Model Question Paper-1 with effect from 2022-23 (CBCS Scheme)

USN | | | | | | | | | | |

Fourth Semester B.E. Degree Examination

Subject: ELECTROMAGNETIC THEORY

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02.
03.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	State and explain the Cylindrical coordinate systems in detail	L1	05
	b	Show that electric field intensity at a point, due to 'n' number of point charges, is given by $\vec{E} = \frac{1}{4\pi\epsilon_o}\sum_{i=1}^{n}\frac{Q_i}{R_i^2}\hat{a}_{R_i}$ V / m.	L3	07
	c	Two point charges, Q_1 = 30 μC and Q_2 = -100 μC, are located at (2,0,5) and (-1,0,-2)m respectively. Find (i) force on Q_1(ii) force on Q_2 (iii) the magnitude of forces (iv) directions of forces	L3	08
		OR		
Q.02	a	State Coulomb's law of force between any two point charges and indicate the units of the quantities involved.	L1	06
	b	Show that the electric field intensity at any point due to an infinite sheet of charge is independent of the distance to the point from the sheet.	L3	08
	c	Two point charges, Q1 and Q2 are located at (1, 2, 0)m and (2, 0, 0)m respectively. Find the relation between the charges, Q1 and Q2 such that the total force on a unit positive charge at (-1, 1, 0) have (i). no x-component, (ii). no y-component.	L3	08
		Module-2		
Q. 03	a	State and prove Gauss's law for point charge.	L1	06
	b	A point charge, Q = 90 μC is located at the origin and there are surface charge distributions −8 μC /m^2 at r = 1 m and 4.5 μC/m^2 at r = 2 m. Find $\vec{D}$ everywhere.	L3	08
	c	Calculate the divergence of D at the point specified if (i) $\vec{D} = (1/z^2)[10xyz\ \hat{a}_x + 5x^2z\ \hat{a}_y + (2z^3 - 5x^2y)\ \hat{a}_z]$ at P(−2, 3, 5) (ii) $\vec{D} = 5z^2\hat{a}_r + 10\ r\ z\ \hat{a}_z$at P(3, -45^0, 5) (iii) $\vec{D} = 2\ r\sin\theta\sin\Phi\ \hat{a}_r + r\cos\theta\sin\Phi\ \hat{a}_\theta + r\cos\Phi\ \hat{a}_\Phi$ at P(3, 45^0, 45^0)	L3	08
		OR		
Q.04	a	State & prove Divergence theorem.	L1	07
	b	Obtain an expression for electric field intensity due to an infinite line charge along z- axis having a uniform charge of ρ_L C/m using Gauss's law	L3	06
	c	Given $\vec{D}$ = 0.3 r^2 a_r nC/m^2 in free space, (a) find $\vec{E}$ at P(2, 25°, 90°) (b) find the total charge within the sphere, r = 3. (c) Find the total electric flux leaving the sphere, r = 4, m.	L3	07

