RECOMMENDED BOOKS:

- Services Marketing - Valarie A Zeithmal& Mary Jo Bitner, 5/e, TMH, 2011.
- Services Marketing-Christopher Lovelock, Pearson Education.

REFERENCE BOOKS:

- Services Marketing – Rajendra Nargundkar, 3/e, TMH, 2010.
- Services Marketing - Hoffman & Bateson, 4/e, Cengage Learning-2007.
- Services Marketing: Operation, Management and Strategy-Kenneth E Clow& David L. Kurtz, 2/e, Biztantra, 2007.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3					X

MARKETING RESEARCH & ANALYTICIS

Semester	III	CIE Marks	: 40
Course Code	18MBAMM304	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To provide an understanding of the basics of marketing research process.
2. To orient on the theoretical and practical aspects of marketing research.
3. Encourage the students to take up analytical thinking through research.
4. To highlight importance marketing research for enhancing marketing strategies.

UNIT 1:

Marketing Research Dynamics- Introduction, Meaning of Marketing research, when marketing research is unnecessary, Nature and Scope of Marketing Research, Marketing Research in the 21st Century (Indian Scenario), limitations of Marketing Research, threats to marketing research. Introduction to marketing intelligence: what is marketing intelligence (MI), components, need for MI, Domains of MI. Ethics in marketing research.

UNIT 2:

Marketing Research and MIS: Marketing Information System, Importance, Relevance of MkIS, Marketing Research (MR) and MkIS, The marketing information systems and its subsystems, four components: user interfaces, application software, databases, and system support. Advantages & disadvantages of marketing information systems. Internal reporting systems.

UNIT 3:

Decision Support System & Big Data: Marketing Decision Support System-meaning, Use of Decision Support Systems in Marketing Research, Data base & Data warehousing. The three Vs: Volume, Velocity & Varity, The Fourth V: Value. Elements of data base, types of data base, using marketing data base for marketing intelligence, ways to gather consumer data, Data Mining, benefits of data mining, Big Data Analysis, Descriptive Analysis, Prescriptive Analysis, Key challenges of Big Data Integration.

UNIT 4:

Applications of Marketing Research: Introduction, Consumer Market Research, Business-to-Business Market Research, Product Research, Pricing Research, Motivational Research, Distribution Research, Advertising Research, Media research, Sales Analysis and Forecasting.

UNIT 5:

Predictive analysis: Meaning of predictive analysis, how good are models at predictive behavior, benefits of predictive models, and applications of predictive analysis, reaping the benefits, avoiding the pitfalls, Importance of Predictive model, Process of predictive analytics.

UNIT 6:

Predictive analytical process: Project initiation, project requirements, Model building and business evaluation, duration of a predictive analytics project.

Building a predictive model: Exploring the data landscape, Sampling and shaping the development sample, data preparation, creating derived data, understanding the data, data reduction, data transformation, modeling, validation, selling models into business.

PRACTICAL COMPONENTS:

- Choose 5 successful products or services and identify the insight behind them through a field survey.
- Do a comprehensive essay on the difference between consumers vs. trade vs. Competition insights & how best to exploit them.
- Take 5 recent digital innovations like twitter or face book and identify the insights.
- Running case with real data Dell, Comprehensive critical thinking case Baskin-Robbins.
- Data Analysis case with real data IBM.

COURSE OUTCOMES:

The student should be able to:

1. Comprehend the objectives of Market research & its application in solving marketing problems.
2. Appreciate the use of different data collection methods, sampling design techniques, measurement methods to analyze the data.
3. Generalize and interpret the data with the help of various measurement techniques.
4. To understand the emergence of new trends in research.

RECOMMENDED BOOKS:

- Marketing Research an Application Orientation-Naresk K Malhotra,6/e, Pearson, 2013.
- Essentials of Marketing Research – William G. Zikmund et.al. 4/e, Cengage Learning,2010.
- Predictive Analytics, Data Mining and Big Data- S. Finlay, Palgrave Macmillan Publishing.

REFERENCE BOOKS:

- Marketing Research: Methodological Foundations 8 th Edition by Gilbert A. Churchill & Dawan Iacobucci.
- Marketing Research: David A Aker/V.Kumar/Robert P Leone,George S Day. Willey publication.11th edition.
- Essentials of Marketing Research – 4/e, Tony Proctor, PHI, 2005 Market Research Best Practice. 30 Visions of the Future – Peter Mouncey, et.al, 2007.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3					X
CO4	X				

BUSINESS MARKETING

Semester	III	CIE Marks	: 40
Course Code	18MBAMM305	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Objectives:

1. To develop an understanding of the various concepts of Industrial Marketing.
2. To understand the buying process and marketing channels for industrial goods.
3. To acquaint with B-2-B-2-C Strategies and their implementation.
4. To analyze various pricing strategies of industrial goods & their implications.
5. To understand the significance of E-commerce in Business Marketing.

Unit 1:

Nature of Business Marketing: Business Marketing Concept, Business vs. Consumer Marketing, Economics of Industrial demand, Types of Industrial Markets, Types of Business Customers, Classifying Industrial Products & Services, Business customers purchase orientations, Organizational Procurement Characteristics, Environment Analysis in Business Marketing.

Units 2:

Organizational Buying Behaviour: Organizational Buying Process, Types of purchases / buying situations, Buying Centre Concept, Inter Personal Dynamics of Business Buying Behaviour, Roles of Buying centre. The Webster & Wind model of Organizational Buying Behaviour, Ethics in Purchasing. Business Marketing Research: Differences between B2C & B2B Marketing Research, Marketing Research Process, Research Methods.

Unit 3:

Market Segmentation: Segmenting, Targeting and Positioning of Business Market, Value based segmentation, Model for segmenting the organizational Market. Product & Brand Strategy: Developing Product Strategy, Analyzing Industrial Product Life Cycle, Developing Strategies for new and existing products, Branding process & Brand strategy. Business Service Marketing: Special Challenges

Unit 4:

Formulating Channel Strategy: Nature of Business Marketing channels, Intermediaries, Direct and Indirect Channels, Channel Objectives, Channel Design, Managing Channel Members, Selection and Motivation of Channel

Members, Channel conflicts, SCM, Logistics Management, Customer Service, Major cost centres of Market Logistics.

Unit 5:

Pricing Strategies: Price Determinants, Factors that Influence the Pricing Strategies, Pricing Methods, concept of learning curves, Pricing Strategies, Pricing Policies, Terms of Payment, Competitive Bidding, Leasing The Promotional Strategies: Communication Objectives, Role of B-2-B Advertising, Sales Promotion in Industrial Markets, Trade shows and Exhibitions.

Unit 6:

Management of Sales Force: Personal Selling, The Selling Process, Key Account Management, Managing the Industrial Sales Force, Organizing and controlling the industrial sales force activity, planning for sales force Deployment, Measuring the Effectiveness of Sales Force, Customer relationship Management Strategies for Business Markets, Ethical Issues. B2B through E-Commerce: Business-to-Business forms of E-Commerce, Models for B2B ecommerce, Marketing strategy for the electronic market place.

PRACTICAL COMPONENTS:

- Visit Industrial Distributor/Dealer and collect all the conceptual information from purchasing to selling of B2B Products (SCM) to Business Customers.
- Visit at least one Industrial / B2B Trade shows or Exhibitions and prepare a report
- Visit to one Original Equipment Manufacturing (OEM) Industry and one Semi-Finished Goods Industry.
- Students are expected to make a SWOT analysis of Industrial products and services of various sectors.

COURSE OUTCOMES:

Student should be able to

1. Describe the nature of business markets and the related concepts.
2. Familiarize the business buying behaviour of industrial customers.
3. Analyze business situations in the context of buyer-seller relationships.
4. Apply concepts of pricing strategies for industrial goods
5. To evaluate the significance of E –Commerce in Business Marketing.

RECOMMENDED BOOKS:

- Industrial Marketing – Robert R Reeder & Reeder; 2nd Edition; Prentice Hall International Publication.

- Business Marketing – Krishna K Havaldar, Latest Edition, Tata McGraw Hill Publication.
- Business Marketing Management – Michael D Hutt, Thomas W Speh, Latest Edition, Cengage Learning Publication.

REFERENCE BOOKS:

- Business Marketing – Frank G Bingham Jr., Latest Edition; Tata McGraw HillPublication.
- Industrial Marketing – Mukherjee H S; Latest Edition; Excel BOOKS Publication.
- Industrial Marketing – PK Ghosh, Latest Edition; Oxford University Press.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3					X
CO4	X				

SUPPLY CHAIN MANAGEMENT

Semester	III	CIE Marks	: 40
Course Code	18MBAMM306	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Objectives:

1. To understand the basic concepts, processes and key elements of a supply chain.
2. To provide insights for establishing efficient, effective, and sustainable supply chains.
3. To explain the role of technology in supply chain planning, visibility, and execution.

Unit 1:
Introduction: Basic concepts & philosophy of SCM, essential features, decision phases – process view, supply chain framework, key issues in SCM and benefits.

Unit 2:
Designing the supply chain network: Designing the distribution network, role of distribution, factors influencing distribution, design options, distribution networks in practice, network design in the supply chain, factors affecting the network design decisions. Designing and Planning Transportation Networks, role of transportation, modes, design options, tailored transportation.

Unit 3:
Inventory Management: Concept, various costs associated with inventory, EOQ, buffer stock, lead time reduction, reorder point / re-order level fixation, ABC analysis, SDE/VED Analysis.

Unit 4:
Purchasing and vendor management: Centralized and decentralized purchasing, functions and purchase policies, vendor rating/ evaluation, single vendor concept, account for materials, just in time & Kanban systems of inventory management

Unit 5:
Logistics Management: Logistics of part of SCM, logistics costs, logistics, sub-systems, inbound and out bound logistics bullwhip effects in logistics, distribution and warehousing management. Demand Management and Customer Service: Demand Management, CPFRP, customer service, expected cost of stock outs.

Unit6:
Recent issues in SCM: Role of computer/ IT in supply chain management, CRM Vs SCM, Benchmarking concept, features and implementation, outsourcing – basic concepts, value addition in SCM.

PRACTICAL COMPONENTS:

- Students are expected to choose any 4 Indian Organizations and study their supply chain in terms of drivers of the Supply chain and submit a report.
- Students should visit different logistics companies and understand the services provided by them and submit a report.
- Students should identify any product/service and study the type of distribution system used and understand the reason for using that particular type and present it in the class.
- Students should identify the various types of IT applications employed by Indian Organizations in their Supply chain.

COURSE OUTCOMES:

The student should be able to:

1. Demonstrate knowledge of the functions of logistics and supply chain management.
2. To relate concepts and activities of the supply chain to actual organizations.
3. Highlight the role of technology in logistics and supply chain management.
4. Evaluate cases for effective supply chain management and its implementation.

RECOMMENDED BOOKS:

- A Logistic approach to Supply Chain Management – Coyle, Bardi, Longley, 1st Edition, Cengage Learning.
- Supply Chain Logistics Management, Donald J Bowersox, Dand J Closs, M Bixby Coluper,2nd Edition, TMH, 2008.

REFERENCE BOOKS:

- Supply chain management, Chopra Sunil and Peter Meindl - 3rd edition, Pearson, 2007.
- Supply Chain Management-A Managerial Approach,Amith Sinha, Herbert, 2nd edition,TMH.
- A Text Book of Logistics and Supply chain management, Agarwal D.K. - 1st edition,Macmillan

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X		X	X
CO3			X		X
CO4	X				

SEMESTER III
(FINANCE SPECIALISATION)
BANKING & FINANCIAL SERVICES

Semester	III	CIE Marks	: 40
Course Code	18MBAFM301	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To understand the structure and functions of central and Commercial banking in India.
2. To learn the functions of various financial services in India.

Unit 1:

Structure of Banking in India: Functions of RBI, structure and functions of commercial banks. Monetary system, Sources of funds, Quantitative and qualitative measures of credit control. Banking sector reforms, Bank performance analysis and Future of Banking.(Theory)

Unit 2:

Commercial banking: Structure, Functions - Primary & secondary function, Role of commercial banks in socio economic development, Services rendered. Banking Technology- Concept of Universal Banking- Home banking–ATMs-Internet banking– Mobile banking-Core banking solutions–Debit, Credit and Smart cards– Electronic Payment systems- MICR- Cheque Truncation-ECS- EFT – NEFT-RTGS. (Theory)

Unit 3:

Merchant Banking: Categories, Services offered,Issue management – Post and Pre issue management, Issue pricing, preparation of prospectus, Issue Management, Underwriting, Private Placement, Book Building Vs Fixed price issues.(Theory)

Unit 4:

NBFCs an Overview -Types of NBFCs in India. Regulatory framework. Micro finance-Models, services, challenges. Leasing & Hire Purchase: Concept, Types, Evaluation.Problems in Evaluation of Leasing & Hire Purchase. (Theory& Problems)

Unit 5:

Credit rating: Meaning, process of credit rating, rating methodology, rating agencies and symbols.

Venture capital: concept, features, process. Stages, Performance of Venture capital funded companies in India.(Theory)

Unit 6

Mutual Funds: Structure,Functions, Types of Funds, Performance of Mutual Funds, Regulations. Depository system: objectives, activities, NSDL& CDSL. The process of clearing and settlement. Factoring & Forfeiting: Definition, functions, types. Securitization: Meaning, process, Types, Benefits. (Theory)

Question Paper: 90% Theory, 10% Problems (Leasing and hire purchase).

PRACTICAL COMPONENTS:

1. Study and compare the performance of Public and private sector banks.
2. Issue management: Study the recent public issues.
3. Factoring and forfeiting business in India.
4. Venture capital funding and start up challenges.
5. Status of securitization in India.

COURSE OUTCOME:

1. The Student will be acquainted to various Banking and Non-Banking financial services in India.
2. The Student will understand the activities of Merchant Banking and credit rating.
3. The Student will be equipped to understand micro financing and other financial services in India.
4. The Student will understand how to evaluate and compare leasing & hire purchase.

RECOMMENDED BOOKS

- Financial services – Khan M Y, 6/e, McGraw Hill.
- Banking and Financial Services- Mukund Sharma, Himalaya publishing, 2015.
- Management of Banking and Financial services- Padmalatha& Justin Paul, Pearson.

REFERENCE BOOKS

1. Financial Markets and Services – Gordon & Natarajan, 7/e, Himalaya publishing, 2011.

2. Merchant Banking & Financial services- Vij & Dhavan, 1/e, McGraw Hill, 2011.
3. Investment Banking- Pratap G Subramanyam, Tata McGraw Hill, 2012.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X			X	
CO3	X				X
CO4	X			X	

INVESTMENT MANAGEMENT

Semester	**III**	**CIE Marks**	**: 40**
Course Code	**18MBAFM302**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**3-0-2**	**Exam Hours**	**: 03**
	Credits : 04		

Course Objectives:

1. To understand the capital market and various instruments for investment.
2. To learn valuation of equity, debt and mutual funds.
3. To learn the theories of portfolio management.

Unit 1:

Investment: Attributes, Economic vs. Financial Investment, Investment and speculation, Features of a good investment, Investment Process. Financial Instruments: Money Market Instruments, Capital Market Instruments, Derivatives.

Securities Market: Primary Market, Secondary Market. Stock Market Indicators- Types of stock market Indices, Indices of Indian Stock Exchanges (only Theory).

Unit 2:

Risk and Return Concepts: Concept of Risk, Types of Risk- Systematic risk, Unsystematic risk, Calculation of Risk and returns individual security, Portfolio Risk and Return (Theory & Problems).

Unit 3:

Valuation of securities: Bond- Bond features, Types of Bonds, Determinants of interest rates, Bond Management Strategies, Bond Valuation, Bond Duration. Preference Shares- Concept, Features, Yields. Equity shares- Concept, Valuation, Dividend Valuation models. (Theory & Problems).

Unit 4:

Macro-Economic and Industry Analysis: Fundamental analysis-EIC Frame Work, Industry Analysis. Company Analysis- Financial Statement Analysis, Ratio Analysis. Technical Analysis – Concept, Theories- Dow Theory, Eliot wave theory. Charts-Types, Trend and Trend Reversal Patterns. Mathematical Indicators –Moving averages, ROC, RSI, Market Indicators. (Theory only).

Unit 5:

Modern Portfolio Theory: Markowitz Model, Sharpe's single index model, Capital Asset pricing model: Basic Assumptions, CAPM Equation, Security Market line, Extension of Capital Asset pricing Model - Capital market line, SML VS CML. Arbitrage Pricing Theory: Arbitrage, Equation, Assumption, Equilibrium, APT AND CAPM.(Theory & Problems).

Unit 6:

Market Efficiency and Behavioral Finance: Random walk and Efficient Market Hypothesis, Forms of Market Efficiency, Empirical test for different forms of market efficiency. Behavioral Finance – Interpretation, Biases and critiques.

Portfolio Management Strategies: Active and Passive Portfolio Management strategy. Portfolio Revision: Portfolio Revision Strategies – Objectives, Performance plans.

Portfolio performance Evaluation: Holding period returns, Measures of portfolio performance.(Theory & Problems).

PRACTICAL COMPONENTS:

- Each student will be given a virtual cash of Rs.10 Lakhs and they will be asked to invest in equity shares based on fundamental analysis throughout the semester. At the end the best investment will be awarded based on the final net worth. Virtual on line trading account can be opened for the student and every week 2 hours can be allotted to invest, monitor and evaluate.
- Students should study the stock market pages from business press and calculate the risk and return of selected companies.
- Students can do a macro economy using GDP growth.
- Students' are expected to do Industry analysis for specific sectors.
- Students can do Company analysis for select companies using profitability and liquidity ratios.
- Practice technical analysis using Japanese candle sticks.

COURSE OUTCOMES:

1. The student will understand the capital market and various Instruments for Investment.
2. The learner will be able to assess the risk and return associated with investments and methods to value securities.
3. The student will be able to analyse the Economy, Industry and Company framework for Investment Management.
4. The student will learn the theories of Portfolio management and also the tools and techniques for efficient portfolio management.

