Basavarajeswari Group of Institutions

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN										Course Code	2	1	E	C	5	2

Fifth Semester B.E. Degree Examinations, September/October 2024

ELECTROMAGNETIC THEORY

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:PI)
		Module-1		
1.	**a.**	State and explain Coulomb's law. Also express in vector form.	**06**	(2 : 1 : 1.3.1)
	b.	A point charge Q_1= 300 μC located at (1,-1,-3) m experiences a force of $\overline{F} = 8\overline{a_x} - 8\overline{a_y} + 4\overline{a_z}$ N due to point charge Q_2 at (3,-3, 2) m. Determine Q_2.	**06**	(3 : 1 : 2.1.2)
	c.	Derive an expression for Electric field intensity ($\overline{E}$) due to line charge of infinite length.	**08**	(2 : 1 : 1.3.1)
		(OR)		
2.	**a.**	A uniform line charge of linear charge density 25 ηC/m lies on the line x= -3 m and z= 4 m in free space. Find the electric field intensity at a point (2,15,3) m.	**06**	(2 : 1 : 2.1.2)
	b.	State and explain the mathematical representation of Gauss law.	**06**	(2 : 1 : 1.3.1)
	c.	Show that the divergence of electric flux density is equal to volume charge density.	**08**	(2 : 1 : 1.3.1)
		Module-2		
3.	**a.**	Obtain the expression for work done in moving a point charge in an electric field.	**06**	(2 : 2 : 1.3.1)
	b.	Determine work done in carrying a charge of -4C from (2,1,-1) to (8,3,-1) in the electric field $\overline{E} = y\overline{a_x} + x\overline{a_y}\ v/m$, considering the path along the parabola $x=2y^2$.	**06**	(3 : 2 : 2.1.2)
	c.	Show that electric field is a negative gradient of potential.	**08**	(2 : 2 : 1.3.1)
		(OR)		
4.	**a.**	From the Gauss law, derive Poisson's and Laplace equations.	**06**	(2 : 3 : 1.3.1)
	b.	State and prove Uniqueness theorem.	**06**	(2 : 3 : 1.3.1)
	c.	Determine whether or not the following potential fields satisfy the Laplace's equation: (i) $V = r\cos\theta + \phi$ (ii) $V = 2X^2 - 3Y^2 + Z^2$	**08**	(3 : 3 : 2.1.2)
		Module-3		
5.	**a.**	State and explain Biot-Savart law.	**06**	(2 : 4 : 1.3.1)
	b.	Distinguish between scalar and vector magnetic potentials and arrive at an expression for them.	**06**	(2 : 4 : 1.3.1)
	c.	State and prove Ampere's circuital law.	**08**	(2 : 4 : 1.3.1)
		(OR)		

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)

6.	**a.**	State and explain Lorentz force equation.	**06**	(2 : 4 : 1.3.1)
	b.	Derive the expression for magnetic boundary conditions (normal components only) between the two different magnetic medium.	**06**	(2 : 4 : 1.3.1)
	c.	Evaluate both sides of Stoke's theorem for the field $\overline{H} = 6xy\overline{a_x} - 3y^2\overline{a_y}\ A/m$ and the rectangular path around the region, $2 \le X \le 5,\ -1 \le Y \le 1,\ Z = 0.$ Let the positive direction of $\overrightarrow{dS}$ be $\overrightarrow{a_z}$.	**08**	(3 : 4 : 2.1.2)

Module-4

7.	**a.**	Starting from the concept of Faraday's law of electromagnetic induction, derive the Maxwell's equation, $\nabla X \vec{E} = -\frac{\partial \vec{B}}{\partial t}$.	**06**	(3 : 5 : 2.1.2)
	b.	Show that the displacement current in dielectric of parallel plate capacitor is equal to the conduction current in the leads.	**06**	(2 : 5 : 1.3.1)
	c.	List and explain Maxwell's equation in point and integral form.	**08**	(2 : 5 : 1.2.1)

(OR)

8.	**a.**	Write a short note on conduction current density and displacement current density.	**06**	(2 : 5 : 1.3.1)
	b.	In a given lossy dielectric medium, conduction current density $J_c = 0.02 \sin 10^9 t$ (A/m^2). Find the displacement current density if $\sigma = 10^3$ S/m and $\varepsilon_r = 6.5$	**06**	(2 : 5 : 2.1.2)
	c.	What is inconsistency of Ampere's law with continuity equation? Derive the modified Ampere's circuital law by Maxwell to suit for time-varying fields.	**08**	(2 : 5 : 1.3.1)

Module-5

9.	**a.**	Define the following terms: (i) Propagation constant (γ) (ii) Attenuation constant (α) (iii) Phase constant (β) (iv) Phase Velocity (v_p)	**06**	(1: 5 : 1.3.1)
	b.	The depth of penetration in a certain conducting medium is 0.1m and the frequency of electromagnetic wave is 1MHz. Find the conductivity of the conducting medium.	**06**	(2 : 5 : 2.1.2)
	c.	Explain the propagation of uniform waves in free space with necessary equations.	**08**	(2 : 5 : 1.3.1)

(OR)

10	**a.**	Explain the wave propagation in good conductors using the skin depth.	**06**	(2 : 5 : 1.3.1)
	b.	Discuss the goals and importance of electromagnetic compatibility (EMC).	**06**	(1 : 5 : 1.3.1)
	c.	State and explain Poynting theorem and write the equation both in point and integral form.	**08**	(2 : 5 : 1.3.1)

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