

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)**

CLASS: BTECH
BRANCH: EEE

SEMESTER : III
SESSION : MO/2024

SUBJECT: EE253 ENGINEERING ELECTROMAGNETICS

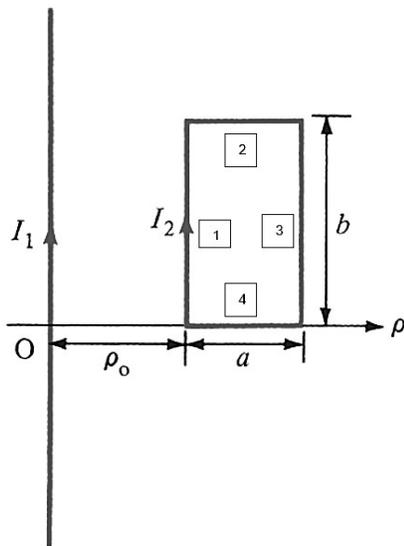
TIME: 3 Hours

FULL MARKS: 50

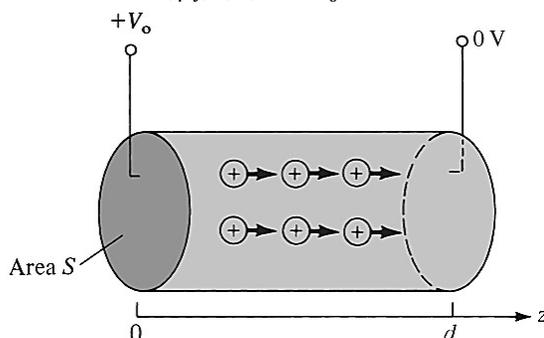
INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Give answer in three decimal places. Answers in fraction is considered as incomplete.

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|---|-----|----|----|
| Q.1(a) What is dielectric constant and dielectric strength? Point charges 16 mC and -5 mC are located at (3,2,-4) and (-2,1,-2), respectively. Calculate the electric force on 16 mC due to -5 mC. | [5] | 1 | 2 |
| Q.1(b) A rectangular loop carrying current I_2 is placed parallel to an infinitely long filamentary wire carrying current I_1 as shown in the figure below. Find the force expressions of each element of the current loop. | [5] | 1 | 3 |



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|---|-----|---|---|
| Q.2(a) Current-carrying components in high-voltage power equipment can be cooled to carry away the heat caused by ohmic losses. A means of pumping is based on the force transmitted to the cooling fluid by charges in an electric field. Electrohydrodynamic (EHD) pumping is modelled in the figure below. The region between the electrodes contains a uniform charge ρ_v and permittivity ϵ , which is generated at the left electrode and collected at the right electrode. Find the expression of voltage and electric field as a function of z, ρ_v, ϵ, d , and V_0 . | [5] | 2 | 3 |
|---|-----|---|---|



Q.2(b) What is displacement current? Write Maxwell's equations in differential and integral form for time varying condition. [5] 1 2

Q.3(a) A lossy dielectric has an intrinsic impedance of $115 \angle 35^\circ \Omega$ at a particular radian frequency ω . If, at that frequency, the plane wave propagating through the dielectric has the magnetic field component $H = 30 e^{-j\alpha} \cos(\omega t - 0.25y) a_z$ mA/m. Find E and α . [5] 4 3

$$\alpha = \omega \sqrt{\frac{\mu\epsilon}{2} \left[\sqrt{1 + \left[\frac{\sigma}{\omega\epsilon} \right]^2} - 1 \right]}$$

$$\beta = \omega \sqrt{\frac{\mu\epsilon}{2} \left[\sqrt{1 + \left[\frac{\sigma}{\omega\epsilon} \right]^2} + 1 \right]}$$

Q.3(b) A plane wave in a nonmagnetic ($\mu = \mu_0$) and lossless medium has $E = 25 \sin(10^9 t + 38.5y) a_x$ kV/m. Find for the given electromagnetic wave a) the direction of polarization b) velocity c) wavelength d) relative permittivity e) intrinsic impedance [5] 4 3

Q.4(a) Given a uniform plane wave in air as $E_i = 25 \cos(\omega t - \beta z) a_x + 15 \sin(\omega t - \beta z) a_y$ V/m. a) Find H_i b) If the wave encounters a perfectly conducting plate normal to the z-axis at $z=0$, find the reflected wave E_r and H_r . [5] 4 3

Q.4(b) In free space $x \leq 0$, a plane wave with $E_i = 16.965 \cos(10^8 t - 0.33x) a_z$ V/m is incident normally on a lossless medium ($\epsilon = 8\epsilon_0, \mu = 4\mu_0, \beta = 1.8856$) in region $x \geq 0$. Determine the expressions for transmitted wave E_t and reflected wave E_r . [5] 3 3

Q.5(a) How are electromagnetic radiations and antenna related? What is retarded vector potential? Why is analysis in antenna done in spherical coordinate system? [5] 5 2

Q.5(b) Discuss radiation intensity and power gain of antenna characteristics. What is half wave dipole antenna? What are the important characteristics of half wave dipole antenna? [5] 5 2

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