RECOMMENDED BOOKS:

- Investment Analysis and Portfolio management – Prasanna Chandra,3/e,TMH, 2010.
- Investments – ZviBodie, Kane, Marcus &Mohanty, 8/e, TMH,2010.
- Security Analysis & Portfolio Management- J Kevin, TMH

REFERENCE BOOKS:

- Analysis of Investments & Management – Reilly & Brown, Cengage, 10e/2017
- Security Analysis & Portfolio Management – Punithavathy EhavathyPandian,2/e, Vikas, 2005.

Question Paper: 60 % Theory 40% problems.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3					X
CO4	X				

DIRECT TAXATION

Semester	III	CIE Marks	: 40
Course Code	18MBAFM303	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To provide the students with a comprehensive understanding of basic concepts of Income tax
2. To understand the computation of taxable Income under different heads.
3. To know the deductions available while computing Income.
4. To understand corporate taxation system in India

Unit 1:

Income Tax Act, 1961, Basic Concepts and definitions, Capital and revenue – receipts, expenditures, Basis of charge and scope of total income , Residential Status and Incidence of Tax, Incomes which do not form part of Total Income (Sec.10), Tax Planning, Tax Evasion and Tax Management. (Problems on residential Status of Individual assessee).

Unit 2:

Income from Salaries: Introduction, Meaning of Salary, Allowances, Valuation & Taxability of Perquisites, Death cum Retirement benefits, Deductions against Salary. Income from House Property (Theory Only). (Problems on salary Income).

Unit 3:

Income under the head Profit and Gains of Business or Professions and its computation- basic method of accounting- scheme of business deductions/ allowance- deemed profits- maintenance of books, Depreciation. (Problems on computation of income from business/ profession of Individual assessee and Depreciation).

Unit 4:

Income under capital gain, basis of charge, transfer of capital asset, inclusion & exclusion from capital asset, capital gain, computation of capital gain, deductions from capital gains. Income from Other Sources (Theory Only). (Problems on computation of Income from capital gain).

Unit 5:

Permissible deductions under section 80C to 80U, computation of tax liability of Individuals. Setoff and carry forward of losses (Theory only). (Problems on Computation of taxable Income and tax liability of Individuals).

Unit 6:

Computation of taxable income of a company with special reference to MAT. (Problems on MAT).

Question Paper: 30 % Theory 70% problems.

PRACTICAL COMPONENT:

- Calculation of Taxable income and tax liability using Excel.
- Encouraging the students to register as tax return preparers.
- Students can be exposed to filing of tax returns of Individual assesses.

COURSE OUTCOME:

At the end of the course, the students are able to:

1. Understand the basics of taxation and process of computing residential status.
2. Calculate taxable income under different heads.
3. Understand deductions and calculation of tax liability of Individuals.
4. Know the corporate tax system.

RECOMMENDED BOOKS :

- Direct Taxes Law and practice, Vinod Singhania and Kapil Singhania, ,Taxman Publications.
- Students Guide to Income Tax Vinod Singhania and Kapil Singhania, – Taxman Publications.

REFERENCE BOOKS:

- T N Manoharan- Students Guide to Income Tax – Snow White
- Direct Tax – Lal &Vashisht – Pearson.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	
CO3	X				
CO4	X				

ADVANCED FINANCIAL MANAGEMENT

Semester	III	CIE Marks	: 40
Course Code	18MBAFM304	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To understand the concept capital structure and capital structure theories.
2. To assess the dividend policy of the firm.
3. To be aware of the management of working capital and its financing.
4. To understand the techniques of managing different components of working capital.

Unit 1:

Capital structure decisions – capital structure & market value of a firm. Theories of capital structure – NI approach, NOI approach, Modigliani Miller approach, Traditional approach. Planning the capital structure: EBIT and EPS analysis. ROI & ROE analysis. (Theory and Problems).

Unit 2:

Dividend policy – Theories of dividend policy: relevance and irrelevance dividend decision. Walter's & Gordon's model, Modigliani & Miller approach. Dividend policies – stable dividend, stable payout and growth. Bonus shares and stock split corporate dividend behavior. (Theory and Problems).

Unit 3:

Working capital management – Determination of level of current assets. Sources for financing working capital. Bank finance for working capital. (No problems on estimation of working capital). Working capital financing: Short term financing of working capital, long term financing of working capital. Working capital leverage. (Theory).

Unit 4:

Inventory Management: Determinations of inventory control levels : ordering, reordering, danger level. EOQ model. Pricing of raw material. Monitoring and control of inventories, ABC Analysis. (Theory and Problems)

Unit 5:

Receivables Management – Credit management through credit policy variables, marginal analysis, Credit evaluation: Numerical credit scoring and Discriminate analysis. Control of accounts receivables, Problems on credit granting decision. (Theory and Problems)

Unit 6:

Cash Management – Forecasting cash flows – Cash budgets, long-term cash forecasting, monitoring collections and receivables, optimal cash balances – Baumol model, Miller-Orr model, Strategies for managing surplus fund. (Theory and Problems)

Question Paper: 40% theory and 60% problems

PRACTICAL COMPONENTS:

- Study the working capital financing provided by a Bank and submit the report on the same.
- Study the annual report of any two companies and prepare a cash budget for next year.
- Study dividend policy of companies and its impact on shareholders' wealth.
- Study implications of bonus issues/stock splits of companies.

COURSE OUTCOMES:

At the end of the course, the students are able to:

1. Get an overview of capital structure theories.
2. Understand and assess the dividend policy of the firm.
3. Realize the importance of management of working capital in an organization.
4. Be aware of the techniques of cash, inventory and receivables management

RECOMMENDED BOOKS:

- Financial Management - M.Y. Khan & P.K. Jain, 6/e, TMH, 2011
- Financial Management - Prasanna Chandra, 8/e, TMH, 2011.
- Financial Management: Comprehensive Text Book with Case Studies – Ravi M. Kishore, 7/e, Taxmann.

REFERENCE BOOKS:

- Financial Management: Theory & Practice - Brigham & Ehrhardt, 10/e, Cenage Learning, 2004.
- Corporate Finance: Ross, Westerfield & Jaffe,– TMH – 8/e, 2010
- Financial Management & Policy - Vanhorne, 12/e, Pearson

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
Co1	X				
CO2				X	
CO3	X				
CO4	X				

COST MANAGEMENT

Semester	III	CIE Marks	: 40
Course Code	18MBAFM305	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To understand various concepts and terminologies used in cost management
2. To explain and critically evaluate various costing methods and techniques such as marginal costing, budgetary control, standard costing, activity based costing etc.
3. To apply and analyse various costing methods and techniques mentioned above

Unit-1: Introduction to Cost Management

Meaning of cost and cost management-Cost accounting vs Cost management-Classification of costs-Methods and techniques of costing-Preparation of cost sheet (Numerical problems on cost sheet).

Unit-2: Overheads

Classification of overheads-Cost allocation and cost apportionment-Primary and secondary distribution of overheads-Simultaneous equation method (Numerical problems on both primary and secondary distribution)-Absorption of Overheads-Under and over absorption of overheads (Only theory).

Unit-3: Marginal Costing

Meaning, advantages and disadvantages of Marginal costing-Marginal cost techniques-Break Even Point (including chart), P/V Ratio and Margin of Safety-Applications of marginal costing technique (All types of numerical problems)-Differential Cost Analysis (Only theory).

Unit-4: Budgetary Control and Standard Costing:

Meaning and objectives of budgetary control-Types of budgets (Purchase budget, production budget, sales budget and master budget). (Numerical problems only on production and flexible budget). Standard Costing: Meaning of standard costing and variance analysis and its comparison with budgetary control (Numerical problems only on material and labour cost variances).

Unit-5: Activity Based Costing (ABC):

Meaning of Activity based costing and its comparison with traditional costing-Cost drivers- Unit level, batch level, product level and facility level cost-Advantages and disadvantages of ABC (Numerical problems on cost analysis under ABC).

Unit-6: Cost Audit and Reporting:

Cost Audit-Meaning, objectives and advantages-Management Audit-Meaning, objectives and Scope-Management Reporting–Objectives and types of reporting-Requisites of a good report- Segmental reporting. Cost Control-Meaning of cost control-cost control vs cost reduction- Target Costing–Meaning and its objectives-Balanced Scorecard-Meaning, objectives and features. (Question Paper:50% Theory and 50% Problems)

Question paper proportion: 40 Theory and 60 Problems

PRACTICAL COMPONENTS:

- The student can choose any product and get details about the actual cost of material, wages and other cost and prepare a cost statement.
- Standard cost of each component has to be obtained and compared with actual cost to find the variance and reasons for variance to assess efficiency of purchase, operations and production.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

1. Understand various cost methods and techniques with their features, merits and demerits).
2. Demonstrate the application of cost sheet, marginal costing, budgetary control techniques, Activity based costing etc. with numerical problems .
3. Analyse the results after applying various costing methods and techniques.
4. Critically evaluate all traditional and non-traditional costing methods such as absorption costing, marginal costing and activity based costing.

RECOMMENDED BOOKS:

- Management Accounting, Khan M. Y and Jain P. K, 6th Edition, McGraw Hill, 2012.
- A Text book of Cost and Management Accounting, Arora M. N, 11th Edition, Vikas.

REFERENCE BOOKS:

- Managerial Accounting, James Jiambalvo, 4nd Edition, Wiley India Pvt. Ltd.
- Cost Accounting, Jawaharlal, & Seema Srivastava, 4th Edition, TMH .

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X				
CO3				X	
CO4				X	

PROJECT APPRAISAL, PLANNING & CONTROL

Semester	III	CIE Marks	: 40
Course Code	18MBAFM306	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To screen and assess project ideas.
2. To plan, appraise and evaluate implementation of a project.
3. To assess financial and social risk concerned with project implementation.
4. To understand various aspects of project management.

Unit 1:

Planning & Analysis Overview: Capital budgeting concepts, objectives and Phases, levels of decision making, Resource Allocation Framework: Key criteria for allocation of resource – elementary investment strategies. Generation and screening of project ideas: Generation of ideas – monitoring the environment – regulatory framework for projects – corporate appraisal – preliminary screening – project rating index (Theory).

Unit 2:

Market and demand analysis, Technical analysis (steps to be discussed in detail). Financial Analysis: Estimation of cost of project and means of financing – estimates of sales and production – cost of production – working capital requirement and its financing – estimates of working results – breakeven points – projected cash flow statement – projected balance sheet. Project cash flows: Appraisal criteria: Net Present Value – benefit cost ratio – internal rate of returns urgency – payback period – accounting rate of returns – investment appraisal in practice. (Theory & Problems) .

Unit 3:

Types and measure of risk – simple estimation of risk – sensitivity analysis – scenario analysis – Monte Carlo simulation – Decision tree analysis – selection of projects under risk – risk analysis in practice.

Special decision situations: Choice between mutually exclusive projects of unequal life – optimal timing decision – determination of economic life – interrelationships between investment and financing aspects – inflation and capital budgeting, International Capital Budgeting. (Theory & Problems).

Unit 4:

Social Cost Benefit Analysis (SCBA): Rationale for SCBA – UNIDO

approach to SCBA – Little and Mirle approach to SCBA. Multiple projects and constraints: Constraints – methods of ranking – mathematical programming approach – linear programming model – Qualitative Analysis: Qualitative factors in capital budgeting – strategic aspects – strategic planning and financial analysis – informational asymmetry and capital budgeting – organizational considerations. (Theory & Problems).

Unit 5:

Multiple projects and constraints: Constraints – methods of ranking – mathematical programming approach – linear programming model.

Qualitative factors in capital budgeting. Judgmental, Behavioral, Strategic and Organizational Considerations. Environmental appraisal of projects: types and dimensions of a project, environmental impact assessment and environmental impact statement (Theory & Problems).

Unit 6:

Project Management: Forms of project organization – project planning – project control – human aspects of project management – prerequisites for successful project implementation. Project review and administrative aspects: Control of in-progress projects, The Post-audit, Abandonment Analysis, administrative aspects of capital budgeting, agency Problem, evaluating the capital budgeting system of an organization. (Theory).

PRACTICAL COMPONENTS:

- Students are asked to identify how the approaches to project appraisal differ between commercial projects in the private sector and a public sector.
- Students can visit a Financial institution/Bank and study the project appraisal criteria adopted by them.
- Students can study the project financing procedure provided by Banks.
- Students can visit the organization which have undertaken large scale projects like ‘Bangalore Metro Rail’ and study the risk associated with such projects and also study how they access and manage such risks.

COURSE OUTCOMES:

1. Students would learn capital budgeting and project financing.
2. Students would be quipped to appraise a project.
3. Students would learn to prepare a Business plan.
4. To understand various financial and technical aspects of project management.

RECOMMENDED BOOKS

- Project Planning: Analysis, Selection, Implementation and Review – Prasanna Chandra, 7/e, TMH, 2011.
- Project Management and Control – Narendra Singh, HPH, 2003.
- Project Management – Bhavesh M. Patel, 2/e, Vikas Publication.

REFERENCE BOOKS

- Project Management for Business and Technology: Principles and Practice – Nicholas, John M., 2/e, Pearson.
- Project Management: The Managerial Process – Gray& Larson, 4/e, TMH, 2011.
- Project Management – Choudhury, 1/e, TMH. 7.

CO-PO MAPPING

Merge	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2					X
CO3				X	
CO4	X				

SEMESTER III
(HUMAN RESOURCES SPECIALISATION)
RECRUITMENT AND SELECTION

Semester	III	CIE Marks	: 40
Course Code	18MBAHR301	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To enable students to understand and apply the principles of recruitment and Selection trends in the industry.
2. To provide a conceptual and Application of Selection Procedure in the Industry.
3. To give an understanding of the components and meaning of Latest Selection Tools in the corporate sector.
4. To Enable students with testing, reference checking and appointment orders in job recruitment and selection

Unit 1:

Job Analysis: Meaning, definition and purpose. Methods of job analysis: job analysis interviews, job analysis questionnaire, task analysis inventory, position analysis questionnaire, subject expert workshops, critical incident technique

Unit 2:

Hiring Process & Hiring decision: Nature of hiring: regular, temporary, full time, part time, apprentice, contractual, and outsourcing, Existing post or new post to be created, Need analysis, cost analysis and job analysis.

Unit 3:

Hiring internally: Meaning and definition of internal recruitment, Advantages and disadvantages in terms of cost, time, quality and suitability. Sources of internal recruitment: - circulars, intranet advertisements, employee referrals, Appointment or promotion, Policy guidelines and union settlements.

Unit 4:

External Hiring: Meaning and definition of external recruitment. Sources of recruitment:- advertisement, in newspaper, TV/Radio, Internet, search on the internet, wanted signboards, consultants, employment exchange, campus recruitment, employee referrals and unsolicited applications. Advantages and disadvantages of the above sources in terms of cost, time, convenience, reach of the targeted population, and quality of applicant pool.

Unit 5:

Screening the candidates: Application Forms: bio-data / resume / curriculum vitae and Weighted application blanks: meaning definition, purpose, advantages and disadvantages – taking a Behavioral approach to recruitment: spotting personality patterns, making basic assumptions, Predicting the future, strategy Vs. Technique, Pinning down what is needed: targeted interviewing, focusing on behavior, assessing how person performs, assuming they have been hired. – Identifying the ingredients of success: the winning candidate's profile, challenges in the Interview, the starting point, day to day execution, dealing with people.

Unit 6:

Testing, Reference checking & Appointment orders: Meaning, definition, purpose, advantages and disadvantages, Ability tests clerical ability test, mechanical ability test, mental ability test, physical ability test, personality assessment test, typing test, shorthand test, computer proficiency test

Reference checking: meaning, definition and purpose. Verification of character, criminal antecedents, previous work behavior and education qualifications.

Appointment orders Meaning, definition, and purpose. Contents of appointment letter, hard copy (or soft copy).

PRACTICAL COMPONENTS:

- Students need to identify two jobs in the college and need to do job analysis for those positions using any of the job analysis methods.
- In teams students can be asked to give presentations about various types of jobs (regular, temporary, full time, part time, apprentice, contractual, and outsourcing) in different industries along with its advantages and disadvantages.
- In Teams, select and analyze any two of the Job postings advertisements in Newspapers to know more about job description and job specification mentioned in each advertisement for every post.
- Obtain online access to the resume data base of Naukri.com or Monsterindia.com for a week give at least four Job Descriptions and specification to each student, to search and download from the data base at least five resumes for each positions.
- Students can identify 4 or 5 jobs of their interest and can create Advertisements for the same imaging that they are Proprietors of the companies and hiring for these positions.
- Debate on Advantages and disadvantages of hiring external and Internal for the selected jobs like Police Constable, Doctor, CEO, Mechanical Engineer, Professor etc.,
- Role play: Students can do the role play for the entire process of hiring and selecting 3 or 4 selected roles in a specific industry.

COURSE OUTCOMES:

At the end of the course students are able to:

1. Gain the insights of various principles and practices of recruitment and selection in an industry.
2. Equip students with various selection procedure practiced in industry.
3. Develop students with latest selection tools in the corporate sector.
4. Develop students with various testing of job recruitment and selection

RECOMMENDED BOOKS:

- Human Resource Selection, Robert D. Gatewood and Hubert S. I, South western Cengage Learning, Mason, Ohio, 2001.
- Staffing Organization, Herbert G. Heneman III, Timothy A. Judge, 5th Edition, McGraw Hill International.
- Recruitment and Selection, Elearn, Revised Edition, Routledge, 2009, ISBN: 1136369317, 9781136369315.

