Basavarajeswari Group of Institutions

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN											Course Code	2	2	E	C	4	2

Fourth Semester B.E. Degree Examinations, September 2024

ENGINEERING ELECTROMAGNETICS

Duration: 3 hrs **Max. Marks: 100**

Note: ***1. Answer any* FIVE *full questions choosing ONE full Question from each Module.***
2. Missing data, if any, may be suitably assumed

Q. No		Question	Marks	(RBTL:CO:PO)
		Module-1		
1.	**a.**	State and explain the experimental law of Coulomb.	**06**	(2:1:1)
	b.	Derive an expression for Electric field intensity due to the Infinite sheet of charge.	**06**	(2:1:1)
	c.	Four 10ηc positive charges are located in z = 0 plane at the corners of a square 8cm on a side. A fifth 10ηc charge is located at a point 8cm distant from the other charges. Calculate the magnitude of total force on this fifth charge (Assume $\varepsilon = \varepsilon_0$).	**08**	(3:1:1)
		OR		
2.	**a.**	State and explain the mathematical representation of Gauss's Law.	**06**	(2:1:1)
	b.	Expand $\nabla.\bar{D}$ in various Coordinate systems. Also list the properties of divergence of Vector field.	**04**	(2:1:1)
	c.	Given that, $\bar{D} = 4x\overline{a_x} + 3y^2\overline{a_y} + 2z^3\overline{a_z}$. Write a MATLAB code to verify both sides of the divergence theorem for the volume bounded by 6 planes where $1 \le x \le 2; 2 \le y \le 3; 3 \le z \le 4$ and support your answer with numerical computations.	**10**	(3:1:5)
		Module-2		
3.	**a.**	Find the work done in moving a point charge Q = 5μC from the origin to (2m, π/4, π/2) in spherical co-ordinates in the field. Given $\vec{E} = 5e^{\frac{-r}{4}}\overrightarrow{a_r} + \frac{10}{rsin\theta}\overrightarrow{a_\theta}$	**06**	(3:2:1)
	b.	Find the expression, establishing the relationship between the Electric field intensity and Potential gradient.	**04**	(2:2:1)
	c.	A point charge of 6 ηC is located at the origin in free space, Write a MATLAB code to find the absolute potential at point P (0.2, -0.4, 0.4) if Vr = 0 at (1,0,0) and support your answer with numerical computations.	**10**	(3:2:5)
		OR		
4.	**a.**	Determine whether or not the following potential fields satisfy the Laplace's Equation: a) $V = 2x^2 - 3y^2 + z^2$ b) $V = r^2 + z^2$.	**06**	(3:2:1)
	b.	State and prove Uniqueness Theorem.	**06**	(2:2:1)
	c.	Derive the Capacitance of a two concentric Spheres of Radius R1 and R2 respectively, where $V=V_0$ at R1 and V=0 at R2 (R2>R1) by Applying Laplace equation.	**08**	(3:2:1)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PO – Programme Outcome)

Module-3

5.	**a.**	State and Explain Biot-Savart Law.	**06**	(2:3:1)
	b.	Obtain the expression for magnetic force between the two differential current elements and hence for current loops.	**06**	(2:3:1)
	c.	Given $\bar{H} = 20r^2\,\overline{a_\phi}$ A/m i) Determine the Current density $\bar{J}$ ii) Also determine the total current that crosses the surface r = 1 m, 0< ϕ<2π and z = 0.	**08**	(3:3:1)

OR

6.	**a.**	Derive the expression for Magnetic field intensity $\bar{H}$ due to infinite current carrying conductor using Ampere's Circuital law.	**06**	(2:3:1)
	b.	Write a short note on Scalar and Vector magnetic potential.	**06**	(2:3:1)
	c.	A point charge Q = 18nC has a velocity of 5 X 10^6 m/s in the direction $\overline{a_v} = 0.6\,\overline{a_x} + 0.75\,\overline{a_y} + 0.3\,\overline{a_z}$. Calculate the Magnitude of the force exerted on the charge by the field. i) $\bar{E} = -3\,\overline{a_x} + 4\,\overline{a_y} + 6\,\overline{a_z}$ KV/m, ii) $\bar{B} = -3\,\overline{a_x} + 4\,\overline{a_y} + 6\,\overline{a_z}$ mT, iii)$\bar{E}$ *and* $\bar{B}$ acting together.	**08**	(3:3:1)

Module-4

7.	**a.**	Derive the continuity equation from Maxwell's equation.	**06**	(3:4:1)
	b.	Tabulate the Maxwell's equations in Point form and integral form.	**06**	(2:4:1)
	c.	A Circular loop of 10 cm radius is located in the x-y plane with magnetic field $\bar{B} = 0.5\,cos(377t)[3\bar{a}_x + 4\bar{a}_z]$ **T.** Calculate the voltage induced in a loop (Apply Faraday's Law)	**08**	(3:4:1)

OR

8.	**a.**	Starting from the concept of Faraday's law of electromagnetic induction, derive the Maxwell's equation, $\nabla \mathrm{X}\,\bar{E} = -\frac{\partial \bar{B}}{\partial t}$	**06**	(3:4:1)
	b.	Modify the Ampere's Circuital law to suit the time-varying conditions.	**06**	(2:4:1)
	c.	A parallel plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage of 50 sin 10^3t volts applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$.	**08**	(3:4:1)

Module-5

9.	**a.**	The depth of penetration in a certain conducting medium is 0.1 m and the frequency of the electromagnetic wave is 1MHz. Find the conductivity of the conducting medium.	**06**	(2:5:1)
	b.	State and prove the Pointing's theorem.	**06**	(3:5:1)
	c.	What is a Uniform Plane wave? Explain the propagation of uniform waves in free space with necessary equations.	**08**	(3:5:1)

OR

10	**a.**	Discuss the goals and importance of electromagnetic compatibility (EMC).	**06**	(2:5:4)
	b.	Explain the electromagnetic wave propagation in perfect dielectric media with the necessary equations.	**06**	(3:5:1)
	c.	A 10 GHz plane wave traveling in free space has an amplitude of $\bar{E}$ as Ex = 10 V/m. Find β, η, ν, λ and amplitude, direction of $\bar{H}$.	**08**	(3:5:1)

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Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PO – Programme Outcome)