B.E DEGREE EXAMINATIONS: DEC 2014

(Regulation 2009)

Third Semester

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ECE104**:** Electromagnetic Fields

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1.   The unit of electric field intensity is

   a)   Coulombs   b)   Joules/m

   c)   Volts/m   d)   A/m

2.   The area of the curved surface of a right circular cylinder of radius 'a' and height 'h' using

   cylindrical coordinates is

   a) $2\pi ah$ b) Πr^2

   c) $r^2 \sin\theta$ d) $\pi r^2 h$

3.   The divergence of a curl is

   a)   J   b)   0

   c)   Unity   d)   ∞

4. ∇. J for steady state current is

   a) $-\partial\rho/\partial t$ b) ρ_v

   c)   0   d)   Q

5.   The static electric field intensity inside a conductor is

   a)   0   b)   uniform

   c)   infinite   d) F/ρ_s

6.   The angle of incidence such that the angle of transmission is 90° and that is called

   a)   Brewster angle   b)   Critical angle

   c)   Phase constant   d)   None of the above

7.   If $\sigma = 2\,\mho$ /m, E = 10V/m, the conduction current density is

   a) $5A/m^2$ b) $20A/m^2$

c) $40A/m^2$ d)   20A

8.   The electric field in free space is

a) D/ε_0 b) D/μ_0

c) $\varepsilon_0 D$ d) σ/z_0

9.   In a lossless media the phase constant is

a) $\omega\sqrt{\mu\varepsilon}$ b) $\sqrt{\dfrac{\omega\mu\sigma}{2}}$

c) $\sqrt{\dfrac{\mu}{\varepsilon}}$ d) $\dfrac{\sigma}{\omega\varepsilon}$

10.   A uniform plane wave is incident obliquely at the interface of two perfect dielectric regions. The boundary conditions needed to obtain the relation between electric field intensity of the reflected wave and electric field intensity of incident wave are

a)   The normal components of magnetic field intensity on two sides of the boundary are equal

b)   The tangential components of magnetic field intensity on two sides of the boundary are equal

c)   The normal components of electric field intensity on two sides of the boundary are equal

d)   The tangential components of electric field intensity on two sides of the boundary are equal

PART B (10 x 2 = 20 Marks)

11.   Determine the area of a surface defined in a spherical coordinate system as $r = 2$ and $\theta = 45° \leq \theta \leq 60°$.

12.   State Guass's law.

13.   State Ampere's law

14.   Given the general vector $A = (\sin 2\Phi)_{a\Phi}$ in cylindrical coordinates. Find curl of A at $(2, \pi/4, 0)$.

15.   Find the capacitance of a parallel plate capacitor containing two dielectrics, $\varepsilon_{r1} = 1.5$ and $\varepsilon_{r2} = 3.5$, each comprising one half of the volume and $A = 2m^2$ and $d = 10^{-3}m$.

16.   Define self inductance and mutual inductance.

17.   State pointing theorem.

18.   State Faraday's law of induced emf.

19.   Define skin depth.

20.   Find wave length of a uniform plane wave in free space at a frequency of 300MHz.

PART C (5 x 14 = 70 Marks)

21. a) (i) A vector of magnitude 10 points from $(5, 5\pi/4, 0)$ is in cylindrical coordinates (4) towards the origin. Express the vector in Cartesian coordinates.

       (ii) Find the force on a point charge of $50\mu C$ at $(0, 0, 5)$ m due to charge of $500\mu C$ (10) that is uniformly distributed over the circular disc with $r \leq 5m$ at $z = 0m$.

(OR)

  b) (i) A circular disc of radius 4m with a charge density of $\rho_s = 12\sin\Phi$ $\mu C/m^2$ is (4) enclosed by surface 'S'. What is the net flux crosses 'S'?

       (ii) Given the electric field $E = 2x_{ax} - 4y_{ay}$ V/m. Find the work done in moving a (10) point charge 2C from $(2,0,0)$m to $(0,0,0)$m and from $(0,0,0)$ to $(0,2,0)$.

22. a) (i) State Biot-Savart law. (2)

       (ii) Derive the expression of magnetic flux intensity at any point due to an infinitely (12) long straight filament carrying a current of 'I'.

(OR)

  b) A coaxial conductor with an inner conductor of radius 'a' and an outer conductor of inner and outer radii 'b' and 'c' respectively carries current 'I' in the inner conductor. Find the magnetic flux per unit length crossing a plane 'Φ' = constant between the conductors.

23. a) Explain the boundary conditions for electric and magnetic fields.

(OR)

  b) Find the capacitance of a coaxial capacitor of length 'L', where the inner conductor has radius 'a' and outer has radius 'b'.

24. a) Derive Maxwell's equations in integral and differential forms.

(OR)

b) An antenna in free space is centered at the origin of a spherical coordinate system. The fields produced by antenna at a radial distance 'r' are given by,

$$E = \frac{E_0}{r} sin\theta . sin\omega (t - \frac{r}{u_0}) a_\theta \quad \text{and}$$

$$H = \frac{E_0}{r\sqrt{\frac{\mu_0}{\varepsilon_0}}} sin\theta . sin\omega (t - \frac{r}{u_0}) a_\varphi$$

Find the poynting vector and the total average power radiated by the antenna.

25. a) A uniform plane wave at a frequency of 1GHz is travelling in a large block of Teflon ($\varepsilon_r \approx 2.1$, $\mu_r = 1$ and $\sigma = 0$. Determine   a) phase velocity (u) b) intrinsic impedance (η) c) phase constant (β) d) wave length (λ).

(OR)

b) Illustrate circular, linear and elliptical polarization of plane waves.

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