REFERENCE BOOKS:

- Employee Selection, Lilly M Berry, 1 edition, Cengage Learning, 2002, ISBN 13-978- 0534580957.
- Online Recruiting and Selection: Innovations in Talent Acquisition, Douglas H. Reynolds, John A. Weiner, John Wiley & Sons, 2009, ISBN: 1444315951, 9781444315950.
- Effective Recruitment and Selection Practices, R. L. Compton, William J. Morrissey, Alan R. Nankervis, Bill Morrissey, CCH Australia Limited, 2009, ISBN: 1921485779, 9781921485770.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X		X		
CO2	X			X	
CO3		X			
CO4		X			X

HR ANALYTICS

Semester	III	CIE Marks	: 40
Course Code	18MBAHR302	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To introduce the student to the theory, concepts, and business application of human resources research, data, metrics, systems, analyses, and reporting.
2. To develop an understanding of the role and importance of HR analytics, and the ability to track, store, retrieve, analyse and interpret HR data to support decision making.
3. To aware the challenges human resources analytics for the competitive advantage of the organization.
4. To enable students to use applicable benchmarks/metrics to conduct research and statistical analyses related to Human Resource Management.

Unit 1:

HR Analytics in Perspective: Role of Analytics, Defining HR Analytics, HR Analytics: The Third Wave for HR value creation, HR Measurement journey in tune with HR maturity journey Understanding the organizational system (Lean) , Locating the HR challenge in the system , Valuing HR Analytics in the organizational system, Typical problems (working session)

Unit 2:

HRA Frameworks: Current approaches to measuring HR and reporting value from HR contributions, Strategic HR Metrics versus Benchmarking, HR Scorecards & Workforce Scorecards and how they are different from HR Analytics, HR Maturity Framework: From level 1 to level 5, HR Analytics Frameworks: (a) LAMP framework; (b) HCM:21 Framework and (c) Talentship Framework, 5 overarching components of an effective Analytics framework.

Unit 3:

Basics of HR Analytics: Basics of HR Analytics, what is Analytics, Evolution, Analytical capabilities, Analytic value chain, Analytical Model, Typical application of HR analytics.

Predictive Analytics: Steps involved in predictive analytics: Determine key performance indicator, analyse and report data, interpreting the results and predicting the future. Metrics and Regression analysis and Causation.

Unit 4:

Insight into Data Driven HRA: Typical data sources, Typical questions faced (survey), Typical data issues, Connecting HR Analytics to business benefit (case studies), Techniques for establishing questions, Building support and interest, Obtaining data, Cleaning data (exercise), Supplementing data.

Unit 5:

HR Matrics – Defining metrics, Demographics, data sources and requirements, Types of data, tying data sets together, Difficulties in obtaining data, ethics of measurement and evaluation. Human capital analytics continuum.

HR Dashboards

Statistical software used for HR analytics: MS-Excel, IBM- SPSS, IBM-AMOS, SAS, and R programming and data visualisation tools such as Tableau, Ploty, Click view and Fusion Charts.

Unit 6:

HR Scorecard

Assessing HR Program, engagement and Turnover, Finding money in Analytics, Linking HR Data to operational performance, HR Data and stock performance. Creating HR Scorecard, develop an HR measurement system, guidelines for implementing a HR Scorecard.

PRACTICAL COMPONENT:

- To solve case studies on Workplace EthicsDiscussion on "How to have/ evaluate the performance of the MBA students"
- To visit organizations and find out the problems and causes for unethical behavior at Workplace.
- Identify the important HR metrics used in manufacturing companies.
- Ask students to collect manpower data of your institute and prepare HR Dashboards.
- Collect the payroll detail from IT Company and use module 6 contents.

COURSE OUTCOMES:

The students will be able to.

1. Have an understanding of How HR function adds value and demonstrates the value in business terms
2. Measure the value of Intangibles that HR helps builds for the organization given a particular business context to facilitate decision making.
3. Convert soft factors in a people management context into measurable variables across various domains.

4. Devise, conduct and analyse a study on employees or any other related to the HR context in an organization.

RECOMMENDED BOOKS:

- Moore, McCabe, Duckworth, and Alwan. The Practice of Business Statistics: Using Data for Decisions, Second Edition, New York: W.H.Freeman, 2008.
- Predictive analytics for Human Resources, Jac Fitz- enz, John R. Mattox, II, Wiley, 2014.
- Human Capital Analytics: Gene Pease Boyce Byerly, Jac Fitz-enz, Wiley,2013.

REFERENCE BOOKS:

- The HR Scorecard: Linking People, Strategy, and Performance, by Brian E. Becker, Mark A. Huselid, Mark A Huselid, David Ulrich, 2001.
- HR Analytics: The What, Why and How, by Tracey Smith
- The New HR Analytics: Predicting the Economic Value of Your Company's Human By Jac FITZ-ENZ, 2010.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X				
CO3		X			X
CO4		X		X	

COMPENSATION & REWARD SYSTEM

Semester	III	CIE Marks	: 40
Course Code	18MBAHR303	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives

1. To know the theoretical and practical developments in the area of compensation and benefits.
2. To discuss the strategic importance of compensation for the achievement of organizational goals.
3. To understand the relationship between compensation objectives and business strategy.
4. To discuss the role of compensation in attracting, motivating, and retaining a high-quality workforce.

Unit 1:

Introduction to Compensation: Definition of Compensation, Basic concepts of Compensation. (wages, salary, benefits, DA, consolidated pay, Equity based programs, commission, reward, remuneration, bonus etc.,), Types of Compensation Management - The Pay Model, Strategic Pay Policies, Strategic Perspectives of Pay, Strategic Pay Decisions, Best Practices vs. Best Fit Options.

Unit 2:

Internal Alignment: Definition of Internal Alignment, Internal Pay Structures, Strategic Choices in Internal Alignment Design, Internal Structure.

Unit 3:

Job Evaluation: Definition of Job Evaluation, Major Decisions in Job Evaluation, Job Evaluation Methods, Final Result - Pay Structure - various methods of calculation of compensation: Straight Halsey Premium Bonus Plan, Halsey Weir Premium Plan, Rowan Premium Bonus Plan, Emerson Efficiency Plan, Bedeaux Point Method. Based on productivity: Taylor Differential Piece Rate Method, Merrick's Multiple Piece Rate Plan, Gantts Task & Bonus Wage Plans.

Unit 4:

Determining External Competitiveness and Benefits Management: Competitiveness: Definition of Competitiveness, Pay Policy Alternatives, Wage Surveys, Interpreting Survey Results, Pay Policy Line, Pay Grades

Benefits: Benefits Determination Process, Value of Benefits, Legally Required Benefits, Retirement, Medical, & Other Benefits.

Unit 5:

Performance Based Compensation System: Employee Contributions: Pay For Performance (PFP): Rewarding Desired Behaviors, Designing PFP Plans, Merit Pay/Variable Pay, Compensation of Special Groups, Compensation Strategies for Special Groups.

Incentives: Positive & negative incentives, Types of individual incentives: incentive plans for blue collar workers: individual incentive plans: based on time & based on productivity. Group incentive plans: Pristman's plan, scanlan plan, profit sharing, co-partnership, cafeteria compensation plan, ESOP. incentive plans for white collar worker: straight salary, straight commission, combination plans.

Unit 6:

Legal & Administrative Issues in Compensation Global Compensation: Legal Issues, Pay Discrimination, Comparable Worth, Budgets and Administration: Recognizing Variations, Social Contract, Culture & Pay, Strategic Choices in Global Compensation, Comparing Systems, Expatriate Pay.

PRACTICAL COMPONENT:

- Students must prepare a comprehensive compensation plan to be offered to a Sales Executive, A General Manager and The CEO of an organization.
- Students must compare and analyze compensation practices in different countries.
- Students to collect information from an IT organization regarding the Cost To Company of an employee.
- Students have to prepare questionnaire for conducting wage survey and carry out wage survey for any selected sector and prepare a report for the same.
- Students to calculate the bonus amount eligible to an employee working as a HR Executive for the past 10 years in manufacturing organization.

COURSE OUTCOMES:

The students will be able to.

1. Gain insights of various conceptual aspects of Compensation and Benefits to achieve organizational goals.
2. Determine the performance based compensation system for business excellence and solve various cases.

3. Designing the compensation strategies for attraction, motivation and retaining high quality workforce.
4. Understand the Legal & Administrative Issues in global compensation to prepare compensation plan, CTC, wage survey and calculate various bonus.

RECOMMENDED BOOKS:

- Compensation & Reward Management, BD Singh, 2ndedition, Excel books, 2012.
- Compensation, Milkovich& Newman, 9th edition, 2017, Irwin/McGraw-Hill.
- Compensation and Benefit Design, Bashker D. Biswas, FT Press, 2012.
- An Introduction to Executive Compensation, Steven Balsam, Academic Press, 2002.

REFERENCE BOOKS:

- Strategic Compensation, Joseph J. Martocchio, 3rd Edition, Prentice Hall, 2004.
- Compensation Management in Knowledge based world, Richard I. Anderson, 10th edition, Pearson Education.
- Compensation Management, ErSoniShyam Singh, Excel Books.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				X
CO2		X	X		
CO3		X			
CO4				X	X

LEARNING AND DEVELOPMENT

Semester	III	CIE Marks	: 40
Course Code	18MBAHR304	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To enable students to be aware of the field of learning and development and its role in optimizing performance.
2. To make students understand the process of analyzing training needs and evaluating training programs.
3. To provide the students an overview of the various Training and Management Development Method.

Unit 1:

Introduction to Employee learning and Development, learning, Meaning and significance, The Forces Influencing Working and Learning, classification of learning capabilities, learning theories- Reinforcement Theory, Social Learning Theory, Goal Theories, Expectancy Theory, Adult Learning Theory, pedagogy and andragogy; The basic principles of learning, The Learning Process , Mental and Physical Processes, The Learning Cycle, Instructional Emphasis for Learning Outcomes.

Unit 2:

Training and Learning: Introduction, Relationship, meaning, Designing Effective Training, Forces influencing working & learning, Strategic Training, Work Environment, Characteristics influencing transfer of training, organizational environments encouraging transfer.

Unit 3:

Training Needs Analysis: Meaning and significance of training needs, types of needs, components of needs, data collection, analysis and interpretation. Meaning and significance of training design and development, principles of training design, design process, identifying the training objectives, determining structure, content, duration, method, learning activities

Unit 4:

Training implementation & Methods: Meaning and significance of implementation, making or buying decision, implementation process for making and buying decisions, skills of effective trainer.

Training Methods: Presentation Methods, Hands-on Methods, Group Building Methods. Choosing Training methods. E-Learning & Use of Technology in Training: Technology's Influence on Training, Technology & Multimedia, Computer-Based Training, Developing Effective Online Learning, Blended Learning, Simulations, Mobile Technology & Training Methods, Intelligent Tutoring Systems, Distance Learning, Technologies for Training Support, Technologies for Training Administration, Learning Management Systems (LMSs), Systems for Training Delivery, Support & Administration, Choosing New Technology Training Methods.

Outward bound methods: Meaning and significance of outward bound learning (OBL) methods, process of OBL, risk, safety and ethical issues. Training aids.

Unit 5:

Training Evaluation: Meaning, Reasons for Evaluating Training and significance of training evaluation, Donald Kirk patrick's Evaluation Model, Return on investment in Training, Types of Evaluation Designs, Considerations in Choosing an Evaluation Design, data collection for training evaluation, Threats to Validity, Determining Costs, Evaluation Practices in different organizations, Measuring Human Capital and Training Activity.

Unit 6:

Executive Development/ Management Development/ Career Management.

Need, factors affecting MDP, methods, process, administration, delivery, costing & pricing, Company Strategies for Providing Development, Increased Use of New Technologies for Learning, Increased Demand for Learning for Virtual Work Arrangements, Increased Use of Training Partnerships & Outsourcing Training.

Careers and Career Management: Introduction, Importance. Career: meaning, A Model of Career Development (Career Stages), Career Management Systems.

PRACTICAL COMPONENTS:

- Study training programs and processes in different organizations and analyze their effectiveness.
- Students to design a training program for a specific job role.
- Students are expected to conduct a mock training session including need identification and a set of students to evaluate the effectiveness of the same.
- Give a training needs analysis case and ask the students to find out the training needs.
- Implement various training methods, observe and submit a report on its effectiveness.

COURSE OUTCOMES:

1. Understand the concepts of learning and development and its role .
2. Learn various contemporary methods of learning and development.
3. Gain insights of various training evaluation methods and career planning.
4. Develop students with career management systems.

RECOMMENDED BOOKS:

- Effective Training, P Nick and Blanchard, 2nd Edition, Pearson Education/PHI, 2005.
- Training & Development, Dr. B. Janakiraman, Biztantra/Wiley Dreamtech, 2005.
- Employee Training & Development, Noe A Raymond, 2nd edition, McGraw Hill Publication, 2011, ISBN: 0072436611, 9780072436617.
- Management Training and Development, Gupta B.L, 1st Edition, Vrinda Publications, 2011.
- Training and Development Methods, Dr. Rishipal, 1st Edition, S. Chand, 2011.
- Personal Growth and Training & Development, Ruchi Srivastava, 1st Edition, Vrinda Publications, 2011.

REFERENCE BOOKS:

- Training for development– Rolf Lynton &UdaiPareek, Sage Publications, 2011.
- Effective HR Training Development Strategy – Ratan Reddy, HPH, 2005.
- Training in organizations - Goldstein, 4th Edition, Cengage learning.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3					X
CO4			X	X	

INDUSTRIAL RELATIONS AND LEGISLATIONS

Semester	III	CIE Marks	: 40
Course Code	18MBAHR305	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To enable students to understand and apply the principles of IR and develop an awareness of the significance of industrial peace.
2. To provide a conceptual basis of Industrial Relations.
3. To give an understanding of the components and meaning of sustaining Industrial peace anchored on harmonious Employee-Management relations.
4. To discuss the various Industrial acts.

PART A: INDUSTRIAL RELATIONS

Unit 1:

Introduction: Background of Industrial Relations - Definition, scope, objectives, factors affecting IR, participants of IR, importance of IR. Approaches to Industrial relations, system of IR in India - Historical perspective & post-independence period, Code of Discipline and historical initiatives for harmonious IR, Government policies relating to labor, ILO and its influence on Legal enactments in India.

Unit 2:

Collective Bargaining & Negotiation: Collective Bargaining: Definition, Meaning, Nature, essential conditions for the success of collective bargaining, functions of collective bargaining, importance of Collective Bargaining, collective bargaining process, prerequisites for collective bargaining, implementation and administration of agreements. Negotiations - Types of Negotiations Problem solving attitude, Techniques of negotiation, negotiation process, essential skills for negotiation, Workers Participation in Management.

Unit 3:

Trade Union: Meaning, trade union movement in India, Objective, role and functions of the Trade Unions in Modern Industrial Society of India, Procedure for registration of Trade Unions, Grounds for the withdrawal and cancellation of registration, union structure, Rights and responsibilities of TUs, Problems of trade unions, Employee relations in IT sector.

Unit 4:

Grievance procedure and Discipline management: Grievance - Meaning and forms, sources of grievance, approaches to grievance machinery, Grievance procedures, model grievance procedure. Disciplinary procedures, approaches to manage discipline in Industry, Principles of Hot stove rule.

PRACTICAL COMPONENT:

- Identify different sectors of industries like manufacturing, service, hospitality, health, etc and find out how grievances are redressed and disciplinary procedures are practiced.
- Solve case study of Maruthi Manesar Plant GM (HR) burned to death, 91 workers arrested; Government says business confidence intact. July 19th 2012 incident.
- Students must prepare a comprehensive report of various collective bargaining and negotiations of industries in around the city/local/state/nation/global
- Student must have a debate: trade union is a boon or bane/ trade union issues and challenges/ metamorphosis of trade union

RECOMMENDED BOOKS:

- Employee Relations Management, P N Singh, Singh P. N., - Pearson Publications, 2011.
- Dynamics of Industrial Relations, Mamoria & Mamoria, Himalaya Publications, 2012.
- Human Resource Management Principles & Practice, Aquinas, Vikas Publication.

REFERENCE BOOKS:

- Industrial Relations, Trade Unions &Labour Legislation, P R N Sinha et al, Pearson Education, 2004.
- Industrial Relations and labor laws, Arun Monappa, Ranjeet Nambudiri, Patturaju Selvaraj, TMH, 1997.
- Industrial relations, trade unions and labor legislations, P R N Sinha, InduBala Sinha, Seema Priyadarshini Shekar, Pearson Education, 2013, ISBN: 9788131731642.

PART B:

Unit 5:

INDUSTRIAL LEGISLATIONS

Only basic objectives and major provisions of the following legislations:
Factories Act 1948.
Industrial Employment (Standing orders) Act, 1946.
Employees' State Insurance (ESI) Act, 1948.
Maternity Benefit Act, 1961.
Contract Labour Act.
Shops and Establishments Act.
Child Labour (Prohibition & Regulation) Act, 1986.
Industrial Disputes Act of 1947.

Unit 6:

Minimum Wages Act, 1948.
Payment of Wages Act, 1936.
Payment of Gratuity Act 1972.
Employees' Provident Fund and Miscellaneous Provisions Act 1952.;
Payment of Bonus Act, 1965.
Employees Compensation Act in 2013.

PRACTICAL COMPONENT:

- Students to calculate the bonus amount, gratuity amount, employee compensation eligible to an employee working as a HR Executive for the past 10 years in an automobile manufacturing organization.
- Students must compare Factories Act with Karnataka, Kerala, Tamil Nadu, Maharastra etc or any other Sate.
- Students to prepare synopsis of legal cases pending before different courts: subject matter of disputes, case number, court where pending, misconduct, status, claim, department handling, hearing dates etc.

COURSE OUTCOMES:

The students should be able to:

1. Gain the insights of IR concepts and practices to design programs for better industrial relations and peace.
2. Develop the knowledge related to employee-management relations and demonstrate it in solving human resource issues.
3. Enhance necessary critical thinking skills in order to evaluate different labour laws for harmonious employee – management relations.
4. Implementation of various industrial acts to an industry working.

RECOMMENDED BOOKS:

- Labor Laws for Managers, BD Singh, Excel Books, 2009
- Industrial Relations and Labor laws, SC Srivatava, 5th Edition, Vikas Publications.
- Elements of Mercantile Law - N. D Kapoor, Sultan Chand, 2004.

