Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 40444

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fourth Semester

Electronics and Communication Engineering

EC 8451 – ELECTROMAGNETIC FIELDS

(Common to Electronics and Telecommunication Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Stoke's theorem.

2. Write the vector $A = r^2 a_r + \sin(\theta) a_\phi$ in Cartesian coordinate system.

3. State Gauss's law.

4. What is the volume charge density and Electric field inside a perfect conductor?

5. Write Lorentz Force equation.

6. Avery long solenoid with 1 × 1 cm cross section has an iron core (μ_r = 1000) and 3000 turns per meter. It carries a current of 500 mA. Find the self-inductance of the solenoid.

7. Write the point form of Maxwell's equations for free space.

8. A parallel plate capacitor with a plate area of 2 cm^2 and plate separation of 3 mm has a voltage 40 sin (1000 t) V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0\varepsilon_0 = 8.854 \times 10^{-12}$ F/m.

9. State Poynting theorem.

10. Find the skin depth of copper at 10 GHz. For copper, $\sigma = 5.8 \times 10^7$ S/m, $\mu = \mu_0$.

PART B — ($5 \times 13 = 65$ marks)

11. (a) Verify the divergence theorem for the vector function $A = r^2 a_r + 2z\,a_z$ for the circular $r = 5, z = 0$ and $z = 4$.

Or

(b) Determine the divergence and curl of the following vector fields (6 + 7)

(i) $A = x^3 y^2 z\,a_x + x_z a_z$

(ii) $B = r\sin(\phi)a_r + r^2\,z\,a_\phi + z\cos(\phi)a_z$.

12. (a) Determine the E field caused by a spherical cloud of electrons with a volume charge density $\rho = -\rho_0$ for $0 \le R \le b$ (both ρ_0 and b are positive) and $\rho = 0$ for $> b \cdot b$ is the radius of the sphere.

Or

(b) A cylindrical capacitor consists of an inner conductor of radius a and outer conductor whose inner radius is b. The space between the conductors is filled with a dielectric of permittivity ε, and length of the capacitor is L. Determine the capacitance of the capacitor.

13. (a) Derive the boundary conditions for the static magnetic field at the interface of two different magnetic medium with permeability μ_1 and μ_2.

Or

(b) Derive an expression for energy stored in the magnetic medium in terms of field quantities.

14. (a) Derive the integral and point form of the Maxwell's equations form Ampere's law and Faraday's law.

Or

(b) Derive the wave equations from Maxwell's equations and solve it for free space conditions.

15. (a) A plane wave propagating through a medium with $\varepsilon_r = 8$, $\mu_r = 2$ has $E = 0.5e^{-z/3}\sin(10^8 t - \beta z)a_x$ V/m. Determine β, wave velocity, loss tangent, H field and intrinsic impedance.

Or

(b) In free space $(z \le 0)$, a plane with $H_i = 10\cos(10^8 t - \beta z)\,a_x$ mA/m is incident normally on a lossless medium $(\varepsilon = 2\varepsilon_0,\ \mu = 8\mu_0)$ in region $z \ge 0$. Determine the reflected wave H_r, E_r and the transmitted wave, H_t, E_t.

PART C — (1 × 15 = 15 marks)

16. (a) Three electric charges are located in air medium as shown in Figure 16(a). The values of charges are Q_1 = 10 nC, Q_2 = –15 nC and Q_3 = 20 nC. The charge Q_2 is enclosed by a copper sheet (2mm thickness) as shown in Figure 1 and grounded. Calculate the electric field at point P due to charges Q_1, Q_2 and Q_3. $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m. (15)

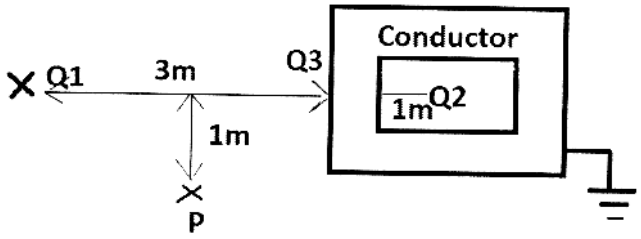

Figure 16(a)

Or

(b) The Electric field intensity in air medium is given by $E = 0.1\sin(10\pi x)\cos(6\pi 10^9 t - \beta z)a_y(V/m)$. Find the magnetic field intensity H and β (15)