Model Question Paper -1 with effect from 2020-21(CBCS Scheme)

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

Fifth Semester B.E. Degree Examination

Electromagnetic Waves

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

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

		Module – 1	Marks
Q.1	(a)	Point charges of 60nC each are located at A(0,0,1) B(-1,0,1) C(1,0,1) and D(-1,1,0) in free space. Find the total force on the charge at B.	8
	(b)	Define Electric Field intensity. Find an expression for Electric field intensity due to N different point charges.	4
	(c)	Derive an expression for Electric field intensity due to infinite surface charge.	8
		OR	
Q.2	(a)	Transform the vector field $\vec{A} = \frac{xz}{y}\hat{a}_x$ into spherical components and variables.	6
	(b)	Uniform line charge of infinite length with $\rho_l = 50$ nC/m lies along z-axis. Find $\vec{E}$ at (-4, 3, 6)	5
	(c)	Find the total charge contained in a 2cm length of the electron beam with $2 < z < 4$ cm, ρ =1 cm, with $\rho_v = -5\, e^{-10^5 \rho z}$ μC/m^3.	9
		Module – 2	
Q.3	(a)	Given $\vec{D} = z \sin \Phi\, \hat{a}_\rho + \rho \sin \Phi\, \hat{a}_z$ C/m^2. Find the Volume charge density at (2, 40°, 2)	4
	(b)	Verify both sides of Gauss Divergence theorem if $\vec{D} = 2xy\, \hat{a}_x + x^2 \hat{a}_y$ C/ m^2 present in the region bounded by $0 \le x \le 1$, $0 \le y \le 2$ and $0 \le z \le 3$	8
	(c)	Obtain $\vec{E}$ and $\vec{D}$ for an infinite line charge of density ρ_l using Gauss law.	8
		OR	
Q.4	(a)	A non-uniform field $\vec{E} = y\, \hat{a}_x + x\hat{a}_y + 2\hat{a}_z$. Determine the work expended in carrying 2C from B(1,0,1) to A(0.8,0.6,1) along the shorter arc of the circle $x^2 + y^2 = 1$ and z=1	8
	(b)	Derive the expression for equation of current continuity.	8
	(c)	If $V = \frac{30 \sin \theta}{R^2}$ volts. find V and $\vec{E}$ at P(4,50°,25°)	4
		Module – 3	
Q.5	(a)	Find $\vec{E}$ at P (3, 1, 2) for the field of two co-axial conducting cylinders V=50 V at ρ =2 m and V=20 V at ρ =3 m.	8

	(b)	A co-axial cable with radius of inner conductor a, inner radius of outer conductor b and outer radius c carries a current I at inner conductor and -I in outer conductor. Determine and sketch variations of $\vec{H}$ against r for (i) r<a (ii) a<r<b (iii)b<r<c (iv) r>c	8
	(c)	State and prove Stokes theorem.	4
		OR	
Q.6	**(a)**	Find the capacitance between two concentric spheres of radii r=b and r=a. such that b>a, if the potential V=0 at r=b and V=V_0 at r=a using Laplace equation.	10
	(b)	Calculate the value of $\vec{J}$ if $\vec{H} = \frac{1}{\sin\theta}\hat{a}_\theta$ at P(2,30°,20°).	5
	(c)	Explain the concept of scalar and vector magnetic potential.	5
		Module – 4	
Q.7	**(a)**	Derive an equation for the force between the two differential current elements.	6
	(b)	A ferrite material is operating in a linear mode with B=0.5 T, assume μ_r= 50, calculate values of χ_m, M and H	5
	(c)	The field $\vec{B} = -2\hat{a}_x + 3\hat{a}_y + 4\hat{a}_z$ mT is present in free space. Find the vector force exerted on a straight wire carrying 12A in $\hat{a}_{AB}$ direction with A(1,1,1) and B(2,1,1)	9
		OR	
Q.8	**(a)**	Calculate torque on a loop with dimensions 1 m by 2 m lies in the uniform field $\vec{B} = -0.6\hat{a}_x + 0.8\hat{a}_z$ and the loop current is 4 mA. Verify the torque by calculating total force and torque contribution on each side.	8
	(b)	Obtain magnetic boundary conditions	7
	(c)	Using Faraday's law, deduce Maxwell's equation to relate time varying electric and magnetic fields.	5
		Module – 5	
Q.9	**(a)**	Derive Maxwell's equation to correct Ampere's circuital law.	8
	(b)	The depth of penetration in a conducting medium is 0.1 m and the frequency of the electromagnetic wave is 1MHz. Find the conductivity of the conducting medium.	4
	(c)	Given a non-magnetic material having $\varepsilon_r' = 3.2$ and σ= 1.5x10^{-4} S/m. Find the values at 3 MHz for (i) loss tangent (ii) attenuation constant (iii) phase constant (iv) Intrinsic impedance.	8
		OR	
Q.10	**(a)**	Find the amplitude of displacement current density in the free space within large power distribution transformer where $\vec{H} = \cos(377t + 1.2566 \times 10^{-6} z)\,\hat{a}_y$ A/m.	5
	(b)	Derive general wave equation in electric and magnetic fields.	8
	(c)	State and explain Poynting's theorem.	7