REFERENCE BOOKS:

- Industrial Relations, Trade Unions & Labour Legislation, P R N Sinha et al, Pearson Education, 2004.
- Industrial Relations and labor laws, ArunMonappa, Ranjeet Nambudiri, Patturaju Selvaraj, TMH, 1997.
- Fundamentals of Industrial Relations, Shyam Boregowda Ramu, N K Ramachandra Gowda, Y T Krishne Gowda, New Age International Publications, edition 2018, 2019.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X		X	
CO3	X		X		
CO4					X

CONFLICT & NEGOTIATION MANAGEMENT

Semester	III	CIE Marks	: 40
Course Code	18MBAHR306	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-2	Exam Hours	: 03
	Credits : 04		

Course Objectives:

1. To understand the nature of various dimensions of conflict.
2. To learn various strategies and techniques to manage conflicts.
3. To understand the importance and role of negotiation in conflict resolution.
4. To understand the importance of cross-cultural and gender dimensions of negotiation.

Unit 1:

Introduction: Understanding conflict, components, perspectives of conflict, types of conf conflict, models of conflict – Process and Structural Models, functional & dysfunctional conflict, relationship between conflict and performance in team, levels of conflict – intrapersonal, interpersonal, group & organizational conflicts, sources of conflict - intrapersonal, interpersonal, group & organizational sources.

Unit 2:

Conflict Management Design: Nature of conflict Management, contingency approach, conflict management process, the conflict domain, conflict trends, conflict distribution, conflict mapping and tracking.

Unit 3:

Managing Conflict: Managing interpersonal conflict: Thomas conflict resolution approach, behavioral style and conflict handling, the Cosier Schank model of conflict resolution, collaboration & conflict resolution, dealing with difficult subordinates, boss & colleagues, 1 to 1 dispute resolution.

Managing team & organization conflict: techniques to resolve team conflict, strategies to resolve organizational conflict, effective listening and dialogue skills, humor and conflict resolution, negotiation as a tool for conflict resolution.

Unit 4:

Conflict resolution and Cost: Conflict resolution models, framework model, classical ideas, new developments in conflict resolution.

Environmental conflict resolution, gender and conflict resolution. Assessing the cost of workplace conflict.

Unit 5:

Negotiations/ Negotiation strategies -Types of Negotiations, negotiation process, factors for successful negotiations, essential skills for negotiation, tricks used in negotiation process, psychological advantage of negotiations, Techniques of negotiation, issues in negotiations.

Negotiation strategies: Strategy and tactics for distributive bargaining, strategy and tactics for integrative negotiation, negotiation strategy and planning. Finding and using negotiation power, sources of power, Ethics in negotiation.

Unit 6:

Managing difficult negotiations: Third party approaches: Third party interventions, formal intervention methods – Arbitration, Mediation and Process Consultation, Informal intervention methods, best practices in negotiation.

PRACTICAL COMPONENTS

- Survey the conflict resolution techniques adopted by individuals based on individual personality types.
- Dividing students into groups and give a scenario to negotiate and reach conclusion.
- Reading: 8 Habits of Highly Effective People; apply the concepts to understand how people approach negotiation through different mind – sets.
- Conduct Role Plays for different scenarios.
- Solve various case studies dealing with conflict between teams and organizations.
- Ask students to identify three unconscious factors that may affect their negotiation effectiveness and ask them to explain why or how that phenomenon may occur.
- Management games like two dollar game, cross the line games can be played in the class to develop negotiation skills among the students.

COURSE OUTCOMES:

1. Understand the concepts of conflict and negotiation and its role .
2. Learn various contemporary methods of conflict and negotiation.
3. Gain insights of various conflict handling mechanisms.
4. Demonstrate the cross-cultural and gender dimensions of negotiation.

RECOMMENDED BOOKS:

- Corporate Conflict Management - Concepts and Skills, Eirene Leela Rout, Nelson Omiko, Prentice India, 2007.
- Negotiations, Roy J. Lewicki, David M. Saunders, Bruce Barry, 5/e, Mc Graw Hill, 2005, ISBN: 9780072973075.
- Contemporary Conflict Resolution, Oliver Ramsbotham, Hugh Miall, Tom Woodhouse, 3rd edition, Polity publishers, ISBN 0745649734, 9780745649733, 2011.

REFERENCE BOOKS:

- Managing conflict and negotiation, B.D. Singh, 1st edition, Excel books, 2008.
- Conflict Management: Practical guide to develop negotiation strategies, Barbara A Budjac Corvette, Pearson Prentice Hall, 2006, ISBN: 8174466428, 9788174466426
- Managing Conflict in Organizations, M. Afzalur Rahim, 4th Edition, Transaction Publishers, 2011, ISBN 1412844258, 9781412844253.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X		X	
CO3	X		X		
CO4					X

GUIDELINES FOR ORGANISATION STUDY

Semester	III	CIE Marks	: 40
Course Code	18MBAOS307	SEE Marks	: 60
Teaching Hours / week (L:T:P)	0-0-8		
	Credits : 04		

OBJECTIVE

To expose the students to understand the working culture of the organization and apply theoretical concepts in real life situation at the work place for various functions of the organization.

STRUCTURE

The Organisation study shall consist of Study of an organization for 4 credits for 4 weeks.

GENERAL GUIDELINES

- The Organisation study shall be for a period of 4 weeks immediately after the completion of 2nd Semester Examinations but before the commencement of the 3rd semester classes
- The Subject code of the Organisation study shall be 18MBAOS 307 and shall be compulsory for all the students.
- No two students of an institute shall work on the same organization.
- The student shall seek the guidance of the internal guide on a continuous basis, and the guide shall give a certificate to the effect that the candidate has worked satisfactorily under his/her guidance. Student need to identify an external guide (Working in the organization) and seek guidance from him/her.

Submission of Report: Students shall submit one hard copy of the report to the college with hard bound color of royal blue and a soft copy in PDF file (Un-editable Format)

Evaluation: Internal evaluation will be done by the internal guide.

Viva-Voce / Presentation: A viva-voce examination shall be conducted at the respective institution where a student is expected to give a presentation of his/ her work. The viva –voce examination will be conducted by the respective HOD or Senior Professor or internal Guide of the department and an external evaluator drawn from industry. In case of non availability of industry professional, a senior professor or a faculty with more than 10 years of experience may be invited to conduct the viva-voce examination. Organisation study carries 100 marks consisting of 40 marks for Organisation study report (evaluated by internal guide) and 60 marks for

viva-voce examination. Minimum passing marks of the Organization study is 50% in each of the components such as Internal Marks, report evaluation and viva-voce examination.

Contents of the Organisation study Report

- Cover page
- Certificate from the Organization (scanned copy)
- Certificate from the guide, HOD and Head of the Institution (scanned copy) indicating bonafide performance of Organisation study by the student.
- Declaration by the student (scanned copy)
- Acknowledgement
- Table of contents
- List of tables and graphs

Executive summary

Chapter 1: Introduction about the Organisation & Industry.

Chapter 2: Organization Profile

i. Back ground,
ii. Nature of business,
iii. Vision mission, quality policy
iv. Workflow model
v. Product/service profile
vi. Ownership pattern
vii. Achievements/awards if any
viii. Future growth and prospects

Chapter 3: Mckensy's 7S framework and Porter's Five Force Model with special reference to Organization under study.

Chapter 4: SWOT Analysis

Chapter 5: Analysis of financial statements

Chapter 6: Learning experience.

Bibliography

Annexure relevant to the Organization study such as figures, graphs, photographs, Financial statements etc.,

Format of the Organization study : Report shall be prepared using the word processor viz., MS Word, Times New Roman font sized 12, on a page layout of A4 size with 1" margin all sides (1.5" on left side due to binding) and 1.5line spacing. The Organization study report shall not exceed 60 pages.

Marks Sheet format for Viva Voce Examination (SEE) Course code and Course: 18MBAOS307 Organisation study										
Sl No	USN	Aspects								Total
1		1^A	2^A	3^A	4^A	5^A	6^A	7^A	8^A	
2										
3										
4										
5										
6										
7										
8										
9										
10										

Note:

Column marked with	Aspects	Maximum Marks
1^A	Communication skill	5
2^A	Understanding the Industry	5
3^A	Understanding the Corporate Functions/Company profile	10
4^A	Mckensy's 7S framework and Porter's Five Force Model	10
5^A	SWOT analysis justification	10
6^A	Financial statement analysis	10
7^A	Learning experience	5
8^A	Overall presentation	5
	Total	60

Signature of Internal Examiner Signature of External Examiner

Name and Designation with affiliation Name and Designation with affiliation

SEMESTER IV
(MARKETING SPECIALISATION)
SALES MANAGEMENT

Semester	IV	CIE Marks	: 40
Course Code	18MBAMM401	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To provide an understanding of the concepts, techniques and approaches in Sales Management.
2. To emphasize on the Sales Manager's problems and dilemmas.
3. To develop skills for generating, evaluating and selecting sales strategies.

Unit 1:

Introduction to sales management: Meaning, Evaluation, Importance, Personal Selling, Emerging Trends in Sales Management, elementary study of sales organizations, qualities and responsibilities of sales manager. Types of sales organizations.

Unit 2:

Selling skills & selling strategies: Selling and buying Styles, selling skills, situations, selling process, sales presentation, Handling customer objections, Follow-u action.

Unit 3:

Management of Sales Territory & Sales Quota: Sales territory, meaning, size, designing, sales quota, procedure for sales quota. Types of sales quota, Methods of setting quota. Recruitment and selection of sales force, Training of sales force.

Unit 4:

Sales force motivation and compensation: Nature of motivation, Importance, Process and factors in the motivation, Compensation-Meaning, Types of compensation plans and evaluation of sales force by performance and appraisal process. Sales management job: Standard sales management process-international sales management -international market selection market survey approach or strategy.

Unit 5:

Sales Manager and Sales Person: Role of sales manager and sales people;

functions of sales manager, functions of sales person, types and characteristics of sales manager and sales people-Time management for sales manager and sales person.

Unit 6:

Selling on the internet: Selling agents for internet trading-net selling, advertising in net trading, payment system in internet trading-smart card, credit card, debit card- payment by card: advantages and disadvantages; How to make internet selling safe-Digital signature, biometric method and legal or regulatory environment; Growth of internet trading in India.

PRACTICAL COMPONENT:

- Interview a salesperson and write a brief report about what they like and dislike about their jobs, their salary, travelling allowances, sales quotas, why chose sales career, and what does it take to succeed in this profession.
- Ask your friends if they would buy certain goods like groceries, vegetables, socks, mobile, pens etc from the roadside vendor as against a regular shop. Group the products into low risk and high risk ones. Does this buying behaviour also depend on the personality of the individual doing the buying? Or the one doing the selling?
- Students can make a presentation on any product or the services of student choice, covering selling strategies and one day work exposure towards merchandising in any big retail outlets of respective places where the institute if operating. Rural colleges can send the students to the city nearby to observe the merchandising planning in retail outlets and to make a small report.
- Roles and functions of sales manager and sales people are different in every organization Sales people view the roles of sales managers in their own way and vice versa. You are the sales manager of a company. You make an analysis of what you feel should be roles of a sales manager and a salesperson for maximizing sales of the organization.
- Your company is active in internet trading. A current issue in internet trading is : how to make internet selling safe. Different methods have been suggested for safety or security of internet trading. You have to analyze different methods and recommend a method for your company.

COURSE OUTCOMES:

Student should be able to

1. Understand the apply the selling techniques in an organisation.
2. Develop a plan for organising, staffing & training sales force.
3. Organise sales territories to maximize selling effectiveness.
4. Evaluate sales management strategies.

RECOMMENDED BOOKS:

- Sales Management by Charles, Futrell, 6/e, Thomson South Western, 2003.
- Sales & Distribution Management, Tapan K. Panda & Sunil Sahadev, 6/e, OxfordUniversity Press.
- Managing of Sales Force by Spiro Stanton Rich, 11/e, TMH, 2003.

REFERENCE BOOKS:

- Sales & Retail Management, an Indian perspective by Dr.S.L Gupta, 1/e, Excel Books,2007.
- Salesmanship and Sales Management-P.K Sahu & K C Raut, 3/e, Vikas PublishingHouse3.
- Sales Management-Douglas J Dalrymple, William L Crowe-John Wiley & Co.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			X
CO3			X		
CO4		X			

INTEGRATED MARKETING COMMUNICATION

Semester	IV	CIE Marks	: 40
Course Code	18MBAMM402	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To build a comprehensive framework for integrated marketing communications.
2. To the study the advertising, publicity, personal selling, direct marketing and sales promotion.
3. To enhance knowledge of emerging trends in integrated marketing communications.

Unit 1:

Role of IMC in marketing process, IMC planning model, Marketing and promotion processmodel. Communication process, steps involved in developing IMC programme, Effectiveness ofmarketing communications Purpose, Role, Functions, Types, Advertising Vs Marketing mix,Advertising appeal in various stages of PLC.

Unit 2:

Advertising Agency: Type of agencies, Services offered by various agencies, Criteria for selecting the agencies and evaluation. Advertising objectives and Budgeting: Goal setting – DAGMAR approach, various budgeting methods used.

Unit 3:

Media planning: Developing Media plan, Problems encountered, Media Evaluation Print, Broadcast media, Support media in advertising. Media strategy: Creativity, Elements of creative strategies and its implementation, Importance of Headline and body copy.

Unit 4:

Direct Marketing: Features, Functions, Growth, Advantages/ Disadvantages, And Direct Marketing Strategies. Promotion: Meaning, Importance, tools used, Conventional/unconventional, drawbacks, pushpull strategies, Co-operative advertising, Integration with advertising and publicity Public relation/ Publicity:- Meaning, Objectives, tools of public relations, Public relationstrategies, Goals of publicity, Corporate Advertising – Role, Types, Limitations, PR Vs Publicity.

Unit 5:

Monitoring, Evaluation and control: Measurement in advertising, various methods used for evaluation, Pre-testing, Post testing.

Unit 6:

International Advertising: Global environment in advertising, Decision areas in international advertising Internet advertising: Meaning, Components, Advantages and Limitations, Types of Internet advertising Industrial advertising: B 2 B Communication, Special issues in Industrial selling.

PRACTICAL COMPONENTS:

- Study the IMC programs adopted by various colleges to students applying for an MBA course? Is the tactic adopted by your college right? If no, what are your suggestions?
- Study the role of newspapers, radio, television, billboards, internet and other media in the marketing of mobiles. cold drinks, jeans, mobiles etc.
- Observe a marriage in your family and write about how you would 'event manage' it?
- Take an advertisement introducing a new product like soap, biscuit etc and find the media in which it was advertised. Ask your friends if they can recall this advertisement and the message. Analyse if they would or would not buy the product on the basis of this advertisement? And why?
- Students can do a survey on effective media communications.

COURSE OUTCOMES:

Student should be able to

1. Define and apply knowledge of various aspects of managerial decision making related to marketing communications strategy and tactics.
2. Ability to create an integrated marketing communications plan which includes promotional strategies.
3. Explain the role of IMC in the overall marketing &Use effectiveness measures to evaluate IMC strategies.
4. Prepare advertising copy and design other basic IMC tools.

RECOMMENDED BOOKS:

- Advertising and Promotions IMC Perspectives: Belch and Belch, 9/e, Tata McGraw Hill,2012.
- Advertising & Integrated Brand Promotion - O'Guinn, Allen, Semenik, Cenage Learning.

REFERENCE BOOKS:

- Integrated Advertising, Promotion, and Marketing Communications, Clow, Baack, 3/e,Pearson Education, 2007.
- Advertising an IMC perspective, S.N.Murthy & U Bhojanna, Excel Books.
- Integrated Marketing Communications – Niraj Kumar, HPH.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2			X		X
CO3		X			X
CO4	X				

DIGITAL & SOCIAL MEDIA MARKETING

Semester	IV	CIE Marks	: 40
Course Code	18MBAMM403	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To understand the important concepts related to e-marketing
2. To learn the use of different electronic media for designing marketing activities.
3. To acquaint the students with the latest techniques of e-marketing.

Unit 1:

Introduction to digital marketing: Online marketplace analysis: micro-environment, The Internet macro-environment. E-Marketing Plan: Overview of the E-Marketing Planning Process – Creating an E Marketing Plan– A Seven-Step E-Marketing Plan The E-Marketing Environment: Overview of Global E-Marketing Issues – Country and Market Opportunity Analysis – Technological Readiness Influences Marketing – Wireless Internet Access – The Digital Divide Ethical and Legal Issues – Privacy – Digital Property – Online Expression – Cyber Security –Cyber Crime.

Unit 2 :

E-Marketing Research: Data Drive Strategy – Marketing Knowledge Management –Monitoring Social Media – Technology-Enabled Approaches – Real-Space Approaches –Marketing Databases and Data Warehouses – Data Analysis and Distribution – Knowledge Management Metrics - Consumer Behaviour Online – Segmentation – Targeting –Differentiation – Positioning Strategies. Data Analytics: Introduction, Key terms and concepts. Working with data. Setting objectives, goals and KPIs. Tracking and collecting data. Analysing data. Advantages and challenges.

Unit 3 :

E-Marketing Management: Product – Products on Internet – Creating Customer Value Online– Product Benefits – E-Marketing Enhanced Product Development – Price – Change in Pricing Strategies – Buyer and Seller Perspectives – Payment Options – Pricing Strategies – Distribution– Online Channel Intermediaries – Distribution Channel Length and Functions – Channel Management and Power – Distribution Channel Metrics.

Unit 4:

Search Engine Optimisation (SEO) Introduction, Understanding SEO. Search engine friendly website structure. SEO and key phrases. Link popularity. User insights. Benefits and challenges.Content Marketing: Introduction, Key terms and concepts, meaning, Strategic building blocks. Content creation. Advantages and challenges.

Search Advertising: Introduction, Key terms and concepts. Advertising in search. The elements of a search ad. Targeting options. Bidding and ranking for search ads. Tracking. Advantages and challenges.

Online Advertising: Introduction, Key terms and concepts. Types of display adverts. Payment models for display Advertising. Getting your ads online. Targeting and optimising. Step-by-step guide to online Advertising. Advantages and challenges.

