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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Third Semester

Electrical and Electronics Engineering

EE 3301 — ELECTROMAGNETIC FIELDS

(Common to : PTEE 3301 Electromagnetic Fields for B.E (Part Time) Second Semester – Electrical and Electronics Engineering – Regulations 2023)

(Regulations 2021)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the assumptions made while defining a Coulomb's law.
2. What is physical significance of curl of a vector field?
3. If the electric field intensity is given by $E = (X\,u_x + Y\,u_y + Z\,u_z)$ volt/m, Find the potential difference between $X(2, 0, 0)$ and $Y(1, 2, 3)$.
4. What is polarization of dielectrics?
5. Define magnetic dipole moment.
6. Determine the maximum torque on 80 turn rectangular coil of 0.25 m × 0.4 m, carrying a current of 10 A in a field of 0.8 Tesla.
7. Examine whether the following fields satisfy Maxwell's equations or not. $E = [E_m \sin x \sin t\, a_y]$ and $H = [(E_m/\mu_0)\cos x \cos t\, a_z]$.
8. State faradays law.
9. Find the velocity of a plane wave in a lossless medium having relative permittivity of 5 and relative permeability of unity.
10. Define Intrinsic impedance and estimate its value for free space.

PART B — (5 × 13 = 65 marks)

11. (a) Find the electric field intensity at a point P located at (0, 0, h)m due to charge of surface charge density $\sigma\, C/m^2$ uniformly distributed over the circular dics $r \le a$, $z = 0$ m and correlate your result by applying Gauss's law.

Or

(b) Evaluate the following vectors in to Cartesian coordinate systems. $A = \rho z \sin\varphi\, a_\rho + 3\rho \cos\varphi\, a_\varphi + \rho \cos\varphi \sin\varphi a_z$.

12. (a) In region 1, $Z < 0$ is a dielectric media for which $D_1 = (30a_x + 50\, a_y + 70\, a_z) wb/m^2$ and $\varepsilon_{r_1} = 3.2$. Region 2, $z > 0$ is a dielectric media for which $\varepsilon_{r_2} = 2$. Determine E_2, D_2, θ_1 and θ_2.

Or

(b) Derive an expression for capacitance of co-axial cable with single dielectric medium.

13. (a) An electron beam at a given instant has a velocity $V = (3 \times 10^5 a_y + 4 \times 10^5 a_z) m/s$ at some position in space. The vector E & B at that point have E = (400 a_z) v/m, B = (0.005) a_y wb/m². Estimate the total force acting on the electron.

Or

(b) Determine the inductance of the loop of a 15 km transmission line consisting of 1.25 cm diameter conductors spaced 1.25m apart. Assume 1-ph system. Also find the inductive reactance of the loop.

14. (a) Develop Maxwell's equations in Integral and Differential forms. Also deduce them for harmonically varying fields.

Or

(b) In a material for which $\sigma = 4.5\, mho/m$ and $\in r = 1$. The electric field intensity $E = (300 \sin 10^9 t\, u_z)$ V/m. Evaluate the conduction and displacement current densities. Also estimate the frequency at which they have equal magnitudes.

15. (a) Develop the wave equations from Maxwell's equations for lossless dielectric materials.

Or

(b) State Poynting's theorem and justify using Maxwell's equations.

PART C — (1 × 15 = 15 marks)

16. (a) Derive the expression for torque developed in a rectangular closed circuit carrying current I in a uniform field.

Or

(b) A plane wave propagating through a medium with $\varepsilon_r = 8, \mu_r = 2$ has $E = 0.5 \sin(10^8 t - z)\beta z \, v/m$. Determine

(i) β (3)

(ii) The loss tangent (3)

(iii) Wave impedance (3)

(iv) Wave velocity (3)

(v) Magnetic field. (3)