भारतीय सूचना प्रौद्योगिकी संस्थान कोटा

# INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTA

### B.Tech. (ECE)
### End Term Examination, Even Semester 2023-24

#### Electromagnetic Theory (ECT208); Close Book
**Marks: 40 (Weightage – 40%)**　　　　**Time: 120 minutes**　　　　**Date: May 16, 2024**

1. What is volume current density? If the current density $J = (2\cos\theta\, a_r + \sin\theta\, a_\theta)/r^3$ A/m², then calculate the current passing through a spherical shell of radius 10 cm.　　　　[2+6]

2. Two homogeneous isotropic dielectric materials have the boundary at $z = 0$ plane. The dielectric constants $\varepsilon_{r1} = 4$ for $z \geq 0$ and $\varepsilon_{r2} = 3$ for $z \leq 0$. If the electric field $E_1 = (5a_x - 2a_y + 3a_z)$ kV/m exists for $z \geq 0$ then find out the electric field $E_2$ for $z \leq 0$. Also find out the angle of $E_1$ and $E_2$ with the interface.　　　　[4+4]

3. A transmission line has the following per-unit-length parameters: L = 0.5 μH/m, C = 200 pF/m, R = 4.0 /m, and G = 0.02 S/m. Calculate the propagation constant and characteristic impedance of this line at 800 MHz. If the line is 30 cm long, what is the attenuation in dB?　　　　[2+3+3]

4. Write down the Maxwell equation which is based on the Faraday's law of electromagnetic induction. Starting from Maxwell's equations, develop the wave equations in source free region.　　　　[2+6]

5. A plane wave propagating in a lossless dielectric medium has an electric field given as $E_x = E_0 \cos(\omega t - \beta z)\, a_x$ V/m with a frequency of 5.0 GHz and a wavelength in the material of 3.0 cm. Determine the propagation constant, phase velocity and permittivity of the medium.　　　　[2+2+4]

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