Affiliate Marketing: Introduction, Key terms and concepts. The building blocks of affiliate marketing. Setting up a campaign. Advantages and challenges.

Unit 5:

Customer Acquisition and Retention: Profile of Consumers – Browsing Behaviour Model – Elements of Social Media – Social Media Strategies – Social Media Performance Metrics – Building Customer Relationships – Relationship Marketing – Stakeholders – Three Pillars of Relationship Marketing – Customer Relationship Management (CRM) – CRM Building Blocks – Ten rules for CRM Success.

Unit 6:

Social Media Channels: Introduction, Key terms and concepts, Traditional media vs Social media. Social media channels: Social networking. Content creation, Bookmarking & aggregating and Location & social media. Tracking social media campaigns.Social media marketing: Rules of engagement. Advantages and challenges.

Social Media Strategy: Introduction, Key terms and concepts. Using social media to solve business challenges. Step-by-step guide to creating a social media strategy. Documents and processes. Dealing with opportunities and threats. Step-by-step guide for recovering from an online brand attack. Social media risks and challenges.

COURSE OUTCOMES:

Student should be able to

1. Recognize appropriate e-marketing objectives.
2. Appreciate the e-commerce framework and technology.
3. Illustrate the use of search engine marketing, online advertising and marketing strategies.
4. Use social media & create temples.
5. Develop social media strategy's to solve business problems.

RECOMMENDED BOOKS:

- Digital Marketing: Strategy, Implementation and Practice, Chaffey D., Ellis-Chadwick, 5th Edition, F., Pearson, 2012.
- https://www.redandyellow.co.za/content/uploads/woocommerce_uploads/2017/10/emarketing_textbook_download.pdf.
- E-Marketing, Judy Strauss and Raymond Frost, Prentice Hall, 6th Edition, 2013
- Internet Marketing: Integrating Online and Offline Strategies. M. L. Roberts and Debra Zahay, 3rd edition, Cengage Publishing, 2013

REFERENCE BOOKS:

- The Essential Guide to Online Marketing, Rob Strokes, Quirk, ISBN: 9781936126323
- E-Commerce: An Indian Perspective, P. T. Joseph, Prentice Hall, 4th Edition, 2013
- Electronic Commerce: A Simplified Approach, Munesh Chandra Trivedi, Jaico Publishing House, 2011.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2			X		X
CO3		X		X	
CO4				X	X
CO5			X		

STRATEGIC BRAND MANAGEMENT

Semester	IV	CIE Marks	: 40
Course Code	18MBAMM404	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To appreciate the relationship between corporate strategy and Brand Management.
2. To explore the various issues related to Brand Management, brand association, brand identity, brand architecture, leveraging brand assets, brand portfolio management.
3. To develop familiarity and competence with the strategies and tactics involved in building, leveraging and defending strong brands in different sectors.

Unit 1:

Introduction to the concept of Brand Management: Brand –Meaning, Definition, Evolution of Brands, Functions of Brand to consumer, Role of Brand- Advantages of Brand, Product Vs Brand, Branding- Meaning, Creation of Brands through goods, services, people, Organisation, Retail stores, places, online, entertainment, ideas, challenges to Brand builders Brand Management-Meaning & Definition. Strategic Brand Management Process-Meaning, Steps in Brand Management Process Strong Indian Brands.

Unit 2:

Customer Based Brand Equity: Customer Based Brand Equity-Meaning, Model of CBBE Brand Equity: Meaning, Sources, Steps in Building Brands, Brand building blocks Resonance, Judgments, Feelings, performance, imagery, salience-Brand Building Implications, David Aaker's Brand Equity Mo del. Brand Identity & Positioning: Meaning of Brand identity, Need for Identity & Positioning, Dimensions of brand identity, Brand identity prism, Brand positioning – Meaning, Point of parity & Point of difference, positioning guidelines Brand Value: Definition, Core Brand values, Brand mantras, Internal branding,

Unit 3:

Choosing Brand Elements to Build Brand Equity: Criteria for choosing brand elements, options & tactics for brand elements-Brand name, Naming guidelines, Naming procedure, Awareness, Brand Associations, Logos & Symbols & their benefits, Characters & Benefits, Slogans & Benefits, Packaging. Leveraging Brand Knowledge: Meaning of Brand Knowledge, Dimensions of Brand Knowledge, Meaning of Leveraging Secondary Brand Knowledge & Conceptualizing the leverage process.

Unit 4:

Brand Value chain- Designing Brand Tracking studies, Establishing brand Equity Management Systems. 58 Methods for measuring Brand Equity- Quantitative Techniques & Quantitative Techniques, Comparative methods- Brand based comparisons, marketing based comparisons Conjoint Analysis, Holistic methods. Managing Brand Equity: Brand Reinforcement, Brand Revitalization, Brand Crisis.

Unit5:

Designing and sustaining branding strategies: Brand hierarchy, Branding strategy, Brand extension and brand transfer, Managing Brands overtime. Brand Architecture and brand consolidation. Brand Imitations: Meaning of Brand Imitation, Kinds of imitations, Factors affecting Brand Imitation, Imitation Vs Later market entry, First movers advantages, Free rider effects, Benefits for later entrants, Imitation Strategies.

Unit 6:

Making Brands go Global: Geographic extension, sources of opportunities for global brand, single name to global brand, consumers & globalization, conditions favouring marketing, barriers to globalization, managerial blockages, organization for a global brand, pathways to globalization. Luxury Brand Management: Luxury definition and relativity, luxury goods and luxury brands, basic psychological phenomena associated with luxury purchase, luxury marketing mix, luxury retail, International alluxury markets: historical leaders and emerging countries.

PRACTICAL COMPONENTS:

- Go to a supermarket and find the brand elements in various brands of soaps, mobiles, jeans, and other product.
- If you would start an MBA College, what would the positioning be with POP's and POD's?
- Pick up your college, analyse its positioning and how would you reposition it?
- Pick a multiproduct company and as completely as possible analyze its brand portfolio and brand extensions?
- Consider some groups like Tata's , Birla's, Infosys etc – what is their branding strategy.
- Students are supposed to assess the product life cycle and appraise alternative approaches to luxury brand management.
- Students can select any two popular brands and identify and examine the criteria for success in the luxury brand industry.

COURSE OUTCOMES:

Student should be able to:

1. Develop skills for managing brands strategically.
2. Compare and contrast the elements of product and brand management.
3. Assess growth-opportunities for brands, e.g., brand extension strategies.
4. Critique the different measures of brand equity.

RECOMMENDED BOOKS:

- Strategic Brand Management, Building Measuring & Managing Brand Equity – 2nd Ed Phi / Pearson Education – Kevin Lane Keller.
- Brand Management -The Indian Context – Y L R Moorthi – Vikas Publication.
- Strategic Brand Management – Jean, Noel, Kapferer – Kogan Page India.

REFERENCE BOOKS:

- Compendium Brand Management – Chunnawalla, 1/e, HPH, 2003.
- Strategic Brand Management- Richard Elliott & Larry Perclu, 1/e, Oxford Press.
- Creating powerful brands – Chernatony, 1/e, Elsevier Publication.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			X
CO3			X		
CO4		X			

RURAL MARKETING

Semester	**IV**	**CIE Marks**	**: 40**
Course Code	**18MBAMM405**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**3-0-0**	**Exam Hours**	**: 03**
	Credits : 03		

Course Objectives:

1. To provide a conceptual understanding on the Rural Marketing with special reference to Indian context.
2. To create awareness about the applicability of the concepts, techniques and processes of marketing in rural context.
3. To familiarize with the special problems related to sales in rural markets.

Unit 1:

Introduction to Indian Rural Marketing: Definition, scope of rural marketing, concepts, classification of rural markets, rural vs. urban markets. Rural marketing environment: Population, occupation pattern, income generation, location of rural population, expenditure pattern, literacy level, land distribution, land use pattern, irrigation, development programs, infrastructure facilities, rural credit institutions, rural retail outlets, print media in rural areas,rural areas requirement, rural demand and rural market index, problems in rural marketing.

Unit 2:

Rural Consumer behaviour: Consumer buying behaviour models, Factors affecting Consumer Behaviour, Social factors, Technological Factors, Economic Factors, Political Factors, Characteristics of Rural consumer- Age and Stages of the Life cycle, Occupation and Income, Economic circumstances, Lifestyle, Personality and Brand Belief, Information Search and pre-purchase Evaluation, Rise of Consumerism, Consumer Buying Process, Opinion Leadership Process, Diffusion of Innovation, Brand Loyalty. 60 Researching Rural Market: Sensitizing rural market, Research design- reference frame, Research approach, Diffusion of innovation, Development studies, PRA approach, The need for PRA, Sampling, Operational aspects of data collection.

Unit 3:

Rural Marketing of FMCG's: Indian FMCG industry, characteristics of Indian FMCG sector, Challenges in the FMCG industry, Rural Marketing of FMCG's: Select case studies Rural Marketing of Consumer durables: Issues related to consumer durables in the rural market, Rural Marketing of Consumer durables: Select case studies Rural marketing of financial services: Marketing objectives and approaches, Evolution of rural banking after independence, Challenges in marketing for banking services in rural, opportunities for banking in rural areas, marketing strategies for banking services.

Unit 4:

Marketing of agricultural inputs: Indian tractor industry: A brief overview, Challenges for Indian tractor industry, factors suggesting better future prospects for tractor industry, marketing strategies for tractor industry Fertilizer industry in India: Marketing of fertilizer industry, classification of fertilizer industry, Challenges for marketing of fertilizer industry, marketing strategies for fertilizer industry.

Unit 5:

Marketing of agricultural produce: Profiling of Indian agricultural produces marketing, challenges in marketing of agricultural produce, Strategies to promote marketing of agricultural produce. Corporate sector in agri-business: Reasons for increased interest of corporate sector in agribusiness, opportunities, in the agri-business, benefits of corporate driven agri-business system involvement of corporate sector in agri-business.

Unit 6:

Distribution Strategy: Introduction Accessing Rural Markets, Coverage Status in Rural Markets, Channels of Distribution, Evolution of Rural Distribution Systems- Wholesaling, Rural Retail System, Vans, Rural Mobile Traders: The last Mile Distribution, Haats/Shandies, Public Distribution System, Co-operative Societies Behaviour of the Channel, Prevalent Rural Distribution Models- Distribution Models of FMCG Companies, Distribution Model of Durable Companies, Distribution of fake products, Emerging Distribution Models- Corporate –SHG Linkage, Satellite Distribution, Syndicated Distribution, ITC's Distribution Model, Petrol pumps and Extension counters.

Communication strategy: Challenges in Rural Communication, A view of Communication Process, Developing Effective- Profiling the Target Audience, Determining communication objectives, designing the message, selecting the communication channels, deciding the promotion mix, Creating advertisement for rural audiences rural media- Mass media, Non-Conventional Media, Personalized media, Rural Media: The importance of the two-step flow of communication Media Typology, The Media Model, Media innovation, Influence of Consumer Behaviour on Communication strategies.

PRACTICAL COMPONENTS:

- Visit to the various Micro Finance Institutes, who extend their services in catering rural market.
- Visit to a village and understand the market structure and also understand the functioning part of the rural markets.
- Students should come up with new product designing with the rural marketing mix 4 As (Awareness, Acceptability, Adaptability and Affordability).
- Students can do a survey on corporate farming and its effect on income of the rural farmer.

COURSE OUTCOMES:

The student should be able to.

1. Highlight the characteristics of Indian rural markets and describe the differences between rural and the urban economy.
2. Analyze the roadblocks of Indian rural market and advocate solutions for the problems of rural markets.
3. Emphasize the different strategies adopted by Indian companies for rural markets.
4. Apply the strategies to be adopted for influencing the rural consumers.

RECOMMENDED BOOKS:

- Rural Marketing - Pradeep Kashyap& Siddhartha Raut, Biztantra.
- Rural Marketing - Gopal Swamy T. P, 3/e, Vikas Publishing House.

REFERENCE BOOKS:

- Rural Marketing - Dogra &KarminderGhuman, 1/e, TMH.
- Rural Marketing - Sanal Kumar Velayudhan, 2/e, Response Publication, 2007.
- Agricultural Marketing In India – Acharya , Oxford I B H.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			X
CO3			X		
CO4		X			

INTERNATIONAL MARKETING MANAGEMENT

Semester	IV	CIE Marks	: 40
Course Code	18MBAMM406	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To introduce students to the international marketing management process, design and theories
2. To develop skills relating to international trade.
3. To familiarize the steps involved in import export documentation.

Unit1:

International marketing: Definition – scope and challenges, Reasons and Motivations, Concepts related to the management of international marketing function, differences between international marketing and domestic marketing – transition from domestic to international markets - World Trade and India's foreign trade: an overview.

Unit2:

International Trade Theories and Market research: International Trade Theories- Absolute cost-comparative Cost- H-O Theorem- New Trade Theories- Porter's Diamond Theory- Managerial Implications. Developing a global vision through market research : Breadth and scope of international marketing research , problems in availability and use of secondary data, problems in gathering primary data , multi cultural research – a special problem , research on internet – a new opportunity , estimating market demand, responsibility for conducting marketing research, communicating with decision makers. Identifying foreign markets – classification based on demand , based on the stage of development ,other basis for division of world markets.

Unit 3: Global marketing management

Planning and organization: Global perspective – global gateways – global marketing management – an old debate and a new view – planning for global markets – alternative market entry strategies – organizing for global competition. Global marketing environment – cultural Environment Political and Legal Environment, Economic Environment- Modes of entry in to foreign business.

Unit4: International Product Policy

International Product Policy -Products and services for consumers: Quality – green marketing and product development, products and culture – analyzing product components for adaptation – products for consumers in global markets, product development, product adaptation, product standardization, Cross country segmentation, Product life cycle in International Marketing, International Packaging.

Product and services for businesses.

Demand in global business to business markets- Quality and global standards – business services – tradeshows crucial part of business to business marketing – relationship markets in business to business context.

Module 5

International Pricing, Promotion and distribution decision.

Pricing decision: global pricing frame work, pricing basics, marginal cost pricing and its importance. Transfer pricing, counter trade, systems pricing, pricing and positioning price quotation-INCO terms.

Promotion decision: International Advertising, Sales promotion in International, direct mailing, personal selling, exhibition – generic promotion in international marketing.

Global Distribution decision - Introduction, distribution as competitive advantage, rationalizing local channels, global channel design, Channel alternatives – Importance of Channel decision – Factors influencing the Channel decision – Channel Selection decision.

Unit-6 India's foreign trade

Import policy – procedure and Documentation - balance of trade and payments , Institutional infrastructure for exports promotions in India- India's trade policy- export assistance- exports documentation and procedures including different stages of documentations.

International Retailing.

International expansion of retailers – International retailing defined – retail format – variations in different markets – general merchandise at Retailing – issues in international retailing.

COURSE OUTCOMES:

student should be able to

1. Be aware of the differences between domestic marketing and international marketing.
2. Draft international marketing Strategies.
3. Note down the import export documentation.

RECOMMENDED BOOKS

- International Marketing – Catero, Graham, 15/e, TMH, 2012.
- International Marketing – Varshney, Bhattacharya – S Chand.
- Global marketing management- Warren J.Keegan, 7/e.person.

REFERENCE BOOKS:

- International marketing: analysis and strategy – Sak Onkvisit, Johnshaw, 4/e Biztantra.
- International marketing: Rakesh mohan Joshi, Oxford, 2004.
- International marketing: Michael Czinkota, Illka A. Ronkainen, cenage Learning.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			X
CO3			X		

SEMESTER IV
(FINANCE SPECIALISATION)
MERGERS, ACQUISITIONS & CORPORATE RESTRUCTURING

Semester	**IV**	**CIE Marks**	**: 40**
Course Code	**18MBAFM401**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**3-0-0**	**Exam Hours**	**: 03**
	Credits : 03		

Course Objectives:

1. To understand various concepts and terminologies used in mergers and acquisition.
2. To explain and critically evaluate M&A with its different classifications, strategies, theories, synergy etc.
3. To apply and analyse financial evaluation and accounting aspects of M&A.

Unit1:

Introduction of M & A: Meaning-types of mergers–Merger Motives-Theories of Mergers-Mergers and industry life cycle, Reasons for failures of M & A-synergy-types of synergy–value creation in M&A-SWOT analysis-BCG matrix. (Theory).

Unit2:

Merger Process: Procedure for effecting M & A-Five-stage model–Due diligence–Types, process and challenges of due diligence-HR aspects of M & A–Tips for successful mergers-Process of merger integration. (Theory).

Unit3:

Financial Evaluation of M & A: Merger as a capital budgeting-Business valuation approaches-asset based, market based and income based approaches-Exchange Ratio (Swap Ratio)-Methods of determining exchange rate. (Theory and Problems).

Unit4:

Accounting aspects of Amalgamation: Types of amalgamations (Amalgamation in the nature of merger and amalgamation in the nature of purchase)-Methods of Accounting-Pooling of interest method and Purchase method)–Calculation of purchase consideration-Journal entries in the books of transferor & transferee company-Ledger accounts in the books of transferor and transferee companies. (Theory and Problems).

Unit 5:

Acquisitions/Takeovers: Meaning and types of acquisition/takeovers

(Friendly and Hostile takeovers)-Anti-takeover strategies-Anti-takeover amendments-Legal aspects of M & A-Combination and Competition Act-2002Competition Commission of India (CCI)-The SEBI Substantial Acquisition of Shares and Takeover (Takeover code-2011). (Theory).

Unit 6:

Corporate Restructuring: Meaning, significance and forms of restructuring–sell-off, spin-off, divestitures, demerger, Equity Carve Out (ECO), Leveraged Buy Outs (LBO), Management Buy Out (MBO), Master Limited Partnership (MLP), Limited Liability Partnership (LLP) and joint ventures. (Theory).

Question paper : 60% theory and 40% problems

COURSE OUTCOMES:

At the end of the course, the students will be able to:

1. Understand M&A with its different classifications, strategies, theories, synergy etc.
2. Conduct financial evaluation of M&A
3. Analyse the results after evaluation.
4. Critically evaluate different types of M&A, takeover and antitakeover strategies.

