Hall Ticket No | | | | | | | | | | | Question Paper Code: AEEC06

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

B.Tech III SEMESTER END EXAMINATIONS (REGULAR/ SUPPLEMENTARY) - FEBRUARY 2024
Regulation: UG20
ELECTROMAGNETIC FIELDS
Time: 3 Hours (ELECTRICAL AND ELECTRONICS ENGINEERING) Max Marks: 70

Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) State Gauss's law and find the electric field intensity due to
   i) A line charge
   ii) A point charge using Gauss's law [BL: Understand| CO: 1|Marks: 7]

   (b) Determine the electric potential at the point (1,0,1) generated by point charges of -4μC and 5μC located at (2,-1,3) and (0,4,-2), respectively. Assume zero potential at infinity in the electrostatic system. [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) Derive the electric boundary conditions that govern the interface between a dielectric and a conductor medium. Explore the implications of these conditions on the electric field and charge distribution, considering factors such as polarization, surface charge density, and the dielectric constant in this electrostatic scenario. [BL: Understand| CO: 2|Marks: 7]

   (b) A capacitor consists of two parallel metal plates 30cm*30cm surface area, separated by 5mm in air. Determine its capacitance. Find the total energy stored by the capacitor and the energy density, if the capacitor is charged to a potential difference of 500V?
   [BL: Apply| CO: 2|Marks: 7]

MODULE – III

3. (a) Determine the magnetic field intensity along the axis of a circular coil with radius 'a' carrying current. Utilize Ampère's law to establish an expression for the magnetic field at any point along the axis, considering the coil's geometry and current flow. [BL: Understand| CO: 3|Marks: 7]

   (b) Planes Z = 0 and Z=4 carry current K = -10 ax A/m and K= 10 ax A/m respectively. Determine H at (1, 1, 1) and (0,-3, 10). Utilize Ampère's law to calculate H considering the contributions from both current-carrying planes. [BL: Apply| CO: 3|Marks: 7]

4. (a) Develop the expression for magnetic flux density 'B' resulting from an infinitely long conductor carrying current. [BL: Understand| CO: 4|Marks: 7]

   (b) An iron ring with a cross sectional area of $3cm^2$ and mean circumference of 15cm is wound with 250 turns wire carrying a current of 0.3A. The relative permeability of ring is 1500. Calculate the flux established in the ring. [BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Obtain the torque expression for a rectangular closed circuit with current I in a uniform magnetic field. Utilize the cross product of current elements and magnetic field vectors, exploring the dependence on circuit geometry and the magnetic field strength.

[BL: Understand| CO: 5|Marks: 7]

(b) If 8 A of current flows in the first wire, 11 A of current flows in the second wire and the distance between two wires is 15 m, find the magnetic force between the two wires?

[BL: Apply| CO: 5|Marks: 7].

6. (a) Find the expression for the inductance of a long solenoid coil. Explore the contributions of coil length, cross-sectional area, number of turns, and permeability of the medium.

[BL: Understand| CO: 5|Marks: 7]

(b) Given the magnetic vector potential A = $(-\rho^2/4)$ a_z Wb/m, calculate the total magnetic flux crossing the surface $\phi = \pi/2$, $1 \leq \rho \leq 2$ m and $0 \leq z \leq 5$ m. [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) Develop the point form and integral form of Faraday's law. Express how the electromotive force induced in a closed loop is related to the time rate of change of magnetic flux passing through the loop, both in differential and integral forms? Explore the implications for electromagnetic induction. [BL: Understand| CO: 6|Marks: 7]

(b) Consider the loop of Figure 1 shown below, if B=0.592 Wb/m^2, R=20 Ohms , L=10cm and the rod is moving with a constant velocity of 8 $\overrightarrow{(ax)}$ m/s, find

i) The induced current through the resistor

ii) The motional force on the rod

iii) The power dissipated by the resistor [BL: Apply| CO: 6|Marks: 7]

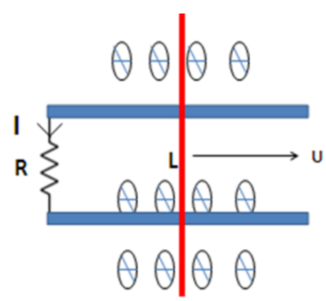

Figure 1

8. (a) Prove that the net power flowing out of a given volume is equal to the decrease in the energy stored within and the Ohmic losses when the EM wave is transmitted from source to destination.

[BL: Understand| CO: 6|Marks: 7]

(b) The electric field intensity in a dielectric medium ($\epsilon = \epsilon_r \epsilon_0$, $\mu = \mu_0$) is given by
$\overrightarrow{E}$ = 150cos(10^9t+8x)$\hat{a}$ V/m. Calculate

i) The dielectric constant

ii) The intrinsic impedance

iii) The velocity of propagation [BL: Apply| CO: 6|Marks: 7]

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