

Fourth Semester B.E./B.Tech. Degree Examination, June / July 2026
Electromagnetic 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.	Transform the vector field, to spherical co-ordinates. i) $10a_{\hat{x}}$ at $p(x = -3, y = 2, z = 4)$ ii) $10a_{\hat{y}}$ at $Q(r = 5, \phi = 30^\circ, z = 4)$	06	L3	CO1
	b.	State and explain Coulomb's law of force between two point charges in vector form.	06	L2	CO1
	c.	Point charges of 50 nC each located at A (1, 0, 0) , B (-1, 0, 0), C (0,1,0) and D (0, -1, 0) in free space . Find total force on the charge at A.	08	L3	CO1
OR					
Q.2	a.	Derive an expression for electric field intensity due to Infinite line charge.	08	L2	CO1
	b.	A uniform line charge of 16 nC/m is located along the line defined by $y = -2, z = 5$. Find $\vec{E}$ at $P(1,2,3)$	06	L3	CO1
	c.	Three infinite uniform sheets of charge are located in free space as follows $\rho_{s1} = 3 \text{ nC/m}^2$ at $z = -4$, $\rho_{s2} = 6 \text{ nC/m}^2$ at $z = 1$ and $\rho_{s3} = -8 \text{ nC/m}^2$ at $z = 4$. Find $\vec{E}$ at the point i) $P_A (-1, -5, 2)$ ii) $P_B (-2, 4, 5)$	06	L3	CO1
Module – 2					
Q.3	a.	State and prove Gauss's law for point charge.	06	L2	CO2
	b.	Given $\vec{D} = 0.3r^2 \hat{a}_r \text{ nC/m}^2$ in free space. i) Find the total charge within the sphere $r = 3$ ii) Find the total flux leaving the sphere $r = 4$	06	L3	CO2
	c.	Obtain the expression for work done in moving a point charge in an electric field.	08	L2	CO2
OR					
Q.4	a.	Evaluate both sides of Divergence theorem for the field $\vec{D} = 2xya_{\hat{x}} + x^2a_{\hat{y}} \text{ C/m}^2$ and rectangular parallelopiped formed by planes $x = 0$ and $y = 0$ and $2z = 0$ and 3.	08	L3	CO2
	b.	Derive the expression for equation of continuity.	06	L2	CO2
	c.	Calculate work done in moving a 4C charge from B (1,0,0) to A (0,2,0) along the path $y = 2 - 2x, z = 0$ in the field $\vec{E} = 5x a_{\hat{x}} + 5a_{\hat{y}} \text{ V/m}$.	06	L3	CO2

Module – 3

Q.5	a.	Derive the expression for Poisson's equation and Laplace's equation.	06	L2	CO3
	b.	Using Laplace's equation, derive the expression for capacitance per unit length of a co-axial cable using the following boundary condition $V = V_0$ at $r = R_1$ and $V = 0$ at $r = R_2$ and $R_2 > R_1$ where R_1 and R_2 are inner and outer radius of co-axial cable.	08	L3	CO3
	c.	State and prove Amper's Circuital Law.	06	L2	CO3

OR

Q.6	a.	Define stokes theorem and evaluate both sides of the stokes theorem for the field $\vec{H} = 6xy \hat{a}_x - 3y^2 \hat{a}_y$ A/m and the rectangular path around the region $2 \leq x \leq 5$, $-1 \leq y \leq 1$ and $z = 0$. Let the direction of $\vec{ds}$ be $\hat{a}_z$.	12	L3	CO3
	b.	Define Curl. Write Curl equation in various co-ordinate s / m	08	L2	CO3

Module – 4

Q.7	a.	Derive an expression for Lorentz force equation.	06	L2	CO4
	b.	A conductor 4 m long lies along the y – axis with a current of 10 A in the $\hat{a}_y$ direction. Find the force on the conductor if the field in the region is $\vec{B} = 0.005 \hat{a}_x$ Tesla.	06	L3	CO4
	c.	Find the magnetization in a magnetic material where i) $M = 1.8 \times 10^{-5}$ H /m and $ \vec{H} = 120$ A /m ii) $M_r = 22$, where there are 8.3×10^{28} atoms /m ³ and each atom has a dipole moment of 4.5×10^{-27} A m ² iii) $ \vec{B} = 300$ mT and $\chi_m = 15$	08	L3	CO4

OR

Q.8	a.	Obtain the expression for magnetic force between the differential current elements.	06	L2	CO4
	b.	If $\vec{B} = 0.05x \hat{a}_y$ Tesla in a material for which $X_m = 2.5$. Find i) M_r ii) μ iii) $\vec{H}$ iv) $\vec{M}$ v) $\vec{J}$ vi) $\vec{J}_b$	06	L2	CO1
	c.	Derive the expression for boundary conditions between the two magnetic materials.	08	L2	CO4

Module – 5

Q.9	a.	List and explain Maxwell's equations in point form and integral form.	08	L2	CO5
	b.	Derive expression for uniform plane wave for a free space.	08	L2	CO5
	c.	Find the frequency at which conduction current density and displacement current are equal in a medium with $\sigma = 2 \times 10^{-4}$ mho / m and $\epsilon_r = 81$	04	L3	CO5

OR

Q.10	a.	State and prove Poynting theorem.	10	L2	CO5
	b.	Let $\mu = 10^{-5}$ H/m $\epsilon = 4 \times 10^{-9}$ F/m and $\sigma = 0$ and $P_v = 0$. Determine 'K' so that each of the following pairs of fields satisfy Maxwell's equation. i) $\vec{D} = 2x \hat{a}_x - 3y \hat{a}_y + 4z \hat{a}_z$, $\vec{H} = Kx \hat{a}_x + 10y \hat{a}_y - 25z \hat{a}_z$ A /m ii) $\vec{E} = (20y - kt) \hat{a}_x$ v /m, $\vec{H} = (y + 2 \times 10^6 t) \hat{a}_z$ A /m	10	L2	CO5