

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/Backlog), November-December 2015

B. Tech in Electronics & Communication Engineering, Semester III

Roll No.....

ECE 303: Electromagnetic Field Theory

Time: 3 hours

Max. Marks: 100

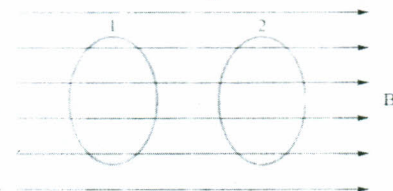
Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.
4. Anything written in **bold** must be treated as vector quantity

Q.1A All subparts of this question carry equal marks

10

- i. An antenna located in a city is a source of radio waves. How much time does it take the wave to reach a town 12,000 km away?
(a) 36 s (b) 40 ms (c) 36 ms (d) 20 ms
- ii. Which of the following statements is not true of waves in general?
(a) The phenomenon may be a function of time only
(b) The phenomenon may be sinusoidal or cosinusoidal
(c) The phenomenon must be a function of time and space
(d) For practical reasons, it must be finite in extent
- iii. What is the major factor for determining whether a medium is free space, lossless dielectric, lossy dielectric, or good conductor?
(a) Attenuation constant (c) Constitutive parameters (σ, ϵ, μ)
(b) Loss tangent (d) Reflection coefficient
- iv. Two conducting coils 1 and 2 (identical except that 2 is split) are placed in a uniform magnetic field that decreases at a constant rate as in figure. If the plane of the coils is perpendicular to the field lines, which of the following is true?
(a) An emf is induced in both coils
(b) An emf is induced in split coil 2
(c) Equal Joule heating occurs in both coils
(d) Joule heating does not occur in either coil
- v. Which one of these equations is not Maxwell's equation for a static electromagnetic field in a linear homogeneous medium?
(a) $\nabla \cdot \mathbf{B} = 0$ (b) $\nabla \times \mathbf{D} = 0$ (c) $\nabla^2 \mathbf{A} = \mu_0 \mathbf{J}$ (d) None
- vi. Which of the following potential does not satisfy Laplace's equation?
(a) $V = 2x + 5$ (b) $V = 10/r$ (c) $V = 10xy$ (d) All satisfy
- vii. Coulomb's law for the force between electric charges most closely resembles with
(a) Newton's law of motion (c) Gauss's theorem
(b) Law of conservation of energy (d) Newton's law of gravitation



- viii. Given field $\mathbf{A} = 3x^2yz \mathbf{a}_x + x^3z \mathbf{a}_y + (x^3y - 2z) \mathbf{a}_z$, it can be said that $\mathbf{A}$ is
 (a) Harmonic (b) Conservative (c) Solenoidal (d) Rotational
- ix. $r = 4$, $\theta = \pi/6$ is a
 (a) Sphere (b) Circle (c) Semi Circle (d) Semi infinite circle
- x. Where surfaces $\rho = 2$ and $z = 1$ intersects is
 (a) An infinite plane (b) A circle (c) A semi-infinite plane (d) A cone

Q.2 All subparts of this question carry equal marks 10

- Explain the working of quarter-wave monopole antenna in short.
- Explain Grounding in short.
- Draw equipotential surfaces for (a) point charge (b) an electric dipole.
- What do you understand by curl? Explain Stokes theorem using curl.

Q.3A The heat flow vector $\mathbf{H} = k \nabla T$, where T is the temperature and k is the thermal conductivity. Show that where $T = 50 \sin(\pi x/2) \cosh(\pi y/2)$ then $\nabla \cdot \mathbf{H} = 0$. 05

Q.3B A charge distribution in free space has $\rho_v = 2r \text{ nC/m}^3$ for $0 \leq r \leq 10\text{m}$ and zero otherwise. Determine $\mathbf{E}$ at $r = 2\text{m}$ and $r = 12\text{m}$. 05

Q.4A A point charge of 60mC is placed at the center of a cube. Find the total flux passing through one face of the cube. 05

