CBCS SCHEME

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BEC401

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2024
Electromagnetics Theory

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	State and explain spherical coordinate system in detail.	5	L2	CO1
	b.	Four point charges each of 10 μC are placed in free space at the points (1, 0, 0), (-1, 0, 0), (0, 1, 0) and (0, -1, 0) m respectively. Determine the force on a point charge of 30 μC located at a point (0, 0, 1) m.	8	L3	CO1
	c.	Show that electric field intensity at a point, due to 'n' number of point charges, is given by, $E = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{Q_i}{R_i^2}a_{R_i}$ V/m	7	L3	CO1
		OR			
Q.2	a.	Define electric field intensity. Derive the expression for electric field intensity due to infinite line charge.	9	L1	CO1
	b.	Given the two points $A(\rho = 4.4, \phi = -115^\circ, Z = 2)$ and B(x = -3.1, y = 2.6, z = -3), find (i) The rectangular coordinate of point A (ii) The cylindrical coordinate of point B (iii) The distance between A and B.	5	L3	CO1
	c.	Find E at P(1, 5, 2) m in free space if a point charge of 6 μC is located at (0, 0, 1), the uniform line charge density $\rho_L = 180$ nC/m along x axis.	6	L3	CO1
		Module – 2			
Q.3	a.	State and prove Gauss's law for point charge.	6	L3	CO2
	b.	Calculate the divergence of D at the point specified if, (i) $D = (2xyz - y^2)a_x + (x^2z - 2xy)a_y + x^2ya_z$ C/m^2 at P_A (2, 3, -1) (ii) $D = 2\rho Z^2\sin^2\phi a_\rho + \rho Z^2\sin 2\phi a_\phi + 2\rho^2 Z\sin^2\phi a_z$ C/m^2 at $P_B(\rho = 2, \phi = 110^\circ, Z = -1)$ (iii) $D = 2r\sin\theta\cos\phi a_r + r\cos\theta\cos\phi a_\theta - r\sin\phi a_\phi$ C/m^2 at $P_C(r = 1.5, \theta = 30^\circ, \phi = 50^\circ)$	9	L3	CO2
	c.	Find electric field intensity at the point A(1, 2, -1) given the potential $V = 3x^2y + 2y^2z + 3xyz$	5	L3	CO2
		OR			
Q.4	a.	Evaluate both sides of divergence theorem if $D = \frac{5r^2}{4}a_r$ C/m^2 in spherical co-ordinate for the volume enclosed by r = 4 m and $\theta = \frac{\pi}{4}$ radians.	8	L3	CO2

	b.	Calculate the work done in moving a charge 4C from B(1, 0, 0) to A(0, 2, 0) along the path $y = 2 - zx$, $z = 0$ in the field (i)$E = 5a_x$ V/m (ii) $E = 5xa_x$ V/m (iii) $E = 5xa_x + 5ya_y$ V/m	6	L3	CO2
	c.	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) $\|E\|$ (iv) $\|D\|$ (v) ρ_V	6	L3	CO2
		Module – 3			
Q.5	a.	Evaluate the expression for capacitance of two uniformly charged parallel planes of infinite extent.	8	L2	CO3
	b.	Determine whether or not the potential equations satisfies Laplaces equation : (i) $V = 2x^2 - 4y^2 + z^2$ (ii) $V = \phi\cos\phi + z$ (iii) $V = r^2\cos\phi + \theta$	5	L3	CO3
	c.	An assembly of two concentric spherical shell is considered. The inner spherical shell is at a distance of 0.1 m and is at a potential of 0 volts. The outer spherical shell is at a distance of 0.2 m and at a potential of 100 V. The medium between them is a free space. Find E and D using spherical co-ordinate system.	7	L3	CO3
		OR			
Q.6	a.	State and explain Biot-Savarts law applicable to magnetic field.	6	L2	CO3
	b.	Evaluate both sides of the stokes theorem for the field, $H = 6xya_x - 3y^2a_y$ 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 ds be a_z.	8	L3	CO3
	c.	Let $A = (3y - z)a_x + 2xza_y$ wb/m in a certain region of free space. (i) Show that $\nabla.A = 0$ (ii) At P(2, -1, 3) find A, B, H and J.	6	L3	CO3
		Module – 4			
Q.7	a.	Obtain the expression for magnetic force between differential current elements.	6	L1	CO4
	b.	The point charge $Q = 18$nC has a velocity of 5×10^6 m/s in the direction $a_V = 0.60a_x + 0.75a_y + 0.30a_z$. Calculate the magnitude of force exerted on the charge by the field. (i) $B = -3a_x + 4a_y + 6a_z$ mT (ii) $E = -3a_x + 4a_y + 6a_z$ KV/m	6	L3	CO4
	c.	The magnetization in a magnetic material for which $\chi_m = 8$ is given in a certain region as $150\,Z^2a_x$ A/m. At $Z = 4$ cm, find the magnitude of, i) J_T ii) J iii) J_b.	8	L3	CO4
		OR			
Q.8	a.	Obtain the magnetic boundary conditions at interface between two different magnetic material.	8	L2	CO4
	b.	Two differential current elements $I_1dl_1 = 10^{-4}a_z$Am at $P_1(1, 0, 0)$ and $I_2dl_2 = 3\times10^{-6}(-0.5a_x + 0.4a_y + 0.3a_z)$ Am at $P_2(2, 2, 2)$ are located in free space. Find the vector force exerted on, (i) I_2dl_2 by I_1dl_1 (ii) I_1dl_1 by I_2dl_2	6	L3	CO4

	c.	The interface between two different regions is normal to one of three Cartesian axes. If $B_1 = \mu_0(43.5a_x + 24.0a_z)$ and $B_2 = \mu_0(22a_x + 24a_z)$. What is the ratio $\frac{\tan\theta_1}{\tan\theta_2}$?	6	L3	CO4
		Module – 5			
Q.9	a.	For the given medium $\varepsilon = 4\times10^{-9}$ F/m and $\sigma = 0$. Find K so that the following pair of fields satisfies Maxwell's equation, $E = (20y - Kt)a_x$ V/m, $H = (y + 2\times10^6 t)a_z$ A/m.	6	L3	CO5
	b.	Within a certain region $\varepsilon = 10^{-11}$ F/m and $\mu = 10^{-5}$ H/m, If $B = 2\times10^{-4}\cos10^5 t \sin10^{-3} y$ T ; (i) Find E (ii) Find total magnetic flux passing through the surface x = 0, 0 < y < 40 m, 0 < z < 2m at t = 1 μsec.	8	L3	CO5
	c.	State and explain pointing theorem.	6	L2	CO5
		OR			
Q.10	a.	Derive the modified Ampere's law by Maxwells for time varying fields.	5	L2	CO5
	b.	Show that the intrinsic impedance of the perfect dielectric $\eta = \frac{\lvert E\rvert}{\lvert H\rvert} = \sqrt{\frac{\mu}{\varepsilon}}$ and show that its value in free space is 377 Ω	7	L2	CO5
	c.	A plane electromagnetic wave having a frequency of 10 MHz has an average pointing vector of 1 W/m^2. If medium is lossless with relative permeability of 2 and relative permittivity of 3 find (i) The velocity of propagation. (ii) Wavelength. (iii) Impedance of the medium (iv) rms electric field.	8	L3	CO5

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