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B.E./B.Tech. (FULL TIME) DEGREE END SEMESTER EXAMINATION NOV/DEC2012

Electronics and Communication Engineering

Third Semester

EC 9201 – ELECTROMAGNETIC FIELDS AND WAVES
(Regulation: R-2008)

Time: Three Hours Maximum: 100 Marks

Answer ALL questions

PART - A (10x2=20 Marks)

1. Point charges 5 nC and 3 nC are located at (2,1,1) and (3,0,4),respectively. Find the electric field **E** at (1,1,0).

2. Find the capacitance of parallel plate capacitor with plate area 30 cm^2 and separated by a distance of 4 mm. The permittivity of dielectric medium is 6 ε_o. ($\varepsilon_o = 8.854 \times 10^{-12}$ F/m).

3. State Biot–Savart's law.

4. Region $0 \le z \le 2$ m is occupied by an infinite slab of permeable material ($\mu_r = 3$, $\mu_o = 4\pi \times 10^{-7}$ H/m). If $\mathbf{B} = 10y\,\mathbf{a}_x - 5x\,\mathbf{a}_y$ m Wb/m^2 within the slab, determine the current density (**J**).

5. Write any four comparisons between circuit theory and field theory.

6. Write the differential form of Maxwell's equations for free space medium.

7. Calculate the intrinsic impedance for 900 MHz electromagnetic wave travels in a medium if $\varepsilon = 4\varepsilon_o$, $\mu = \mu_o$.

8. Find skin depth in copper at 2.4 GHz. (for copper $\sigma = 5.8 \times 10^7$ S/m, $\mu = \mu_o$)

9. Write any two applications of static electric field.

10. What are the steps involved in Finite Element Method (FEM) while solving the system of equations?

PART- B (5 x 16 = 80 marks)

11.a.i. Determine the electric filed intensity **E** of an infinitely planar charge of uniform surface charge density ρ_s in air. (8)

ii. A spherical capacitor consists of an inner conducting sphere of radius R_i and an outer conductor with spherical inner wall of radius R_o. The space in between is filled with a dielectric of permittivity ε. Determine the capacitance. (8)

12.a.i. A direct current I flows in a straight wire of length '2L'.Find the magnetic flux density **B** at a point located at a distance 'r' from the wire in the bisecting plane. (8)

ii. Derive the expression for energy stored in magnetic field in terms of field quantities. (8)

(OR)

12.b.i. An air coaxial transmission line has a solid inner conductor of radius 'a' and a very thin outer conductor of inner radius 'b'. Determine the inductance per unit length of the line. (8)

ii. For a current distribution in free space, $\mathbf{A} = (2x^2y+yz)\,\mathbf{a}_x + (xy^2-xz^3)\,\mathbf{a}_y - (6xyz- 2x^2y^2)\,\mathbf{a}_z$ (Wb/m). Calculate magnetic flux density and its divergence. (8)

13.a.i. Derive the Maxwell's equations both in integral form and differential form from Ampere's law and Faraday's law. (8)

ii. In a dielectric medium $\mathbf{E} = 20 \sin (10^8t - 0.6z)\mathbf{a}_y$ (V/m).Determine the value of displacement current density and magnetic field intensity. ($\varepsilon_r = 8$) (8)

(OR)

13.b.i. State and explain Poynting theorem. (6)

ii. Find the Poynting vector on the surface of a long, straight conducting wire (radius 'b' and conductivity 'σ') that carries a direct current 'I'. Verify Poynting theorem. (6)

iii. Write the boundary conditions for an electromagnetic wave incident on dielectric and conductor interface. (4)

14.a.i. Derive the harmonic form of wave equation from Maxwell's equations. (8)

ii. A plane wave propagating through a medium with $\varepsilon_r = 8$, $\mu_r = 2$, has $\mathbf{E} = 0.5 \sin (10^8t - \beta z)\,\mathbf{a}_x$ (V/m). Determine β, wave velocity, intrinsic impedance and magnetic field intensity **H**. (8)

(OR)

14.b. i). Derive the expression for reflection and transmission coefficient when uniform plane wave normally incident on perfect conductor medium. (8)

ii) Derive the expression for ac resistance for a good conductor with radius 'a', length 'L' and conductivity 'σ'. Determine the ratio of ac resistance to dc resistance for copper at 500 kHz, 900 MHz and 5.8 GHz.
(for copper $\sigma = 5.8 \times 10^7$ S/m, $\mu = \mu_o = 4\pi \times 10^{-7}$ H/m) (8)

15.a. Explain the working principle of ink-jet printer and magnetic separator with neat block diagram. (16)

(OR)

15.b. Solve Poisson's equation by using finite difference method. (16)
