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, April/May 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.**	Define Electric field intensity and derive $\overline{E}$ due to several (multiple) point charges.	**06**	(2 :1: 1.3.1)
	b.	State and explain the vector form of Coulomb's law with necessary illustrations.	**06**	(2 :1: 1.3.1)
	c.	Three Point charges Q1= -1μC, Q2= -2μC, and Q3= -3μC are placed at the corners of an equilateral triangle of side 1 m. Find the magnitude of electric field intensity at the point bisecting the line joining Q1 and Q2.	**08**	(3 :1: 1.4.1)
		(OR)		
2.	**a.**	State and prove Gauss's law in integral form.	**06**	(2 :1: 1.3.1)
	b.	Derive an expression for Electric field intensity $\left(\overline{E}\right)$ due to infinite line charge using Gauss's law.	**06**	(2 :1: 1.3.1)
	c.	Given that, $\overline{D} = \frac{5r^2}{4}\overline{a_r}$ C/m^2, evaluate both sides of the divergence theorem for the volume enclosed by r = 4 m and θ =π/4 rad = 45^0 and take 0 < φ < 2π (Use Spherical Coordinates).	**08**	(3 :1: 1.4.1)
		Module-2		
3.	**a.**	Find the work done in moving a charge of +2 C from (2,0,0) m to (0,2,0) m along the straight-line path joining two points if the electric field is $\overline{E} = \left(12x\overline{a_x} - 4y\overline{a_y}\right)$ v/m.	**06**	(3 :2: 1.4.1)
	b.	Let $V = \cos 2\phi / r$ in the free space in cylindrical coordinates, Find Electric field intensity $\left(\overline{E}\right)$ at a point P (2, 30^0, 1).	**06**	(3 :2: 1.4.1)
	c.	Define potential difference and derive the potential difference between two points due to point charge in an electric field.	**08**	(2 :2: 1.3.1)
		(OR)		
4.	**a.**	Start from Gauss's law, derive Poisson's and Laplace's equations, and mention their significance.	**06**	(2 :3: 1.3.1)
	b.	Determine whether or not the following potential fields satisfy Laplace's equation: (i) V = 2x^2 - 3y^2 + z^2 (ii) V = r^2 + z^2.	**06**	(3 :3: 1.4.1)
	c.	Find the expression for the capacitance of a two-parallel plate capacitor by applying Laplace's equation.	**08**	(3 :3: 1.4.1)

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

Module-3

5.	**a.**	State and prove Ampere's circuital law.	**06**	(2 :4: 1.3.1)
	b.	Given that $\overline{H} = 20r^2\overline{a_\varphi}$ A/m (i) Determine the current density $\overline{J}$ (ii) Also determine the total current that crosses the surface r = 1 m, $0 < \varphi < 2\pi$ and z = 0 (In Cylindrical Coordinates).	**06**	(3 :4: 1.4.1)
	c.	Obtain the expression for magnetic field intensity at a point P due to an infinite current-carrying conductor applying Biot-Savart law.	**08**	(3 :4: 1.3.1)
		(OR)		
6.	**a.**	State and explain the Lorentz force equation.	**06**	(2 :4: 1.3.1)
	b.	A conductor 4 cm long lies along the y-axis with a current of 10 mA in the $\overline{a_y}$ direction. Find the force on the current carrying conductor due to magnetic field, if the field in the region is $\overline{H} = \left[5\overline{a_x}/\mu\right]$ A/m.	**06**	(3 :4: 1.4.1)
	c.	State and prove Stoke's theorem.	**08**	(3 :4: 1.4.1)

Module-4

7.	**a.**	What is the inconsistency of Ampere's law with the continuity equation? Derive the modified Ampere's circuital law by Maxwell to suit for time-varying fields.	**06**	(2 :5: 1.3.1)
	b.	Derive the point form of the continuity equation for current from Maxwell's equation.	**06**	(2 :5: 1.3.1)
	c.	A circular conducting loop of radius 40 cm lies in the x-y plane and has a resistance of 20 Ω. If the magnetic flux density in the region is given by, $\overline{B} = 0.2\cos 500t\overline{a_x} + 0.75\sin t\overline{a_y} + 1.2\cos 314t\overline{a_z}\ T$, determine the effective value of induced current in the loop using Faraday's law.	**08**	(3 :5: 2.1.3)
		(OR)		
8.	**a.**	List and tabulate Maxwell equations in point form and differential form for good conductors.	**06**	(2 :5: 1.3.1)
	b.	Prove that the conduction current is equal to the displacement current between the two plates for $V = V_o e^{j\omega t}$ in a parallel plate capacitor.	**06**	(3 :5: 1.4.1)
	c.	State and explain Faraday's law of electromagnetic induction. Derive its equation in integral and differential form.	**08**	(3:5:1.3.1)

Module-5

9.	**a.**	Briefly explain the applications of Electromagnetic Compatibility.	**06**	(2:5:1.3.1)
	b.	List the expressions for α, β, γ, v_p, λ and η in free space.	**06**	(2:5:1.3.1)
	c.	Illustrate the wave propagation in good conductors using the skin depth.	**08**	(3:5:2.1.3)
		(OR)		
10	**a.**	State and Explain Poynting theorem.	**06**	(2:5:1.4.1)
	b.	The depth of penetration in a certain conducting medium is 0.1 m and the frequency of the electromagnetic wave is 1.0 MHz Find the conductivity of the conducting medium.	**06**	(2:5:1.4.1)
	c.	Starting from Maxwell's equations, obtain the general wave equations in electric and magnetic fields.	**08**	(3:5:2.1.3)

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