		Module-3		
Q. 05	a	Derive expression for potential and capacitance between the planes at z=0 and z=d if the potential v = V_1 and v = V_2 respectively using Laplace's equation.	L3	06
	b	If potential of $V = x^2yz + Ay^3z$ Volts, i) find A so that the Laplace's equation is satisfied. ii) With that value A, determine the electric field at a point p whose coordinates are (2, 1, -1).	L3	08
	c	There exists a potential of V = -2.5 volts on a conductor at0.02 m and V = 15 volts at r = 0.35 m. Determine E and D by solving the Laplace's equation in spherical coordinates representing the potential system.	L3	08
		OR		
Q. 06	a	Derivation of Ampere's Circuital Law in point form using Strokes theorem.	L3	06
	b	Derive Poisson's and Laplace equations and writ Laplace equation in cylindrical and polar coordinates.	L3	06
	c	Long concentric and right conducting cylinders in free space, at r = 5 mm and r = 25 mm in cylindrical coordinates have voltages of zero and V_o respectively. If the electric field intensity, $\vec{E}$= -8.28×$10^3\hat{a}_r$ at r = 15 mm, find V_o and the charge density on the outer conductor by using Laplace's equation.	L3	08
		Module-4		
Q. 07	a	State and Explain the force between differential Current Elements.	L1	05
	b	Find the force per meter length between two long parallel wires separated by 10cm in air and carrying current of 100A in opposite direction state the nature of force between wires	L3	07
	c	Find magnetization in a magnetic material where, (i)$\mu = 1.8X10^{-5}\left(\frac{H}{m}\right) and\ M = 120\ \left(\frac{H}{m}\right)$. (ii) $\mu_r = 22$, there are $8.3X10^{28}$ atoms/m^3 and each atom has dipole moment of 4.5X10^{-27} (A.M^2) and (iii) B=300(μT) and Xm=15.	L3	08
		OR		
Q. 08	a	Write short notes Magnetic Boundary Conditions.	L1	05
	b	Derive the equations for Magnetic circuits with suitable diagram.	L3	07
	c	A conductor 4m long lies along the y-axis with a current of 10A in the $\overrightarrow{a_y}$ direction. Find the force on the conductor if the field in the region is (in region is) $\vec{B} = 0.005\overrightarrow{a_x}$ Tesla.	L3	08
		Module-5		
Q. 09	a	What is a uniform wave? Explain its propagation in free space with necessary equations	L1	05
	b	Starting from Maxwell's equations, derive the wave equation for sinusoidal waves in good dielectric medium.	L3	07
	c	A 9.375 GHz uniform plane wave is propagating in polyethylene (ϵ_r = 2.26). If the amplitude of the electric field is 500 V/m and the material is assumed to be lossless, find (i) Phase constant (ii) Wavelength (iii) Velocity of propagation (iv) Intrinsic impedance (v) magnetic field intensity	L3	08
		OR		
Q. 10	a	Show that the uniform plane wave is transverse in nature.	L3	07

	b	I. Write a short note on: Skin effect in conductors. II. What do you mean by depth of penetration?	L1	05
	c	With respect to wave propagation in good conductors, describe what the skin effect is and derive an expression for the depth of penetration. If $\sigma = 58 \times 10^6$ mhos/m at frequency 10 MHz, determine the depth of penetration.	L3	08

*Bloom's Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of questions.

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Fourth Semester B.E. Degree Examination

Subject: ELECTROMAGNETIC THEORY

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02.
03.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	State and explain vector form of Coulomb's law	L1	06
	b	Infinite line charges of 5nC/m along the (positive and negative) x and y axes in free space. Find E at $P_A(0,0,4)$	L3	04
	c	Four 10nC positive charges are located in z=0 plane at the corners of a square 8cm on a side. A fifth 10nC charge is located at a point 8cm distant from other charges. Calculate the magnitude of total force on the fifth charge for $\varepsilon = \varepsilon_0$	L3	10
		OR		
Q.02	a	Given the two points, C(-3,2,1) and D(r=5, $\theta=20^\circ$, $\Phi=-70^\circ$), find a. the spherical coordinates of C b. the rectangular coordinates of D	L1	05
	b	Derive electric field intensity due to line charge density	L3	08
	c	Find Electric field intensity at origin if the following charge distributions are present in free space a. Point charge 12nC at P(2,0,6) b. uniform line charge density 3nC/m at x=-2 and y=3 c. uniform surface charge density 0.2nC/m^2 at x=2	L3	07
		Module-2		
Q. 03	a	State and explain Gauss's law and write point form and integral form of Gauss law.	L1	06
	b	Evaluate both sides of divergence theorem if $\mathbf{D}=\frac{5r^2}{4}\mathbf{a_r}$ C/m^2 in spherical coordinate for the volume enclosed between r=1m and r=2m	L3	06
	c	Find the volume charge density at the points indicated if i. $D = 4rz \sin\Phi\, a_r + 2rz\cos\Phi\, a_\Phi + 2r^2 \sin\Phi\, a_z$ C/m^2 at $P_A(1, \pi/2, 2)$ ii. $D = \sin\Theta\cos\Phi\, a_r + \cos\Theta\sin\Phi\, a_\Theta - \sin\Phi\, a_\Phi$ at $P_B(2, \pi/3, \pi/6)$	L3	08
		OR		
Q.04	a	Derive the equation of continuity	L1	06
	b	Derive the expression for the work done in moving a point charge within an electric field.	L3	06
	c	Find the work done in moving a 5 μC charge from origin to P(2,-1,4) through $\boldsymbol{E = 2xyz\, a_x + x^2z\, a_y + x^2y\, a_z}$ V/m; via the path i. Straight line segments (0, 0, 0) to (2, 0, 0) to (2, -1, 0) to (2, -1, 4) ii. Straight line x = - 2 y; z = 2x	L3	08
		Module-3		
Q. 05	a	Derive Poisson's and Laplace's Equation	L3	06
	b	Given the potential field V = $(Ar^4 + Br^{-4})\sin(4\Phi)$. Show that potential field satisfies Laplace's equation. Also find A and B such that V =100 V and lEl = 500 V/m at P(1,22.5°, 2)	L3	08
	c	Evaluate expression for capacitance of spherical shell using Laplaces equation	L3	08
		OR		