RECOMMENDED BOOKS:

1. Mergers Acquisitions & Corporate Restructuring - Strategies & Practices, Rabi Narayan Kar and Minakshi, Taxmanns.
2. Mergers and Acquisitions, Sheeba Kapil and Kanwal N. Kapil, Wiley.
3. Mergers, Acquisitions and Takeovers, Machiraju H.R., New Age International (P) Ltd., New Delhi 2003.

REFERENCE BOOKS:

1. Mergers etal.-Issues, Implications, and Case Law in Corporate Restructuring, Ramanujam S., Tata McGraw Hill Publishing House, 2000.
2. Takeovers, Restructuring and Corporate Governance, Weston, Mitchell and Mulherin, 4th Edition, Pearson Education, 2003.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	x				
CO2				x	
CO3				x	
CO4				x	

RISK MANAGEMENT AND INSURANCE

Semester	IV	CIE Marks	: 40
Course Code	18MBAFM402	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:
1. To provide an understanding of different types of risk.
2. To provide an understanding of the risk identification and measurement.
3. To give an overview of role of Life Insurance in risk management.
4. To provide an understanding of general insurance contract.

Unit 1:
Introduction to Risk Management and Risk Identification: Risk-Risk and Uncertainty-Types of Risk-Burden of Risk-Sources of Risk-Methods of handling Risk-Degree of Risk-Management of Risk. Risk Identification-Business Risk Exposures-Individual Exposures-Exposures of Physical Assets -Exposures of Financial Assets -Exposures of Human Assets -Exposures to Legal Liability - Exposure to Work-Related Injury. (Theory).

Unit 2:
Risk Measurement-Evaluating the Frequency and Severity of Losses-Risk Control-Risk Financing Techniques-Risk Management Decision Methods-Pooling Arrangements and Diversification of Risk. Advanced Issues in Risk Management: The Changing Scope of Risk Management-Insurance Market Dynamics-Loss Forecasting-Financial Analysis in Risk Management --Decision Making Other Risk Management Tools. (Theory).

Unit 3:
Introduction to Insurance Risk and Insurance- Definition and Basic Characteristics of Insurance-Requirements of an Insurable Risk-Adverse Selection and Insurance-Insurance vs. Gambling Insurance vs. HedgingTypes of Insurance-Essentials of Insurance Contracts. Indian Insurance Industry -Historical Framework of Insurance, Insurance sector Reforms in India. IRDA-Duties and powers of IRDA-IRDA Act 1999. (Theory).

Unit 4:
Life Insurance Basics of Life Insurance-Growth of Actuarial Science-Features of Life Insurance-Life Insurance Contract-Life Insurance Documents-Insurance Premium Calculations. Life Insurance

Classification-Classification on the Basis –Duration-Premium PaymentParticipation in Profit-Number of Persons Assured-Payment of Policy Amount-Money Back Policies-Unit Linked Plans. Annuities-Need of Annuity Contracts, Annuity V/s Life Insurance, Classification of Annuities. (Theory).

Unit 5:
General Insurance-Laws Related to General Insurance-General Insurance Contract-General Insurance Corporation(GIC). Health Insurance-Individual Medical Expense Insurance – Long Term Care Coverage – Disability Income Insurance – Medi-claim Policy – Group Medi-claim Policy – Personal Accident Policy – Child Welfare Policy-Employee Group Insurance – Features of Group Health Insurance – Group Availability Plan. Fire Insurance-Essentials of Fire Insurance Contracts, Types of Fire Insurance Policies, Fire Insurance Coverage. Marine Insurance-Types of Marine Insurance – Marine Insurance principles Important Clauses in Marine Insurance– Marine Insurance Policies –Marine Risks-Clauses in Marine Policy. Motor Vehicles Insurance-Need for Motor Insurance, Types of Motor Insurance, Factors to be considered for Premium Fixing. (Theory).

Unit 6:
Management of Insurance Companies Functions and Organization of Insurers- Types of Insurance Organization, Organizational Structure of Insurance Companies-Functions of Insurers. Underwriting-Principles of Underwriting, Underwriting in Life Insurance, Underwriting in nonlife Insurance. Claims Management-Claim Settlement in General Insurance-Claim Settlement in Life Insurance. (Theory).

Question Paper: 100 % Theory

COURSE OUTCOME:
At the end of the course, the students will be able to :
1. Understand various types of risks .
2. Assess the process of identifying and measuring the risk.
3. Acquaint with the functioning of life Insurance in risk management.
4. Understand general insurance contract.

RECOMMENDED BOOKS

1. Principles of Risk Management and Insurance, George E Rejda, (2009),Twelfth Edition, Pearson, New Delhi.
2. Insurance and Risk Management, P.K. Gupta, (2010), First Edition, Himalaya Publishing House, Mumbai.
3. Introduction to Risk Management and Insurance, Dorfman, Mark S., (2008), 10th Edition, Prentice Hall India, New Delhi.

REFERENCE BOOKS:

1. Risk Management and Insurance, Scott E. Harrington, Gregory R Niehaus, (2007), Second Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.
2. Principles and Practice of Insurance, P. Periasamy, (2009), Second Edition, Himalaya Publishing House, Mumbai.
3. Risk Management and Insurance, C. Arthur Williams, Jr. Peter Young, Michael Smith, (2007), Eighth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X				
CO3	X				
CO4	X				

INDIRECT TAXATION

Semester	IV	CIE Marks	: 40
Course Code	18MBAFM403	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To provide an overview of GST in India.
2. To provide an understanding of levy and collection of GST.
3. To give an overview of customs duty in India.
4. To provide an understanding of valuation for customs duty.

Unit 1:

Introduction to Goods and Services Tax (GST): Goods and Services Tax Act & Rules, Need for GST in India, Dual GST Model - Central Goods and Services Tax Act, 2017 (CGST) State Goods and Services Tax Act, 2017 (SGST) Union Territory Goods and Services Tax Act, 2017 (UTGST) Integrated Goods and Services Tax Act, 2017 (IGST) Goods and Services Tax Network (GSTN), GST Council Guiding principle and Functions of the GST Council. (Theory).

Unit 2:

Levy and Collection of Tax: Scope of Supply, Composite and Mixed Supplies , Levy and Collection, Composition Levy , Exemptions Person Liable to pay GST, Exemption from tax. (Simple problems on calculation of value of taxable supply and GST Levy). (Theory and Problems).

Unit 3:

Time and Value of supply: Time of Supply , Change in Rate of Tax in respect of Supply of Goods or Services , Place of Supply and Value of Supply. (Simple problems on Time of supply, place of supply and value of supply) (Theory and Problems).

Unit 4:

Input Tax Credit: Introduction and Eligibility to avail Input Tax Credit (ITC). Registration under GST: Persons not liable for Registration , Compulsory Registration in Certain Cases, Procedure for Registration , Deemed Registration. Returns under GST: Furnishing of Returns, First Return , Revision of Returns and Penalty/Late Fee. (Theory).

Unit 5:

Introduction to Customs Duty. Definitions, Circumstances of Levy of

Customs Duties and Types of Duties and Exemption from Customs Duty. Valuation under customs: Valuation of Imported Goods and Valuation of Export Goods.. (Problems on Valuation of Imported Goods). (Theory and Problems).

Unit 6:

Import and Export Procedure under Customs: Introduction to Baggage and General Free Allowance. Provisional Assessment of Duty, Due Dates for Payment of Duty , Penalties under Customs, Seizure of Goods , Confiscation of Goods. (Theory).

Question Paper: 60 % Theory 40% problems

COURSE OUTCOME:

At the end of the course, the students are able to:

1. Have clarity about GST system in India.
2. Understanding of levy and collection of GST in India.
3. Have an overview of customs duty in India.
4. Understanding of valuation for customs duty.

RECOMMENDED BOOKS:

1. Indirect Taxes Law and practices, V S Datey, Taxmanns
2. GST & Customs Law (University Edition), K.M Bansal, Taxmanns.

REFERENCE BOOKS:

1. Principles of GST & Customs Law, V.S. Datey and Dr. Krishnan Sachdeva, Taxmanns
2. Goods & Services Tax (GST) in India , B. Viswanathan UBS Publishers

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X				
CO3	X				
CO4					X

INTERNATIONAL FINANCIAL MANAGEMENT

Semester	IV	CIE Marks	: 40
Course Code	18MBAFM404	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To understand the International Financial Environment and the Foreign Exchange market.
2. To learn hedging and Forex risk management.
3. To learn the Firm's Exposure to risk in International environment and various theories associated with it.

Unit 1:

International financial Environment- The Importance, rewards & risk of international finance- Goals of MNC- International Business methods. Balance of Payments (BoP), Fundamentals of BoP, Accounting components of BOP, Equilibrium & Disequilibrium, International Monetary System: Evolution, Gold Standard, Bretton Woods system, the flexible exchange rate regime, the current exchange rate arrangements, the Economic and Monetary Union (EMU).(Only Theory).

Unit 2:

Foreign Exchange Market: Function and Structure of the Forex markets, Foreign exchange market participants, Types of transactions and Settlements Dates, Exchange rate quotations, Determination of Exchange rates in Spot markets. Exchange rates determinations in Forward markets. Exchange rate behavior-Cross Rates- - Bid – Ask – Spread (Theory & Problems).

Unit 3:

Foreign exchange risk Management: Hedging against foreign exchange exposure – Forward Market- Futures Market- Options Market- Currency Swaps-Interest Rate Swap- problems on both two way and three way swaps.(Theory & Problems).

Unit 4:

International Financial Markets and Instruments: Foreign Portfolio Investment. International Bond & Equity market. GDR, ADR, International Financial Instruments: Foreign Bonds & Eurobonds, Global Bonds. Floating rate Notes, Zero coupon Bonds, International Money Markets, International Banking services –Correspondent Bank, Representative offices, Foreign Branches. Forward Rate Agreements. (Only Theory).

Unit 5:

International Parity Relationships & Forecasting Foreign Exchange

rate: Measuring exchange rate movements-Exchange rate equilibrium –Factors effecting foreign exchange rate- Forecasting foreign exchange rates.Interest Rate Parity, Purchasing Power Parity &International Fisher effects, Arbitrage, Types of Arbitrage – Locational, Triangular and Covered Interest Arbitrage. (Theory & Problems).

Unit 6:

Foreign Exchange exposure: Management of Transaction exposure-Management of Translation exposure- Management of Economic exposure-Management of political Exposure- Management of Interest rate exposure.

International Capital Budgeting: Concept, Evaluation of a project. (Theory & Problems).

Question Paper: 60 % Theory 40% problems. Case preferably from capital budgeting.

COURSE OUTCOMES:

1. The student will have an understanding of the International Financial Environment.
2. The student will learn about the foreign exchange market, participants and transactions.
3. The student will be able to use derivatives in foreign exchange risk management.
4. The student will be able to evaluate the Firm's Exposure to risk in International environment and various theories associated with it.

RECOMMENDED BOOKS:

1. International Corporate Finance - Jeff madura, Cengage Learning, 10/e 2012.
2. International Finance Management - Eun&Resnick, 4/e, Tata McGraw Hill.

REFERENCE BOOKS:

1. International Financial Management – Apte P. G, 6/e, TMH, 2011.
2. International Financial Management – MadhuVij, Excel Books, 2010.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3				X	
CO4	X				

FINANCIAL DERIVATIVES

Semester	IV	CIE Marks	: 40
Course Code	18MBAFM405	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To understand various concepts and terminologies used in various financial derivatives.
2. To explain and critically evaluate various financial derivatives such as forwards, futures, options, financial swaps, credit derivatives etc.
3. To apply various financial derivatives in hedging risk and analyse it.

Unit1:

An Overview of Financial Derivatives: Meaning, benefits, types (both exchange traded and OTC traded) and features of financial derivatives-Factors causing growth of derivatives-functions of derivatives market-Derivative market players (Hedgers, speculators and arbitragers)-Derivatives market in India. (Theory).

Unit2:

Futures and Forwards: Meaning, features and types of futures/forwards-Futures vs Forwards-Mechanics of buying and selling futures/forwards-Hedging through futures/forwards-Marking-to-market process-contract specifications of stock, index and commodity futures–valuation of futures/forwards using cost of carry model-Arbitrage process-Interest Rate Futures & options. (Numerical problems on MTM and valuation of futures/forwards). (Theory and Problems).

Unit3:

Option Contracts: Meaning, features and types of option contracts-Options vs futures/forwards-Mechanics of buying and selling option contracts-contract specifications of stock, index and commodity options-Option pricing-factors affecting option pricing-Valuation of option contracts using Black Scholes model and Binomial model-Put-call parity theory-Option Greeks-Option Trading strategies-Interest rate options-Exotic options. (Numerical problems on all aspects except exotic options). (Theory and Problems).

Unit4:

Financial Swaps: Meaning, features and advantages of financial swaps-Types of financial swaps (Interest rate swap, currency swap, equity swap and commodity swap)-Mechanics of interest rate swaps– Triangular swap (Numerical problems only on interest rate swap including triangular swap)-valuation of interest rate swaps- Only theory. (Theory and Problems).

Unit5:

Commodity Derivative Market: Meaning of commodity derivatives-Commodity derivative exchanges (with commodities traded) in India-Trading and settlement system of commodity derivatives-SEBI Guidelines for commodity market-commodities traded. (Theory).

Unit6:

Credit Derivatives and VaR: Credit Derivatives-Total Return Swap (TRS)-Credit Default Swap (CDS)-Types of CDS-Asset Backed Securities (ABS)-Collateralised Debt Obligation (CDO)-Sub-Prime Crisis-2007-Credit Spread Options-Probability of Default- Forward Rate Agreement (FRA)-Interest Rate Caps/Floors/Collars-Types of Interest Rates-Zero Rate-Forward Rate-Value-at-Risk-Meaning, VaR Models-Stress testing and back testing. (Numerical problems only on VaR, Zero Rate and Forward rate). (Theory and Problems).

Question paper: 40 %Theory and 60% Problems.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

1. Understand the mechanism of forwards/futures, options, financial swaps, various credit derivatives and VaR with their features, merits and demerits.
2. Assess the application of forwards/futures, options, financial swaps, various credit derivatives and VaR using numerical problems.
3. Application of financial derivatives in risk management.
4. Critically evaluate various financial derivatives.

RECOMMENDED BOOKS:

1. Options Futures & Other Derivatives, John C. Hull, Pearson Education.
2. Derivatives and Risk Management, Rajiv Srivastava, Oxford University Press, 2010.
3. Options & Futures- Vohra & Bagri, 2/e, TMH.

REFERENCE BOOKS:

1. Derivatives, Principles and Practice, Sundaram& Das, Mc Graw Hill.
2. Options & Futures –Edwards & Ma, 1/e, McGraw Hill.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X			X	
CO3				X	
CO4				X	

CORPORATE VALUATION

Semester	IV	CIE Marks	: 40
Course Code	18MBAFM406	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. Identify the purpose of corporate valuation and to obtain an overview of the basic corporate valuation process
2. To familiarize the students with the standard techniques of corporate valuation.
3. To develop analytical skills and communication strategies for discussing corporate valuation.
4 To understand the valuation in the contexts of IPOs, M&As, Bankruptcy cases

Unit 1:

Corporate valuation-an Overview-Context of valuation-Approaches to Valuation-Features ofthe valuation process:

Enterprise DCF Model-Analysing historical performance-Estimating the cost of Capital-Forecasting performance-Estimating the continuing value-Calculating and interpreting theresults-Other DCF models: Equity DCF Model: Dividend discount model, free cash flow toEquity (FCFE) model-Adjusted present value model-Economic profit model-Applicability and Limitations of DCF analysis (Theory and problems).

Unit 2:

Non DCF approaches to valuation: Book value approach, Adjusted book value approach, Stock and debt approach(numerical problems in each of the these methods).Market efficiency and valuation.Call option based valuation (theory only because Numerical problems on Black and Scholes –Binomial methods are considered in Derivatives).Relative valuation-Steps involved in Relative valuation-Equity valuation multiples-Enterprise valuation multiples-Choice of multiple-Best practices using multiples-Assessment of relativ evaluation. (Theory and problems).

Unit3:

Advanced issues in valuation-Valuation of companies of different kinds-valuation in different contexts-Loose ends of valuation-Valuation of intangible assets: Patents, trademarks,copyrights and licenses; Franchises; Brands,WACCVs Flow to equity method. (Theory and problems).

Unit 4:

Strategic financing decisions: Valuation and financing Decisions in ideal capital markets, Capital structure and value in a perfect world ,Information asymmetry ,Share buy back and valuation. (Theory).

Unit 5:
Leverage decisions, Agency costs of Debt, financial distress, Bankruptcy. Role of Government, securities Markets and financial institutions in IPO valuations and M&As. (Theory).

Unit 6:
Value Based Management- Methods and Key premises of VBM-Marakon approach-Alcarapproach-Mckinsey approach-Stern Stewart approach-BCG approach-Lessons from the experiences of VBM adopters. (Theory).
Question Paper: 60 % Theory40% problems.

COURSE OUTCOMES:
At the end of the course, the students will be able to:
1. Understand corporate valuation and valuation process.
2. Familiarize himself with the standard techniques of corporate valuation.

RECOMMENDED BOOKS
1. Prasanna Chandra, Corporate Valuation and Value Creation, Tata McGraw Hill,2011.
2. AswathDamodaran, Damodaran on Valuation, 2/e, John Wiley and Sons,2006.