Table showing the Bloom's Taxonomy Level, Course Outcome and Programme Outcome				
Question		**Bloom's Taxonomy Level attached**	**Course Outcome**	**Programme Outcome**
Q.1	(a)	L3	Evaluate problems on Electrostatic force	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L2	Evaluate problems on Electric field due to point charge	Engineering Knowledge (PO1)
	(c)	L3	Evaluate problems on Electric field due to surface charge	Engineering Knowledge (PO1)
Q.2	(a)	L3	Evaluate co-ordinate system	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L3	Evaluate problems on Electric field due to line charge	Engineering Knowledge (PO1), Problem solving (PO2)
	(c)	L3	Evaluate problems volume charge	Engineering Knowledge (PO1), Problem solving (PO2)
Q.3	(a)	L3	Apply Gauss law to find volume charge density	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L4	Evaluate Gauss divergence theorem to find charge	Complex problem solving (PO3)
	(c)	L3	Apply Gauss law to find Electric field and electric flux density	Engineering Knowledge (PO1), Problem solving (PO2)
Q.4	(a)	L3	To determine energy with respect to point charge	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L2	Apply Gauss divergence theorem to obtain continuity equation	Engineering Knowledge (PO1),
	(c)	L3	To determine Electric field from potential of point charge	Engineering Knowledge (PO1), Problem solving (PO2)
Q.5	(a)	L3	To determine electric field using boundary conditions	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L3	Apply Biot Savart's law for evaluating Magnetic field on Co-axial cable	Engineering Knowledge (PO1), Problem solving (PO2)
	(c)	L2	To find Current by using Stokes theorem	Engineering Knowledge (PO1)
Q.6	(a)	L3	To determine capacitance using Laplace equation.	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L3	Apply Ampere's law to evaluate magnetic field intensity	Engineering Knowledge (PO1), Problem solving (PO2)
	(c)	L2	To determine potential due to magnetic field	Engineering Knowledge (PO1)
Q.7	(a)	L2	To calculate magnetic force of a current element	Engineering Knowledge (PO1)
	(b)	L3	Calculate magnetization and voltage induced in magnetic materials	Engineering Knowledge (PO1), Problem solving (PO2)
	(c)	L4	To calculate magnetic force in electric circuits	Engineering Knowledge (PO1), Problem solving (PO2)

Q.8	(a)	L4	To calculate torque for current carrying loops	Complex problem solving (PO3)
	(b)	L3	To determine the boundary conditions w.r.t magnetic fields	Engineering Knowledge (PO1)
	(c)	L3	Apply Faradays law to obtain Maxwell's equations	Engineering Knowledge (PO1)
Q.9	(a)	L3	Apply Maxwells' equation for time varying fields	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L3	To analyze wave propagation in conductors	Engineering Knowledge (PO1), Problem solving (PO2)
	(c)	L3	To analyze wave propagation in dielectrics	Engineering Knowledge (PO1), Problem solving (PO2)
Q.10	(a)	L3	Apply Maxwell's equation to determine the fields	Engineering Knowledge (PO1), Problem solving (PO2)
	(b)	L3	To analyze wave propagation in free space	Engineering Knowledge (PO1), Problem solving (PO2)
	(c)	L3	To evaluate power associated with EM waves using Poynting theorem	Engineering Knowledge (PO1), Problem solving (PO2)

Bloom's Taxonomy Levels			
	Lower order thinking skills		
	Remembering(knowledge):L_1	Understanding Comprehension): L_2	Applying (Application): L_3
	Higher order thinking skills		
	Analyzing (Analysis): L_4	Valuating (Evaluation): L_5	Creating (Synthesis): L_6