USN

CBCS SCHEME - Make-Up Exam

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 $\rho_L = 40$ μc/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 $\vec{H} = 2.5\vec{a}_v + \vec{a}_\phi$ 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 $\vec{V} = (5\vec{a}_x + 2\vec{a}_y - 3\vec{a}_z)$ m/sec. Find the magnitude of the force exerted on the charge if : i) $\vec{E} = -18\vec{a}_x + 5\vec{a}_y - 10\vec{a}_z$ V/m ii) $\vec{B} = -4\vec{a}_x + 4\vec{a}_y + 3\vec{a}_z$ 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 $\vec{B} = 0.08\vec{a}_x$ 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 $\vec{B} = 0.05x\,\vec{a}_y$ T in a material for which $x_m = 2.5$. 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 $\sigma = 10^{-2}$ 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**

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