

CBCS SCHEME - Make-Up Exam

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BEC401

Fourth Semester B.E/B.Tech. Degree Examination, June/July 2025

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
1	a.	State vector form of Coulomb's law of force between two point charges and indicate the units of quantities in the equation.	6	L2	CO1
	b.	Q_1 and Q_2 are the point charges located at (0, -4, 3) and (0, 1, 1). If Q_1 is $2nc$, find Q_2 such that the force on a test charge at (0, -3, 4) has no Z component.	8	L3	CO1
	c.	Calculate the electric field intensity at a point (3, 4, 5) due to a charge of $5 nc$ placed at (1, 2, 3).	6	L3	CO1
OR					
2	a.	Derive an expression for the electric field intensity due to infinite line charge.	8	L2	CO1
	b.	Find $\vec{D}$ in Cartesian co-ordinate system at point P(6, 8, -10) due to: i) a point charge of $40 mc$ at the origin ii) a uniform line charge of $\rho_L = 40 \mu c/m$ on the Z-axis.	8	L3	CO1
	c.	Define electric flux and flux density.	4	L1	CO1
Module – 2					
3	a.	State and prove Gauss law as applied to an electric field.	8	L3	CO2
	b.	The flux density $D = \frac{r}{3} \vec{a}_r$ nc / m ² is in the free space i) Find $\vec{E}$ at $r = 0.2m$ ii) Find the total electric flux leaving the sphere of $r = 0.2 m$ iii) Find the total charge within the sphere of $r = 0.3m$.	8	L3	CO2
	c.	Find the divergence of $\vec{A}$ at $P\left(5, \frac{\pi}{2}, 1\right)$ where $A = r Z \sin \phi \vec{a}_r + 3rZ^2 \cos \phi \vec{a}_\phi$.	4	L3	CO2
OR					
4	a.	State and prove Gauss divergence theorem.	8	L3	CO2
	b.	If the potential field V is $V = 100 (x^2 - y^2)$. Find $\vec{E}$, V at a point (2, -1, 3) and the equation representing the locus of all points having a potential of 300 V.	4	L3	CO2
	c.	Derive continuity of current equation.	8	L2	CO2
Module – 3					
5	a.	Using Biot-Savart's law, determine the magnetic field intensity at a pint due to infinite long straight conductor.	7	L3	CO3
	b.	Verify the potential field given below satisfies the Laplace's equation : $V = 2x^2 - 3y^2 + z^2$.	5	L3	CO3
	c.	Derive Laplace and Poisson's equations and write Laplace equation in all 3 co-ordinate systems.	8	L2	CO3

OR

6	a.	State and explain Amperes circuital law.	8	L2	CO3
	b.	Given that the general vector $\vec{A}$ is $\vec{H} = 2.5\vec{a}_x + \vec{a}_y$ in spherical co-ordinates. Find the curl of H at $(2, \pi/6, 0)$.	6	L3	CO3
	c.	Given that the vector magnetic potential $\vec{A} = x^2 \vec{a}_x + 2yz \vec{a}_y + (-x)^2 \vec{a}_z$. Find the magnetic flux density.	6	L3	CO3

Module – 4

7	a.	Derive the expression for the force between two differential current elements.	6	L2	CO4
	b.	A point charge of $Q = -1.2c$ has velocity $\vec{V} = (5\vec{a}_x + 2\vec{a}_y - 3\vec{a}_z) \text{ m/sec}$. Find the magnitude of the force exerted on the charge if : i) $\vec{E} = -18\vec{a}_x + 5\vec{a}_y - 10\vec{a}_z \text{ V/m}$ ii) $\vec{B} = -4\vec{a}_x + 4\vec{a}_y + 3\vec{a}_z \text{ T}$ iii) Both are present simultaneously.	9	L3	CO4
	c.	A conductor 6 m long lies along Z-direction with a current of 2A in $\vec{a}_z$ direction. Find the force experienced by conductor if $\vec{B} = 0.08\vec{a}_x \text{ T}$.	5	L3	CO4

OR

8	a.	Write a note on : i) Magnetization ii) Permeability iii) Forces on magnetic materials.	6	L1	CO4
	b.	If $\vec{B} = 0.05x \vec{a}_y \text{ T}$ in a material for which $\chi_m = 2.5$. Find : i) μ_r ii) μ iii) $\vec{H}$ iv) $\vec{M}$ v) $\vec{J}$.	8	L3	CO4
	c.	Discuss on magnetic boundary conditions.	6	L2	CO4

Module – 5

9	a.	List Maxwell's equations for steady and time varying field in : i) Point form ii) Integral form.	6	L2	CO5
	b.	State and explain Faraday's law of electromagnetic induction.	6	L2	CO5
	c.	If the magnetic field $\vec{H} = [3x \cos \beta + 6y \sin \alpha] \vec{a}_z$. Find current density $\vec{J}$ if fields are invariant with time.	8	L3	CO5

OR

10	a.	Obtain solution of the wave equation for a uniform plane wave in free space.	8	L1	CO5
	b.	State and prove Poynting theorem.	8	L3	CO5
	c.	Wet marshy soil is characterized by $\sigma = 10^{-2} \text{ s/m}$, $\epsilon_r = 15$ and $\mu_r = 1$. Show that at 60 Hz, it can be considered as good conductor. Hence at 60 Hz calculate : i) Skin depth ii) Intrinsic impedance iii) Propagation constant.	4	L3	CO3
