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**Question Paper Code : 73447**

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fourth Semester

Electronics and Communication Engineering

EC 2253/EC 43/EC 1253/080290021/10144 EC 404 — ELECTROMAGNETIC FIELDS

(Regulations 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Determine the gradient of the scalar field $F = 5r^2 + r\sin\theta$.

2. What is an electric dipole? Write down the potential due to an electric dipole.

3. What is magnetic dipole moment?

4. Write the Lorentz force equation.

5. State Poisson's and Laplace's equations.

6. What is mutual inductance?

7. Distinguish between conduction current and displacement current.

8. Write down the expressions for instantaneous and complex Poynting vector.

9. What do you mean by a wave?

10. An EM wave has electric component given by, $E = E_0 \sin(\omega t - \beta z)\ (\vec{a}_x + \vec{a}_y) V/m$. Comment on the polarization of the wave.

PART B — (5 × 16 = 80 marks)

11. (a) Apply Gauss law to find charge enclosed in hollow sphere whose surface is uniformly charged. Derive the equation for potential due to a system of point charges. (16)

Or

(b) State and prove stoke's theorem and divergence theorem. (16)

12. (a) (i) Find H in rectangular co-ordinates at P(2, 3, 4) if there is a current filament on the z axis carrying 8 mA in the $a_z$ direction. (4)

(ii) Express Biot-Savart Law in vector form and describe it. (4)

(iii) State Ampere's circuital law and discuss about any two simple applications of it. (8)

Or

(b) (i) Derive an expression for Torque on a loop carrying a current I. (12)

(ii) Define magnetic flux density and magnetic moment. (4)

13. (a) (i) Write down the Poisson's and Laplace's equations. State their significance in electrostatic problems. (4)

(ii) Two parallel conducting plates are separated by distance 'd' apart and filled with dielectric medium having '$\varepsilon_r$' as relative permittivity. Using Laplace's equation, derive an expression for capacitance per unit length of parallel plate capacitor, if it is connected to a *DC* source supplying 'V volts. (12)

Or

(b) (i) Derive the expression for inductance of a toroidal coil carrying current. (8)

(ii) A solenoid is 50 cm long, 2 cm in diameter and contains 1500 turns. The cylindrical core has a diameter of 2 cm and a relative permeability of 75. This coil is co-axial with a second solenoid, of 50 cm long, but 3 cm diameter and 1200 turns. Calculate L for the inner solenoid; and L for the outer solenoid. (8)

14. (a) With necessary explanation derive the Maxwell's equation in differential and integral forms. (16)

Or

(b) (i) The conduction current flowing through a wire with conductivity $\sigma = 3 \times 10^7\ s/m$ and the relative permeability $\varepsilon_r = 1$ is given by $I_c = 3 \sin \varpi t (mA)$. If $\varpi = 10^8$ rad/sec, find the displacement current. (8)

(ii) An electric field in a medium, which is source free is given by $E = 1.5 \cos (10^8 t - \beta z) \overline{a}_x\ V/m$. Find B, H and D. Assume $\varepsilon_r = 1,\ \mu_r = 1,\ \sigma = 0$. (8)

15. (a) (i) From the Maxwell's equation, derive the electromagnetic wave equation in conducting medium for E and H fields. (10)

(ii) Calculate the attenuation constant and phase constant for the uniform plane wave with the frequency of 100 GHz in a conducting medium for which $\mu_r = 1$ and $\sigma = 58 \times 10^6 \, S/m$. (6)

Or

(b) (i) With reference electro magnetic waves, explain the following :

(1) linear polarization. (3)

(2) circular polarization. (3)

(3) elliptical polarization. (2)

(ii) A plane wave is incident, normally on a perfect conductor. Derive the expression for standing wave. Find the location of nodes and antinodes in E and H fields. Sketch the Standing wave pattern. (8)