Reg. No. : | | | | | | | | | | | | |

Question Paper Code: R3304

B.E./B.Tech. DEGREE EXAMINATION, NOV 2025

Third Semester

R21UEE304 – ELECTROMAGNETIC FIELDS

Electrical and Electronics Engineering

(Regulations R2021)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1.	List the sources of electromagnetic fields.	CO1- U
2.	Name the three commonly used coordinate systems.	CO1- U
3.	Define electric field intensity.	CO1- U
4.	Describe the electric field intensity due to a point charge.	CO1- U
5.	Define magnetic field intensity (H).	CO1- U
6.	Explain Ampere's Circuital Law.	CO1- U
7.	State Faraday's first law of electromagnetic induction.	CO1- U
8.	Write the expression for induced emf according to Faraday's law.	CO1- U
9.	Write the general wave equation in free space.	CO1- U
10.	Illustrate the relation between electric field E and magnetic field H in an electromagnetic wave.	CO1- U

PART – B (5 x 16= 80 Marks)

11.	(a)	Explain in detail the different types of coordinate systems used in electromagnetic field theory. Derive the expressions for differential length, area, and volume in each.	CO1- U	(16)
		Or		
	(b)	Define the Del operator and explain how it is used to find the gradient, divergence, and curl of a vector field with suitable examples.	CO1- U	(16)

12.	(a)	(i) A thin wire of length 2 m carries a total charge of 10 μC uniformly distributed. Find the linear charge density. (ii) A metal plate of area 0.5 m^2 has a total charge of 1μC uniformly spread over it. Find the surface charge density. (iii) A cube of side 0.1 m has a total charge of 5μC uniformly distributed in its volume. Find the volume charge density. (iv) An infinite line of charge has a linear charge density of $\lambda=2 \times 10^{-6}$ C/m Find the electric field at a distance of 0.1 m from the line.	CO3- App	(16)
		Or		
	(b)	(i)Two charges of +3μC and +2 μC are placed 0.1 m apart in air. Find the electrostatic force between them. (ii)Two point charges +5μC and −4μC are 0.2 m apart. Find the force between them.	CO3- App	(16)
13.	(a)	Using Biot–Savart's law, derive the expression for the magnetic field intensity due to a finite straight conductor, and analyze how the field expression simplifies in the near-field ($r \ll L$) and far-field ($r \gg L$) regions.	CO5- Ana	(16)
		Or		
	(b)	Analyze Ampere's Law in integral form and its application in determining the magnetic field inside a long coaxial cable carrying current I.	CO5- Ana	(16)
14.	(a)	i)A point charge of 10 μCis placed at the center of a sphere of radius 0.2 m. Using Maxwell's first equation, find the electric flux through the surface of the sphere. (ii) A sphere of radius 0.5 m contains a uniform volume charge density $\rho_v=3\times10^{-6}$ C/m^3. Find the total electric flux leaving the surface of the sphere. (iii)A cube of side 0.1 m contains a uniform charge density of 2×10−5 C/m3. Find the outward flux through the cube. (iv) An electric flux density vector is given as:D=5xî +3yĵ +2z □ˆ C/m2) Find the volume charge density ρv .	CO3- App	(16)
		Or		

	(b)	(i)A long straight conductor carries a current of I=10 A. Find the magnetic field intensity H at a distance of r=0.05 m from the conductor using Ampere's Law. (ii) A parallel plate capacitor has plate area A=0.01 m2 and spacing d=1 mm. It is connected to a voltage source V(t)=100sin(1000t) V. Find the displacement current between the plates.	CO3- App	(16)
15.	(a)	(i) Derive the electromagnetic wave equations from Maxwell's equations for free space. (ii) Analyze how the wave equation modifies in the presence of a conducting medium.	CO4- Ana	(16)
		Or		
	(b)	(i) Derive expressions for velocity of propagation, intrinsic impedance, and propagation constant of an electromagnetic wave in a lossy dielectric. (ii) Compare and analyze the results for lossless dielectric and perfect conductor cases.	CO4- Ana	(16)