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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Electronics & Telecommunication Engineering **Duration: 3 hrs.**

Course Code: 23ET5PCEMC / 22ET5PCEM1 **Max Marks: 100**

Course: ELECTROMAGNETICS

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT – I	*CO*	*PO*	Marks
1	a)		State and Explain Coulomb's law of force between two point charges in vector form.	*CO1*		**05**
	b)		Point charges of 50nC each are located at A(1,0,0), B(-1,0,0),C(0,1,0) and D(0,-1,0) in free space. Find the total force on the charge at A.	*CO2*	*PO1*	**08**
	c)		Derive an Expression for Electric field intensity due to an infinite line charge.	*CO2*	*PO1*	**07**
			OR			
2	a)		State and Prove Gauss Law.	*C02*	*PO1*	**05**
	b)		Derive the expression for **E** due to sheet charge using Gauss's law.	*CO2*	*PO1*	**05**
	c)		Evaluate both sides of the divergence theorem for the defined plane in which $1 \le x \le 2$, $2 \le y \le 3$, $3 \le z \le 4$, if $\mathbf{D} = 4x\,\mathbf{a_x} + 3y^2\mathbf{a_y} + 2z^3\,\mathbf{a_z}$ c/m^2.	*CO2*	*PO1*	**10**
			UNIT – II			
3	a)		Obtain the expression for the work done in moving a point charge in an Electric field.	*CO2*	*PO1*	**07**
	b)		Given $V=2x^2y-5z$ at point P(-4,3,6), Find the potential, electric field intensity and volume charge density.	*CO2*	*PO1*	**07**
	c)		Calculate the work done in moving a charge 4C from (1,0,0) to A(0 ,2, 0) along the path y= 2-zx, z=0 in the field i) $\mathbf{E}=5\,\mathbf{a_x}$ v/m ii) $\mathbf{E}= 5x\,\mathbf{a_x}$ v/m iii) $\mathbf{E}= 5x\,\mathbf{a_x} + 5y\,\mathbf{a_y}$ v/m	*CO2*	*PO1*	**06**
			OR			
4	a)		Derive the expression for equation of continuity of current.	*CO3*	*PO2*	**08**
	b)		Electrical potential at an arbitrary point in free space is given as $V=2(x+1)^2(y+2)^2(z+3)^2$ volt at a point P(2,-1,4).Find i) V ii) **E** iii) $\lvert\mathbf{E}\rvert$ iv) $\lvert\mathbf{D}\rvert$ v) ρ_v	*CO2*	*PO1*	**06**

		c)	Define potential difference. Derive the expression for potential field of a point charge.	*CO2, CO3*	*PO1, PO2*	**06**
			UNIT – III			
	5	a)	Solve the Laplace's equation for the potential field in the homogeneous region between the two concentric conducting sphere with radii 'a' and 'b' such that b > a. If potential V = 0 at r = b and $V=V_0$ at r = a. Also find the capacitance between concentric spheres.	*CO3*	*PO2*	**10**
		b)	Determine whether the following potentials satisfy Laplace's equation. i) $V = 2x^2-3y^2+Z^2$ ii) V = r cosθ +ϕ	*CO3*	*PO2*	**06**
		c)	Write Laplace's equation in different coordinate systems.	*CO1*		**04**
			OR			
	6	a)	Derive an expression for capacitance of two uniformly charged parallel planes of infinite extent.	*CO3*	*PO2*	**08**
		b)	Obtain Poisson's equation from point form of Gauss Law.	*CO2*	*PO1*	**06**
		c)	Calculate numerical values for V and ρ_v at point P in free space where $V = 5\rho^2 \cos 2\varphi$ at $P(\rho = 3, \varphi = \frac{\pi}{3}, z = 2)$.	*CO2*	*PO1*	**06**
			UNIT – IV			
	7	a)	State and Explain Biot Savart's Law.	*CO1*		**06**
		b)	State and prove Ampere's circuital law.	*CO2*	*PO1*	**04**
		c)	Obtain the boundary conditions at the interface between two magnetic materials.	*CO3*	*PO2*	**10**
			OR			
	8	a)	Derive an expression for force between differential current elements.	*CO2*	*PO1*	**08**
		b)	A point charge of Q = 18C has a velocity of $5x10^6$ m/s in the direction $\mathbf{a_v}= 0.6\mathbf{a_x} + 0.75\mathbf{a_y} + 0.3\mathbf{a_z}$ m/s. Find the magnitude of the force exerted on the charge by the field a) $E= - 3\mathbf{a_x} + 4\mathbf{a_y} +6\mathbf{a_z}$ kV/m b) $B = - 3\mathbf{a_x} +4\mathbf{a_y} +6\mathbf{a_z}$ mT	*CO2*	*PO1*	**06**
		c)	Explain the concept of scalar potential.	*CO1*		**06**
			UNIT – V			
	9	a)	List and Explain Maxwell's equation in point form and integral form for time varying fields.	*CO1*		**08**

		b)	For the given medium $\varepsilon=10^{-11}$ F/m and $\mu=10^{-5}$ H /m, if $B = 2x10^{-4}\cos 10^5 t \sin 10^{-3}$ **y** $\mathbf{a_x}$ tesla: i) Find **E** ii) Find the total magnetic flux passing through the surface x = 0, 0 < y < 40 m, 0 < z < 2 m at t = 1 μ sec	*CO2*	*PO1*	**08**
		c)	A conductor of length 4 m long lies along the 'y' axis with a current of 10 Amp in the $\mathbf{a_y}$ direction. Find the force on the conductor if the field in the region is $B=0.005\mathbf{a_x}$ tesla.	*CO2*	*PO1*	**04**
			OR			
	10	a)	State and Prove Poynting theorem.	*CO1*		**08**
		b)	For the given medium $\varepsilon=4x10^{-9}$ F/m and σ =0, find K so that $\mathbf{E}=(20y-kt)\mathbf{a_x}$ V/m and $\mathbf{H}=(y+2x10^6t)\mathbf{a_z}$ A/m.	*CO2*	*PO1*	**06**
		c)	A uniform plane wave of frequency 10 MHz travels in positive direction in a lossy medium with and μ_r =4 and ε_r = 2.5 and conductivity 10^{-3} ʊ/m Find a) attenuation constant b) phase constant c) wave length d) propagation constant and intrinsic impedance.	*CO2*	*PO1*	**06**

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