REFERENCE BOOKS
1. Philip R Daves, Michael C. Ehrhardt, and Ron E. Shrieves, Corporate Valuation: AGuide for Managers and Investors, Cengage Learning,2003.
2. David Frykman, Jakob Tolleryd, Corporate Valuation, Financial Times PrenticeHall,2003.
3. Rawley Thomas, Benton E. Gup, The Valuation Handbook: Valuation Techniques from Today's Top Practitioners, John Wiley & Sons, 2010.
3. Develop analytical skills relevant for corporate evaluation and value based management.
4. Critically evaluate IPOs, M&As, Bankruptcy cases

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X				
CO3				X	
CO4	X			X	

SEMESTER IV

HUMAN RESOURCES SPECIALISATION
PUBLIC RELATIONS

Semester	IV	CIE Marks	: 40
Course Code	18MBAHR401	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:
1. To provide an understanding of the fundamentals tools of public relations practices.
2. To provide a multidisciplinary understanding of the emerging trends in the field of public relations.
3. To Understand the role of employee communication and organizational change.
4. To Understand the importance of community relations

Unit 1:
Public Relation: Proactive and Reactive Approaches – Public Relations Process – Behavoiural Public Relations Model – Persuasion Model – Two way symmetrical Communications Model – When communications is not enough – 20 great truths about Public Relations.

Unit 2:
Theoretical basis for Public Relations –Theories of Relationships –Systems Theory – situational Theory – Theories of Persuasion and Social Influence – Social Exchange Theory – Diffusion Theory – Social Learning Theory – Elaborated Likelihood Theory - Theories of Mass communication – Uses and Gratification Theory – Agenda Setting Theory – Public Relations roles – Models of Public Relations – Approaches to Conflict Resolutions.

Uni 3:
Employee communications – Role of employee communication – concept of Organizational culture – Establishing Communication Policy – Organizational change – Importance of employee communication – Special employee Communication Situations – Media of Employee communications – Objectives of Internal media – Starting internal media – controlling internal. media - Occasional and Special media Rules of Effective Employee Relations. Frontline supervisors as the key communicators.
Case 1: Investing in Employees Pays Off (CJSS).
Case 2: Southwest Airlines – Where Fun, LUV, and Profit Go Hand –in Hand (CJSS).

Unit 4:

Community Relations – Importance of Public Relations – Community Relations Process – Guidelines for Effective Relations Programs -Specific Functions of Public Relations – Criteria for Community relations Activities – Corporate Social Responsibility & Philanthropy-Emerging Challenge of Community Activism.

Case 3: Community Relationships Maintained During Hospital Closing (CJSS).

Unit 5:

Media Relations – Media Relations –Role of Media in Public Relations – Social Media – working with the media –Media Relations Program Elements –Role of Technology in Public Relations.

Case 4: Fatal Tiger Attack at San Francisco Zoo (LLHT).

Unit 6:

Issues in Public Relations/ Crisis Management – public relations challenges –Types of Issues - target audiences-Public Service as Preventive Public Relations – Special Interests – Importance of compromise –Issue Anticipation – Scenario Technique.

Crisis Management – Understanding how people typically react to issues – Human Nature – Role of communications – Types of crises – News media influence - Fundamental guidelines.

Case 5: Take your choice – Tobacco or Health (CJSS).

PRACTICAL COMPONENT:

- Related cases for each module to be discussed in the classes and presentation can be done for each case by group of students.
- Team of students can be made and asked to report the media personalities about the event held in the college. Different styles of reporting the same event can be discussed in the class with its possible reactions from the media.
- Collect the newspaper articles about various messages from organizations through spokespersons and analyze the effect of each type of delivery and impact on the audience.
- Conduct a CSR Programme for the college like Blood donation, Eye camps in association with Lions, Rotary clubs etc and gather the information's about various challenges these organizations face during such community oriented programmes.

COURSE OUTCOMES:

1. To demonstrate an understanding of the fundamentals tools of public relations practices.

2. To describe the various emerging trends in the field of public relations.
3. To analyze the importance of employee communication and organizational change.
4. To evaluate the importance of community relations.

RECOMMENDED BOOKS

1. "Public Relations – The Profession and Practice", Lattimore, Laskin, Heiman & Toth, third edition, Tata McGraw Hill, 2012 (LLHT).
2. "Public Relations Practices – Managerial Case Studies and Problems" Center, Jackson, Smith and Stansbury, Seventh Edition, Prentice Hall of India, 2008 (CJSS).
3. Public Relations - Paul Baines, John Egan, Frank Jefkins, Routledge, 3rd edition, 2007, ISBN - 1136370773, 9781136370779.

REFERENCE BOOKS:

1. Strategic Planning for Public Relations, Ronald D. Smith, revised edition, Taylor & Francis, 2004, ISBN - 1135606080, 9781135606084.
2. Public Relations: A Practical Guide to the Basics, Philip Henslowe, 1st edition, Kogan Page Publishers, 2003, ISBN - 0749440724, 9780749440725.
3. Public Relations Practices, Managerial Case Studies and Problems, Allen H Center, Patrick Jackson, Stacey Smith, Frank R Stansberry, 7th Edition.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X			X	
CO2				X	X
CO3		X			X
CO4	X				X

ORGANIZATIONAL LEADERSHIP

Semester	IV	CIE Marks	: 40
Course Code	18MBAHR402	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To make students understand fundamental concepts and principles of organizational leadership.
2. To make students knowledgeable of the theoretical aspects and practical applications of leadership styles in an organization.
3. To make the students understand the basic concepts of leadership traits and ethics underlying leadership behavior besides developing better insights into one's own self.
4. To make students aware of organizational leadership, Leadership development and succession besides developing a better awareness of how they can be better facilitators for building effective teams as leaders themselves.

Unit 1:

Introduction to Leadership: Definition, Importance of leadership, Roles of a leader, Leadership theory paradigms, levels of analysis of leadership theory.

Unit 2:

Leadership traits and ethics: Personality traits and leadership, traits of effective leaders, Leadership attitudes, ethical leadership, Achievement motivation theory.

Unit 3:

Leadership behaviour and motivation, and contingency leadership:
Leadership behaviour and styles, University of Michigan and Ohio studies, Leadership grid, Leadership and motivation, Content and process theories, Reinforcement theory, Contingency leadership theories and models,
Leadership continuum theory, Normative leadership theory, Leadership substitute theory.

Unit 4:

Team Leadership: The use of teams in organizations, Types of teams, Decision making in teams, Leadership skills for effective team meetings, Ginnet's team effectiveness leadership model, virtual and self managed teams, the changing role of leadership in self-managed teams.

Unit 5:

Leader follower relations: Followers, Evolution of Dyadic theory, Leader member exchange theory, Fellowship, Delegation, Coaching, Managing conflict.

Organizational Leadership: Charismatic and transformational leadership, Stewardship and servant leadership, Leadership of culture and diversity, Creating high performance culture, Strategic leadership.

Unit 6:

Leadership development and succession: Development through self-awareness and self-discipline, Development through education, experience, and mentoring, succession, Leadership development programs, Evaluation of leadership development efforts, Leadership
Leadership development programs, Evaluation of leadership development efforts, Leadership.

COURSE OUTCOMES:

1. Comprehend & correlate organizational leadership styles which are happening around with fundamental concepts of team leadership.
2. Understand the overview of leadership behavior and motivation in organization.
3. Effectively use their skills for self-grooming on leadership traits and ethics that influences them to effectively work in groups to achieve organizational goals.
4. Demonstrate their acumen in applying their knowledge in organizational leadership and behavioral concept in real world/situation.

RECOMMENDED BOOKS:

1. Effective Leadership- Lussier/ Achus, Tjird edition, Thomson South Western, 2007.
2. Leadership-Enhancing the Lessons of experience, Hughes, Ginnet, Curphy, Fifth edition, Tata McGraw Hill, 2006.
3. Leadership-Research findings, Practice, and skills, Andrew J Durbrin, Fourth edition, Biztantra, 2007.

REFERENCE BOOKS:

1. Leadership in Organizations, Gary Yukl, Pearson Education, 6th Edition.
2. The Leadership Eperience, Richard L Daft, Cengage Learning, 2nd Edition, 2002.
3. Dynamics of leadership, Craig Watson, Jaico Publication.
4. The art of leadership, George Manning and Kent, 2nd edition, Mc-Graw Hill Education.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2				X	X
CO3					X
CO4	X				

INTERNATIONAL HUMAN RESOURCE MANAGEMENT

Semester	IV	CIE Marks	: 40
Course Code	18MBA HR403	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. Critically analyse the impact of contemporary issues and global imperatives on Human Resource concepts, policies and practices in multinational organizations.
2. Compare, contrast and explain a variety of strategic approaches to the management of Human Resources in multinational organizations.
3. Apply concepts and knowledge about the range of Human Resource functions to the deployment of expatriate employees and expatriate failures on international assignments.
4. Critically evaluate the effects of different Human Resource and International Industrial Relations strategies adopted by multinational international organisations operating in various regions of the world.

Unit 1:

Introduction to IHRM Definition, The drivers of internationalization of business. The different setting of International Human Resource Management. Development of IHRM. Difference between IHRM and Domestic HRM. Models of IHRM-Matching model, Harvard Model, Contextual Model, 5P Model European Model. SHRM: Evolution of MNE's, Business strategies, IHRM Strategies.

Unit 2:

Strategies for International Growth: Exploiting global integration-The logic of global integration, differentiation, Mastering expatriation, beyond the traditional expatriate model, the limits of global integration. Becoming locally responsive: The roots of responsiveness, understanding diversity, responding to diversity, the challenges of localization. Managing alliances and joint ventures.

Unit 3:

International Workforce planning and staffing: International labour market International Recruitment function; head-hunters, cross-national advertising, e-recruitment; International staffing choice, different approaches to multinational staffing decisions, Types of international assignments, Selection criteria and techniques, use of selection tests, interviews for international selection, international staffing issues, Successful expatriation, role of an expatriate, female expatriation,

repatriation, re-entry and career issues..

Unit 4 :

Developing Global Mindset: Global Leadership, Cross cultural context and international assignees, Current scenario in international training and development, training & development of international staff, types of expatriate training, sensitivity training, Career Development, repatriate training, developing international staff and multinational teams, knowledge transfer in multinational companies.

Unit 5 :

Performance Management: Performance Management and MNE, Constraints in goal attainment, performance management cycle, Performance Management of International Assignees, third and host country employees, issues and challenges in international performance management, country specific performance management practices.

Unit 6:

International Compensation and International Employment Laws and HRIS: International compensation and international assignees, Forms of compensation, key components of international compensation, Approaches to international compensation, compensation practices across the countries, emerging issues in compensation management. Establishment of labour standards by International Institutions, The global legal and regulatory context of MNE, HRIS: Meaning, Role of IT in HR, Designing of HRIS, Applications of HRIS in Employee Management, Limitation of HRIS.

PRACTICAL COMPONENT:

- Study the Socio-Political-Economic System in U.S, U.K, Japan and India and prepare a comparative analysis.
- Visit an MNE organization and study the HR shared services operations performed.
- Solve a case study to understand the challenges faced by organizations in evaluating the performance of international assignees.
- Study and compare Recruitment, Selection and Training practices in various countries.
- Study Indian and US legal aspects involved when deploying an employee on an International Assignment.

COURSE OUTCOME:

At the end of the course students are able to:

1. Analyse the impact of contemporary issues and global imperatives on Human Resource concepts , policies and practices.

2. Apply concepts and knowledge in deployment, expatriate on international assignments.
3. Evaluate the effects of different human resource and international industrial relations.
4. Develop students to adopt international industrial relation strategies.

RECOMMENDED BOOKS:

- International Human Resource Management - Peter J. Dowling, Denice E. Welch, Cengage Learning.
- Human Resource Information Systems: Basics, Applications, and Future Directions: Basics, Applications, and Future Directions, Michael J. Kavanagh, Mohan Thite, Richard D. Johnson SAGE, 2011, 2/e.
- Strategic International Human Resource Management: Choices and Consequences in Multinational People Management - Stephen J. Perkins, Susan M. Shortland – Kogan Page Publishers, 2006.

REFERENCE BOOKS:

- International Human Resource Management: Policies and Practices By Dennis Briscoe, Randall Schuler, Ibraiz Tarique, Taylor & Francis, 4/e, 2012.
- International Human Resource Management - Anne-Wil Harzing, Joris Van Ruysseveldt - SAGE, 2004.
- International human resource management: think globally, act locally – Derek Torrington - Prentice Hall, 1994.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X		X	
CO3	X		X		
CO4		X			X

ORGANIZATION CHANGE AND DEVELOPMENT

Semester	**IV**	**CIE Marks**	**: 40**
Course Code	**18MBA HR404**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**3-0-0**	**Exam Hours**	**: 03**
	Credits : 03		

Course Objectives:

1. To understand the concepts of change management and to acquire the skills required to manage any change effectively.
2. To understand the various components and constraints involved in Change management.
3. To learn the various tools & techniques for Organization Development.
4. To understand the different OD interventions and its effectiveness.

Unit 1:

Organizational change- Introduction, nature of change, Internal & External changes, types of change, Models of change- Lewis's Force field, Systems Model, Action research model, organizational vision and strategic planning.

Unit 2:

Resistance to change- reasons for the resistance, overcoming resistance for the change, change and person and manager, systematic approach to making change- factors for effective change, skills of leaders in change management, designing the change.

Unit 3:

Organization development-Introduction, history, evolution of OD, OD interventions: Definition, actors to be considered, choosing and sequencing, intervention activities, classification of OD interventions, results of OD, typology of interventions based on target groups.

Process of Organization Development: Entering into OD relationship, developing a contract.

Unit 4:

Diagnosing Organizations- Need for diagnostic models, organization, group, individual level diagnosis, Collecting and analyzing the diagnostic information, Feeding Back of diagnostic information, Designing interventions, overview of interventions, evaluating and Institutionalizing OD Interventions.

Unit 5:

Human Process Interventions: Human process interventions (individual, group and inter-group human relations): Individual based: coaching, counseling, training, behavioralmodeling, delegating, leading, morale boosting, mentoring, motivation, etc., Group based: conflict management, dialoguing, group facilitation, group learning, self-directed work teams, large scale interventions, team building, and virtual teams.

Inter-group based: Organization mirroring, third party peacemaking interventions.

Unit 6:

Techno-structural Interventions and Future of OD: Restructuring Organizations, Employee Involvement, work Design, Balanced scorecard; business process reengineering; downsizing and outsourcing; Strategic Interventions: Competitive and Collaborative Strategies, Organization Transformation.

The Future of OD: The changing environment, Fundamental strengths of OD, Implications of OD for the client, ethical standards in OD, OD's future. OD Consultant's role, issues in consultant-client relationship, Power, Politics & OD, Research on OD.

PRACTICAL COMPONENT:

- To conduct Force field analysis for MBA department.
- Group activity-Identify the need for OD intervention for your college and call the director/ principal of your college to the classroom to explore the possibility for OD intervention.
- Presentation by students: Identify and explore the possibility for OD intervention in your college level, group level and individual level.
- Hold a debate in the classroom about downsizing the workforce.
- Organization change questionnaire data collection and analyzation.
- Group Presentation: Health care, FOO, Education, PSU, Retail, Manufacturing Industries.
- Design a role play event for students, so that they will play it out to mobilize support for a change implementation programme.
- Students are expected to study the changes that have taken place in various industries. over a period of ten years and submit a report.

COURSE OUTCOMES:

1. Gain insights of change management components, process and its functions.
2. Enable with various OD diagnosing models.
3. Ability to handle various OD interventions.
4. Analyze the role of OD Consultant.

RECOMMENDED BOOKS:

1. Theory of Organization Development and Change. Thomas G. Cummings, Christopher G. Worli, Cengage Learning.
2. Understanding the theory and design of organization, Richard L Draft, Cengage Learning.
3. Organization Development, behavioral science interventions for Organization Improvement, Wendell French, Cecil H.Bell, Veena, Jr, Pearson, PHI.

REFERENCE BOOKS:

1. Management of Organizational Change – K Harigopal – Response BOOKS, 2001.
2. Organizational, Design, and Change-Gareth R. Jones, 5th Edition, Pearson Education.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2		X			
CO3			X	X	
CO4					X

STRATEGIC TALENT MANAGEMENT

Semester	IV	CIE Marks	: 40
Course Code	18MBA HR405	SEE Marks	: 60
Teaching Hours / week (L:T:P)	3-0-0	Exam Hours	: 03
	Credits : 03		

Course Objectives:

1. To make the students realize the challenges of acquisition and retention of talents for the competitive advantage of the organization.
2. To develop a conceptual understanding of the management of talents in the competitive environment.
3. To understand how important is to develop and retain the best talents in the industry.
4. To understand the concepts of competency and its usage in evaluating a person's work.
5. To get an idea about different tools in identifying required competencies in a person.

Unit 1:

Basics of Talent Management: Talent- engine of new economy, difference between talents and knowledge workers, leveraging talent, the talent value chain, elements of talent friendly organizations, talent management process, Talent Management System – Components and benefits of Talent Management System; creating TMS, challenges of TMS, Building blocks of talents management: competencies – performance management, conducting performance reviews, Appraising executive talent, selecting the right appraisal.

Unit 2:

Talent Planning – Concept, succession management process, Integrating succession planning and career planning, designing succession planning program, strategic accountability approach in developing the workforce, balanced scorecard, talent development budget, contingency plan for talent; building a reservoir of talent, compensation management within the context of talent management, CEO Succession planning.

Unit 3:

Developing and Retaining Talent – Potential identification and development, coaching for sustained &desired change, integrating coaching, training and development with talent management ,employee retention- motivation and engagement, Return on talent; age of analytics, making outplacement as a part of talent strategy, developing talent management information system.

Unit 4:

Competency mapping: Concepts and definition of competency; types of competencies, competency based HR systems, competency and performance, 5 level competency model, developing various competency models, how competencies relate to career development and organizational goals.

Unit 5:

Methodology of competency mapping : competency model development ,competency models, people capability maturity model ,developing competency framework , competency profiling , competency mapping tools , use of psychological testing in competency mapping , competency based interviewing.

Unit 6:

Measuring Performance, Assessment and Development Centre: background and approaches to performance assessment, competency based performance assessment, diagnosing reasons for performance problems, designing an effective performance management systems, sources of errors in performance measurement.

Assessment and Development Centre : concepts , importance and uses of assessments centre in selecting employees , difference between assessment and development centre, assessment centre approach to competence building , profile of the assessors, steps in assessment centre, designing the assessment centre.