Q. 06	a	Derivation of Ampere's Circuital Law in point form using Strokes theorem.	L3	06
	b	If the magnetic field intensity in a region is H = (3y-2) a_z+ 2x a_y A/m, find the current density at origin. And Calculate the value of J if H=$\frac{1}{\sin\theta}$ a_Θ A/m at P(2,30º, 20º)	L3	08
	c	Long concentric and right conducting cylinders in free space, at r = 5 mm and r = 25 mm in cylindrical coordinates have voltages of zero and V_o respectively. If the electric field intensity, $\vec{E}$= -8.28×$10^3\hat{a}_r$ at r = 15 mm, find V_o and the charge density on the outer conductor by using Laplace's equation.	L3	08
		Module-4		
Q. 07	a	State and Explain the force between differential Current Elements.	L1	05
	b	Find the force per meter length between two long parallel wires separated by 10cm in air and carrying current of 100A in opposite direction state the nature of force between wires	L3	07
	c	Let the permittivity be 5 µH/m in a region A where x<0 and 20µH/m in region B, where x>0, If there is a surface current density K = 150 a_y -200 a_z A/m at x=0 and H_A = 300 a_x – 400 a_y + 500 a_z A/m. Find i. $\|H_{tA}\|$ ii. $\|H_{NA}\|$ iii. $\|H_{tB}\|$ iv. $\|H_{NB}\|$	L3	08
		OR		
Q. 08	a	Determine the boundary conditions for the magnetic field at the interface between two different magnetic materials	L1	08
	b	Derive the equations for Magnetic circuits with suitable diagram.	L3	07
	c	The point charge Q= 18nC has a velocity of 5× 10^6m/s in the direction of a_v = 0.6 a_x +0.75 a_y + 0.3 a_z. calculate the magnitude of the force exerted on the charge by the field i. B = -3 a_x+ 4a_y + 6a_z mT ii. E= -3 a_x+ 4a_y + 6a_z KV/m	L3	05
		Module-5		
Q. 09	a	What is a uniform wave? Explain its propagation in free space with necessary equations	L1	05
	b	What is inconsistency of Ampere's law with continuity equation? Derive the modified Ampere's law by Maxwell for time varying fields	L3	07
	c	A 9.375 GHz uniform plane wave is propagating in polyethylene (ϵ_r = 2.26). If the amplitude of the electric field is 500 V/m and the material is assumed to be lossless, find (i) Phase constant (ii) Wavelength (iii) Velocity of propagation (iv) Intrinsic impedance (v) magnetic field intensity	L3	08
		OR		
Q. 10	a	Show that the uniform plane wave is transverse in nature.	L3	07
	b	State and explain Poynting Theorem .	L1	05
	c	With respect to wave propagation in good conductors, describe what the skin effect is and derive an expression for the depth of penetration. If $\sigma = 58 \times 10^6$ mhos/m at frequency 10 MHz, determine the depth of penetration.	L3	08

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