Model Question Paper-1 with effect from 2019-20(CBCS Scheme)

USN

Fourth Semester B.E. Degree Examination

Electromagnetic Field Theory

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

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

		Module-1	L	CO	PO	Marks
Q.01	(a)	Define scalar and vector. For a given vectors $\mathbf{A} = (6\,\mathbf{a_x} + 2\,\mathbf{a_y} + 6\,\mathbf{a_z})$ and $\mathbf{B} = (-2\,\mathbf{a_x} + 9\,\mathbf{a_y} - \mathbf{a_z})$. Find the cross product between the two vectors **A** and **B**.				
			3	1	2	6
	(b)	Derive the relationship between rectangular and cylindrical coordinates.				
			2	1	2	6
	(c)	Explain gradient of a scalar field. Also express the gradient of a scalar in different coordinate systems.				
			2	1	2	8
		OR				
Q.02	(a)	Explain the Coulomb's law in vector form. Mention the units of all terms involved.				
			2	1	2	7
	(b)	State and derive Gauss theorem of electrostatics.				
			2	1	2	6
	(c)	Two point charges $Q_1 = -0.3$ nC at (25, -30, -15) and $Q_2 = 0.5$ nC at (-10, 8, 12) present in free space. Find **E** at (15, 20, 50).				
			3	1	3	7
		Module-2				
Q.03	(a)	Define potential difference and potential, and establish the relation between E and V.				
			2	2	1	7
	(b)	What is an electric dipole?. Obtain the expression for electric field intensity (**E**) due to an electric dipole.				
			2	2	1	7
	(c)	Determine the work done in carrying charge of 2 C from B (2, 0, 0) to A (0, 2, 0) along the straight line path joining 2 points if the electric field is $\mathbf{E} = (12\,x\,\mathbf{a_x} - 4\,y\,\mathbf{a_y})$				
			3	2	3	6

OR						
Q.04	(a)	Derive an expression for continuity equation in point form.				
			2	2	2	6
	(b)	Derive boundary conditions between conductor and a dielectric medium.				
			2	2	2	7
	(c)	The lines of electric field makes an angle of 45° in air at the boundary between glass ($\varepsilon_r = 5$) and air ($\varepsilon_r = 1$). If the electric flux density in air is 0.5 $\mu C/m^2$, determine the orientation and magnitude of flux density in glass.				
			3	2	3	7
Module-3						
Q.05	(a)	Starting from Gauss' law deduce Poisson's and Laplace's equation. Write Laplace's equation in all the coordinates.				
			2	3	2	7
	(b)	Derive the expression of capacitance for concentric cylindrical conductors using the Laplace's equation.				
			2	3	3	6
	(c)	Determine whether or not the following potential field satisfy the Laplace equation i) $V = x^2 - y^2 + z^2$, ii) $V = r \cos \phi + z$, iii) $V = r \cos \theta + \phi$.				
			3	3	3	7
OR						
Q.06	(a)	State and explain Ampere's Circuital Law.				
			2	3	2	6
	(b)	Derive an expression for magnetic field intensity at a point due to a finite conductor carrying a current of I amps along z axis.				
			2	3	2	7
	(c)	Given that, $\mathbf{H} = 20\ r^2\ \mathbf{a_\phi}$ A/ m. Determine the current density **J,** also determine the total current that crosses the surface $r = 1m$, $0 < \varphi < 2\pi$ and $z = 0$ in cylindrical coordinate.				
			3	3	3	7
Module-4						
Q.07	(a)	Find the work done on a moving the charge along a line from a point 'a' to 'b'.				
			2	4	2	6
	(b)	Derive the expression for Force and Torque on a closed circuit.				
			2	4	2	7
	(c)	A point charge Q = 18 nC has a velocity of 5×10^6 m/s in the direction $\mathbf{a} = 0.6\ \mathbf{a_x} + 0.75\ \mathbf{a_y} + 0.3\ \mathbf{a_z}$. Calculate the magnitude of the force exerted on the charge by the field i) $\mathbf{E} = (-3\ \mathbf{a_x} + 4\ \mathbf{a_y} + 6\ \mathbf{a_z})$ k V/m, ii) $\mathbf{B} = (-3\ \mathbf{a_x} + 4\ \mathbf{a_y} + 6\ \mathbf{a_z})$ mT				

		iii) **B** and **E** acting together.				
			3	4	3	7
OR						
Q.08	(a)	What are the characteristics of magnetic materials? Explain.				
			2	4	2	6
	(b)	Explain the boundary conditions between two magnetic materials.				
			2	4	2	7
	(c)	Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of 6 cm diameter, length of the tube is 60 cm and the solenoid is in air.				
			3	4	3	7
Module-5						
Q.09	(a)	Using Faraday's law, derive an expression for emf used in a stationary conductor placed in a time varying magnetic field.				
			2	5	2	6
	(b)	State Maxwell's equation in point and integral form for time varying fields from Faraday's law.				
			2	5	2	8
	(c)	Given $\mathbf{E} = E_m \sin(\omega t - \beta z)\, \mathbf{a_y}$ in free space. Find **D** and **B**.				
			3	5	3	6
OR						
Q.10	(a)	Using Maxwell's equations derive an expression for uniform plane wave in free space.				
			2	5	2	7
	(b)	Explain skin effect and obtain the expression to find skin depth.				
			2	5	2	6
	(c)	The field in free space is given by $\mathbf{H} = 10 \cos(108t - \beta x)\, \mathbf{a_y}$ A/m. Find β, λ and **E** at P(0.1, 0.2, 0.3) and t = 1 ns.				
			3	5	3	7

CO's :

1. Use different coordinate systems, Coulomb's Law and Gauss Law for the evaluation of electric fields produced by different charge configurations.
2. Calculate the energy and potential due to a system of charges & Explain the behaviour of electric field across a boundary conditions.
3. Explain the Poisson's, Laplace equations and behaviour of steady magnetic fields.
4. Explain the behaviour of magnetic fields and magnetic materials.
5. Explain time varying fields and propagation of waves in different media

PO's:

PO 1	:	**Engineering Knowledge :** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of the complex engineering problems
PO 2	:	**Problem Analysis :** Identify formulate, Review research literature and analyze complex engineering problems.
PO 3	:	**Design Development of Solutions :** Design the solutions for complex engineering problem and design system components or processes that meet the specified needs with appropriate considerations for the public health and safety and cultural and societal and environmental considerations.
PO 4	:	**Conduct Investigations of Complex Problem :** Use research based knowledge and research method including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions**.**
PO 5	:	**Modern Tool Usage :** Create, Select and Apply appropriate techniques, resources, modern engineering and IT tools including prediction and modeling to complex engineering activities with understanding of the limitations**.**
PO 6	:	**Engineer and Society :** Apply reasoning informed by contextual knowledge, to assess societal health, safety, legal and cultural issues and consequent responsibility relevant to professional engineering practices.
PO 7	:	**Environment and Sustainability :** Understand the impact of professional engineering solution in societal and environmental context and demonstrate the knowledge of and need for sustainable development.
PO 8	:	**Ethics :** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practices.
PO 9	:	**Individual and Team Work :** Function effectively as an individual and as a member or leader in diversity and multi-disciplinary settings.
PO 10	:	**Communications :** Communicate effectively on complex engineering activities with the engineering community and with society at large such as being able to comprehend and write effective reports and design documentations, make effective presentations and view and receive clear instructions.
PO 11	:	**Project Management and Finance :** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team to manage project and in multi-disciplinary environments.
PO 12	:	**Life Long Learning :** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.