PRACTICAL COMPONENTS:

- Students are expected to conduct a study on how talents are acquired and retained – in various industries – and various strategies followed by the respective companies.
- Discussion on "How to have/ evaluate the performance of the MBA students".
- Ask the students to find out the best employer surveys conducted during the past one year and make a presentation.
- Identify the important positions in your college or any other organization and ascertain the measures if any taken to develop second line of leadership.
- Ask the students to collect data about the position of principal, director, and other teachers in your college and prepare a competency dictionary for the said positions.
- Presentation by students about the competency directory profiling of various positions.
- Ask the students to role play the behavioural event interview to collect data for competency mapping for the position of management professor.

- Presentation by students about the competency directory profiling of various positions.

COURSE OUTCOME:

At the end of the course students are able to:

1. Aquire knowledge and the various challenges of acquisition and retention of talents for competitive advantage of the organization.
2. Gain insights to develop and retain best talents in the industry.
3. Learn the concepts of competency and its usage in evaluating a person's work.
4. Adhere knowledge in the identified competencies.

RECOMMENDED BOOKS:

- Talent Management – Gowri Joshi, Veena Vohra, Cengage Learning, 2018.
- The Talent Management Hand Book – Lance A. Berger & Dorothy R. Berger, Tata McGraw Hill.
- Competence at work – Lyle M. Spencer, Signe M. Spencer. John Wiley, 1993.
- A Handbook of Competency Mapping – Seema Sangi, Response BOOKS, 2004.

REFERENCE BOOKS:

- The Talent Era, Chowdhary, Subir, Pearson Education, New Delhi.
- Appraising & Developing Managerial Performance- Rao T. V, Excel BOOKS.
- Performance Management – Herman Aguinis, Pearson Education, 2007.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X			X	
CO3		X	X		
CO4		X			X

PERSONAL GROWTH AND INTERPERSONAL EFFECTIVENESS

Semester	**IV**	**CIE Marks**	**: 40**
Course Code	**18MBA HR406**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**3-0-0**	**Exam Hours**	**: 03**
	Credits : 03		

Course Objectives:

1. To identify strengths and weaknesses as an individual, as a member of a group/organization using personality types.
2. To understand the concepts of self awareness, self esteem, NLP and Locus of Control.
3. To understand Interpersonal growth and effectiveness.

Unit 1:

Personal growth: Meaning, nature and scope of personal growth. Self-awareness and self esteem, life roles, social roles and organizational roles, role clarity and role boundaries. Ego states - Id, ego and super ego and defense mechanisms; developing a self improvement plan. Interpersonal Trust: Discovering facets of interpersonal trust through Johari Window (Openness, confidentiality, blind spot and unknown part of personality); Self disclosure, seeking feedback, self reflection and practicing new behaviors.

Unit 2:

Understanding Human Personality: Personality – Meaning & Determinants; Personality theories, Carl Jung's theory of personality Types and Myers Briggs Type Indicator test (MBTI), Trait theories - Guilford Peogut, PF 16 and Type A and B Personalities; Emotional intelligence – Meaning, Dimensions, and Emotionally intelligent Organizations. Artificial Intelligence. (basic Concept).

Unit 3:

Attitudes, beliefs, Values and their impact on behavior; Personal change – meaning, nature and requisites. Locus of control. Habit Formation – Habits of personal effectiveness. Seven habits of highly effective people.

Unit 4:

Basic functions of mind: Creativity and innovation. Blocks to creativity. Creativity processes and tools- convergent and divergent thinking. Six thinking Hats, Neuro Linguistic Programming (NLP). Pedagogy and Androgogy . Adult Learning Process; learning styles and its relatedness to personality development.

Unit 5:

Interpersonal relations and personal growth: Interpersonal needs for openness, inclusion and control. Discovering the interpersonal orientation through FIRO-B. Conflict resolution and negotiation, Time management and honoring the commitments.

Unit 6:

Transactional Analysis: Ego states, types of transactions and time structuring. Life position, scripts and games; strokes and stamps Experiential learning methodologies: T-group sensitivity training, encounter groups and appreciative enquiry.

PRACTICAL COMPONENT:

1. Conduct transactional analysis activities.
2. Discuss a Johari Window case in the class to identify how it can help each individual student to promote his/ her personal growth.
3. Students are expected to conduct an in depth study about various personality traits & TA and submit a detailed report.
4. Students have to undergo psychometric test like MBTI, FIRO-B, Big Five etc ,
5. 5.Organize a workshop on MBTI for the students to know their type and to understand the type dynamics.

COURSE OUTCOMES:

Students will be able to:

1. Understand the components of personal growth for better self actualization in profession as well as personal front.
2. Gain insights of human personality, attitudes, beliefs, values and their impact on individual behavior and to achieve organizational goals.
3. Familiarize the concepts of basic functions of mind to be more creative and innovative.
4. Gain insights in the aspects of interpersonal growth and handling conflicts, managing time, self analysis and transactional analysis.

RECOMMENDED BOOKS:

- Organizational Behaviour: Human Behavior at work – John W. Newstrom and Keith Davis, 11/e, Tata McGraw Hill, 2003.
- Human Relations in organizations – Robert N. Lussier, 6/e, Mc-Graw Hill Education.
- Development of Management Skills – Whetten& Cameron, 7/e, PHI.

REFERENCE BOOKS:

- Understanding OB – Udai Pareek, Oxford University Press.
- Theories of Personality- Calvin S Hall, 4/e, Wiley India Pvt. Ltd.
- Seven habits of highly effective people – Stephen R Covey, Pocket Books.

CO-PO MAPPING

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X			X	
CO2			X		
CO3		X			
CO4					X

RUBRICS FOR CONTINUOUS INTERNALEVALUATION (CIE) FOR 40 MARKS		
Particulars		**Marks**
Internal Assessment (Average of two best performances out of three internal assessments tests shall beconsidered).		**25**
Seminar/Presentation	Document for the same must be maintained.	**05**
Subject Viva-Voce/ Oral Examination		**05**
Assignment/ Quiz		**05**
	Total	**40**
Note: Course Instructor may introduce/use any activity other than theabove three activities to award 15marks.The activities used by the courseinstructor must be measurable and documented for inspection by VTU.		

QUESTION PAPER PATTERN FOR SEE Semester End Examination (SEE) conducted for100marks and converted to 60 marks.			
Particulars	**Question member**	**Composition of the question**	**Marks**
Part – A Any four full questions to be answered. Total marks for Part – A is 80.	1 to 7	(a)	**03**
		(b)	**07**
		(c)	**10**
		Any two 10 marks sub questions of seven main questions should be pertaining to application oriented topics based on practical Components given at the end of each course.	
Part – B Compulsory Marks for Part – B is 20.	8	Case Study	**20**
		Total	**100**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
SCHEME OF TEACHING AND EXAMINATION

RUBRICS FOR CONTINUOUS INTERNAL EVALUATION (CIE) FOR 40 MARKS

Particulars	Marks	Procedure
Internal Assessment Test	**50+50= 100/4=25**	**Average of two best performances out of three internal assessments tests shall be considered.**
Seminar/Presentation	**05**	**Document for the same must be maintained**
Subject Viva-Voce/ Oral Examination	**05**	**Document for the same must be maintained**
Assignment/ Quiz	**05**	**Document for the same must be maintained**
Note: Course Instructor may introduce/use any activity other than the above three activities to award 15marks.The activities used by the course instructor must be measurable and documented for inspection by VTU.		

Semester End Examination (SEE) conducted for 100marks and converted to 60 marks.

QUESTION PAPER PATTERN for SEE

Q.No.1 to7 PART -A	Marks
a	**3 marks**
b.	**7 marks**
c.	**10 marks**
Total (4/7) 4X20	**80 marks**
PART -B CASE -Compulsory	**20 marks**

Note: For III Semester SEE, 20% marks shall be allocated to application oriented questions based on practical Components given at the end of each course.

GUIDELINES FOR 6 WEEK PROJECT WORK

Semester	**IV**	**CIE Marks**	**: 40**
Course Code	**18MBAPR407**	**SEE Marks**	**: 60**
Teaching Hours / week (L:T:P)	**0-0-12**		
	Credits : 06		

OBJECTIVE

To expose the students to understand the working of the organization/company / industry and take up an in-depth study of an issue / problem in the area of specialization.

GENERAL GUIDELINES

- The project work shall be for a period of 6 weeks immediately after the completion of 3rd Semester Examinations but before the commencement of the 4th semester classes.
- The project work report shall be compulsory for all the students opting for all specializations.
- The University shall receive 2 copies of project reports prior to the commencement of the 4th semester examination. Copies of the project report should be sent to the concerned Regional Office with an intimation to the Registrar (Evaluation)
- By keeping the business trend in the present scenario, university has given an option to the students to select the research problem either from business organization or they can carry out the project on freelance basis subject to the approval of department committee.
- It is the total responsibility of the internal guide to monitor the freelance project.
- In case, business problem selected from a Company, no two students of an institute shall work on the same problem in the same organization.
- The student shall seek the guidance of the internal guide on a continuous basis, and the guide shall give a certificate to the effect that the candidate has worked satisfactorily under his/her guidance.
- On completion of the project work, student shall prepare a report with the following format.
- The Project report shall be prepared using word processor viz. MS Word with New Times Roman, 12 font size
- All the reports shall be printed in the A4 size 1 inch margin on all the sides.
- The report shall be hard bound facing sheet of royal blue color indicating the title of college and month & year of admission (spiral binding not permitted)

- A certificate by the guide, HOD and Head of the institution indicating the bonafide performance of the project by the student to be enclosed.
- An undertaking by the student to the effect that the work is independently carried out by him/her
- The certificate from the organization if applicable.
- Acknowledgement
- Executive Summary

Schedule to be followed before commencement of Project

Activity	Timeline	Remarks
Identifying the organization Problem identification	First week	Student individually identifies an organization OR identifies problem for his/her study, according to his/her interest.
Problem statement Research Design	Second Week	His/ Her interests are discussed with project guides. Discussion with Internal Guide to decide on suitable design for the research
Synopsis Preparation	Third week	Preparation of Synopsis* & formulating the objectives
Presentation of Synopsis	Fourth Week	The student will present the synopsis with the detailed execution plan to the Internal Guide and HOD who will review and may: a. Approve b. Approve with modification or c. Reject for fresh synopsis
Approval Status	Fifth & Sixth week	The approval status is submitted to HOD who will officially give concurrence for the execution of the Project

*Synopsis: It is a three page document or hard copy to be submitted to the HOD with the signatures of the Guide and the student.

Page 1	Title, Contact Address of student- with details of Internal and External Guide (if applicable)
Page 2	Short introduction with objectives and summary (300 words). Review of Articles / Literature about the topic with source of information
Page 3	Time Activity Chart

Schedule to be followed during Project work

Activity	Time Line	Remarks
Understanding Structure, Culture and functions of the organization /identifying of business problem from the Industry from the literature study	First week of Project	Student should understand products/services and the problems of the organization.
Preparation of Research design and Research instrument for data collection	2nd week of Project	Discussion with the guide for finalization of research design and instrument in his/her domain and present the same to the guide. (First Presentation)
Data collection	3rd week of Project	Date collected to be edited, coded, tabulated and presented to the guide for suggestions for analysis. (Second Presentation)
Analysis and finalization of report	4th & 5th week of project	Students must use appropriate and latest statistical tools and techniques for analyzing the data. (It is must to use of Statistical Package whose result should be shown in the report) (Third Presentation)
Submission of Report	6th week of Project	Final Report should be submitted to the University before one week of the commencement of theory examination

Evaluation:

- Internal evaluation will be done by the internal guide.
- External valuation shall be done by a faculty member of other institute drawn from VTU affiliated institute with minimum of 10 years experience.
- Viva-Voce / Presentation: A viva-voce examination shall be conducted at the respective Institution where a student is expected to give a presentation of his/ her work.
- The viva –voce examination will be conducted by the respective HOD / Senior Professor of the department and an expert drawn from the VTU affiliated institutes with minimum of 10 years of experience as appointed by the University.
- Project work carries 100 marks consisting of 40 marks for internal marks by the internal guide, average of 30 marks from both internal and external evaluation and 30 marks for viva-voce examination. . Minimum passing marks of the Project work is 50% in each of the components such as Internal Marks, report evaluation and viva-voce examination.
- Format of the project report shall be prepared using the word processor viz., MS Word, Times New Roman font sized 12, on a page layout of A4 size with 1inch margin all sides (1.5inch on left side) and 1.5 line spacing. The Project report shall not exceed 100 pages.

- Submission of Report: Students should submit the Project Report in electronic data form only, in PDF file (Un-editable Format) to the Institute. The Institute in turn shall submit all the CD's of their students along with a consolidated master list as per specialization containing USN, Name of the student, and Title of the Report to Registrar Evaluation) one week before the commencement of the Theory Examinations or as per notification given for this purpose.
- Plagiarism: Plagiarism is considered as academically fraudulent, and an offence against University academic discipline. The University considers plagiarism to be a major offence, and subject to the corrective procedures. It is compulsory for the student to get the plagiarism check done before submission of the project report. Plagiarism of up to 25% is allowed in the project work and report should consist 75% of original content/work.
- Publication of Research Findings: Students are expected to present their research findings in Seminars/ Conferences/ Technical/ Management Fests or publish their research work in Journals in association with their Internal Guide. Appropriate Weightage should be given to this in the internal evaluation as well as in the viva voce examination of the project report.

Contents of the Project Report

- Cover page
- Certificate from the Organization (scanned copy if applicable)
- Certificate from the guide, HOD and Head of the Institution (scanned copy) indicating bonafide performance of Project by the student
- Declaration by the student (scanned copy)
- Acknowledgement
- Table of contents
- List of tables and graphs
- Executive summary

Chapter 1: Introduction

Introduction, Industry profile and company profile: Promoters, vision, Mission & Quality Policy. Products / services profile areas of operation, infrastructure facilities, competitors' information, SWOT Analysis, Future growth and prospects and Financial Statement

Chapter 2: Conceptual background and Literature review

Theoretical background of the study, Literature review with research gap (with minimum 20 literature reviews).

Chapter 3: Research Design

Statement of the problem, Need for the study, Objectives, Scope of the study, Research methodology, Hypotheses, Limitations, Chapter scheme.

Chapter 4: Analysis and Interpretation

Analysis and interpretation of the data- collected with relevant tables and graphs. Results obtained by the using statistical tools must be included.

Chapter 5: Findings, Conclusion and Suggestions

Summary of findings, Conclusion and Suggestions / Recommendations

Bibliography

Annexure relevant to the project such as figures, graphs, photographs etc.,

Rubrics for Project Work (Common to core and Dual Specializations)

Particulars	Marks Allotted
A. Internal Assessment by the Guide- Based on three Presentations by Students	40
B. Report Evaluation by the Guide & External Examiner. Average of the marks awarded by the two Examiners shall be the final evaluation marks for the Dissertation.	30
C. Viva-Voce Examination to be conducted by the Guide and an External examiner from the Industry/ Institute (Joint Evaluation)	30
Total	**100**

Rubrics for Project Evaluation and Viva voce Examination

SL No	Aspects	Marks Allotted
A. Internal Assessment by the Guide- Based on three Presentations by Students		
1	First Presentation	5
2	Second Presentation	5
3	Third Presentation	5
4	Introduction and Methodology	5
5	Industry and Company Profile	5
6	Theoretical background of study	5
7	Data analysis and interpretation	5
8	Summary of findings, suggestions and conclusion	5
	Total	**40**
B. Report Evaluation by the Guide & External Examiner. Average of the marks awarded by the two Examiners shall be the final evaluation marks for the Dissertation.		
1	Introduction & Relevance of the project	5
2	Conceptual background and literature review	5
3	Research design	5
4	Analysis and interpretation	10
5	Summary of findings, suggestions and conclusion	5
	Total	**30**
C. Viva-Voce Examination to be conducted by the Guide and an External examiner from the Industry/ Institute (Joint Evaluation)		
1	Presentation skills	5
2	Communication skills	5
3	Subject knowledge	5
4	Objectives of the study and Methodology	5
5	Analysis using statistical tools and statistical packages	5
6	Findings and appropriate suggestions	5
	Total	**30**

Formats for Project Report and Evaluation

- Format of Cover Page
- Format of certificate by College/Institution or from both
- Format of Declaration Page
- Format of Contents
- Format of List of Tables and Charts
- Format of Bibliography
- Format for Internal Evaluation, External Evaluation and Viva voce

(Title of the Report)

BY

(Student Name)
(USN)

Submitted to
VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

In partial fulfillment of the requirements for the award of the degree of MASTER OF BUSINESS ADMINISTRATION

Under the guidance of

INTERNAL GUIDE	**EXTERNAL GUIDE**
(Name & Designation)	(Name & Designation)

Department of MBA
(Institute Name with Address)

(Month & Year of submission)

CERTIFICATE

This is to certify that (Name of the Student) bearing USN (xxxx), is a bonafide student of Master of Business Administration course of the Institute (Batch), affiliated to Visvesvaraya Technological University, Belgaum. Project report on "(Title of Report)"is prepared by Him/her under the guidance of (Name of the Guide), in partial fulfillment of the requirements for the award of the degree of Master of Business Administration of Visvesvaraya Technological University, Belagavi Karnataka

Signature of Internal Guide　　　　Signature of HOD

Signature of Principal

Viva-voce Examination　　　　**Date:**

Signature of Internal Examiner
Name & affiliation

Signature of External Examiner
Name & affiliation

DECLARATION

I, (Student Name), hereby declare that the Project report entitled "(Title)" with reference to "(Organisation with place)" prepared by me under the guidance of (Guide Name), faculty of M.B.A Department, (Institute name) and external assistance by (External Guide Name, Designation and Organisation). I also declare that this Project work is towards the partial fulfillment of the university

Regulations for the award of degree of Master of Business Administration by Visvesvaraya Technological University, Belgaum. I have undergone a summer project for a period of Six weeks. I further declare that this Project is based on the original study undertaken by me and has not been submitted for the award of any degree/diploma from any other University / Institution.

Place :　　　　**Signature of the Student**
Date:

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LIST OF TABLES