Q.4B Show that following potentials satisfy Laplace's equation. 05
 (a) $V = e^{-5x} \cos 13y \sinh 12z$
 (b) $V = (z \cos \Phi) / \rho$

Q.5A Express the $\mathbf{A} = 6r^2 \sin\theta \cos\Phi \mathbf{a}_r + 4r \cos\theta \sin\Phi \mathbf{a}_\theta + r^3 \mathbf{a}_\Phi$ in the Cartesian system. 05

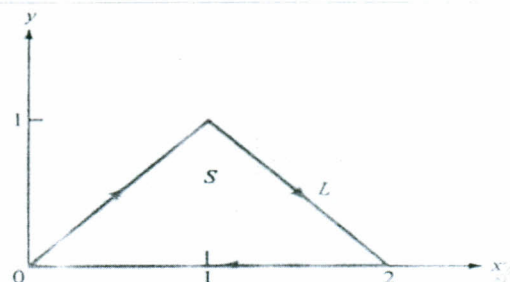
Q.5B Calculate the total outward flux of vector $\mathbf{F} = \rho^2 \sin\Phi \mathbf{a}_\rho + z \cos\Phi \mathbf{a}_\Phi + \rho z \mathbf{a}_z$ through the hollow cylinder defined by $2 \leq \rho \leq 3$, $0 \leq z \leq 5$. 05

Q.6A A stroke of lightning may be regarded as a filamentary line current. If a lightning stroke with current 50 kA occurs 100 m away from your house, calculate the magnetic flux density at your house due to the lightning stroke. 05

Q.6B In a conducting medium $\mathbf{H} = y^2z \mathbf{a}_x + 2(x+1)yz \mathbf{a}_y - (x+1)z^2 \mathbf{a}_z \text{ A/m}$. Find $\mathbf{J}$ at $(1, 0, -3)$. 05

Q.7 For $\mathbf{F} = xy \mathbf{a}_x + y^2 \mathbf{a}_y$, find 10

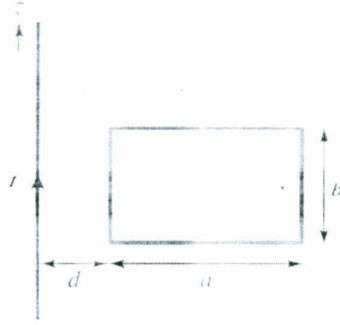
- $\oint_L \mathbf{F} \cdot d\mathbf{l}$ where L is shown in figure
- $\oint_S (\nabla \times \mathbf{F}) \cdot d\mathbf{S}$, where S is the area bounded by L .
- Is Stokes's theorem satisfied?



OR

Q.7 Determine the magnetic flux through a rectangular loop (a X b) due to an infinitely long conductor carrying current I as shown in figure. The loop and the 10

straight conductor are separated by distance d .



Q.8 Determine the time-average radiated power (P_{rad}) by directly using the value of time-average power density (P_{ave}) for Half wave dipole antenna. 10

Q.9A The inner and outer conductors of a coaxial cable have radii a and b , respectively. In the cable, 10

$$E = \frac{V_0}{\rho \ln\left(\frac{b}{a}\right)} \cos(\omega t - \beta z) \mathbf{a}_\rho$$

$$H = \frac{I_0}{2\pi\rho} \cos(\omega t - \beta z) \mathbf{a}_\phi$$

(a) Obtain the Poynting vector.

(b) Find the time-average power flow in the cable.

Q.9B A plane wave in air with $E = (8\mathbf{a}_x + 6\mathbf{a}_y + 5\mathbf{a}_z) \sin(\omega t + 3x - 4y)$ V/m is incident on a perfectly conducting slab in $y \geq 0$. Find the wave and the reflected wave. 10

OR

Q.9B Show that the time varying field $E = 30 \sin 2x \sin(kz - \omega t) \mathbf{a}_y$ V/m, where $k^2 = \mu_0 \epsilon_0 \omega^2 - 4$, is a genuine EM field—that is, it satisfies Maxwell's equations in free space. Find the corresponding H and J_d . 10