Reg. No. :

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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020
Fourth Semester
Electronics and Communication Engineering
EC2253/EC43/EC1253/080290021/10144EC404 – ELECTROMAGNETIC FIELDS
(Regulations 2008/2010)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. State Stokes theorem and give its meaning.

2. A 15 nC point charge is at the origin in free space. Calculate V_1 if point P_1 is located at P_1 (–2, 3, –1) and V = 0 at (6, 5, 4).

3. What is magnetic dipole moment ?

4. Write the Lorentz force equation.

5. Express Laplace equation in spherical coordinates.

6. Write the expression for energy stored in an inductor.

7. Distinguish between conduction current and displacement current.

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

9. A sinusoidal electric intensity of amplitude 250 V/m and frequency 1 GHz exists in a lossy dielectric medium that has a relative permittivity of 2.5 and loss tangent of 0.001. Find the effective conductivity of the lossy medium.

10. What is skin depth ?

PART – B **(5×16=80 Marks)**

11. a) i) State Gauss law and explain its applications. **(6)**

ii) Three infinite uniform sheets of charge are located in free space as follows : 3 nC/m^2 at z = –4, 6 nC/m^2 at z = 1 and –8 nC/m^2 at z = 4. Find E at the points P_A(2, 5, –5), P_B(4, 2, –3), P_C (–1, –5, 2) and P_D (–2, 4, 5). **(6)**

iii) Point charges of 50 nC each are located at A(1, 0, 0), B(–1, 0, 0), C(0, 1, 0) and D (0, –1, 0) in free space. Find the total force on the charge at A. **(4)**

(OR)

b) i) Define curl, Divergence and Gradient and state their meanings. **(6)**

ii) Find the potential due to an electric dipole. **(6)**

iii) Two uniform line charges, 8 nC/m each, are located at x = 1, z = 2 and at x = –1, y = 2 in free space. If the potential at the origin is 100 V, find V at P(4, 1, 3). **(4)**

12. a) Derive an expression for Biot-Savart law. Derive the equation for torque on a current carrying loop. **(16)**

(OR)

b) Find H-field on the axis of a ring carrying a constant current. Highlight the similarities between Biot-Savart law and Coulomb's law. **(16)**

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 'ε_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, also 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 $E = 1.5 \cos(10^8 t - \beta z)\bar{a}_x$ V/m. Find B, H and D. Assume $\varepsilon_r = 1$, $\mu_r = 1$, $\sigma = 0$. **(8)**

15. a) i) Derive the wave equations for Electric and Magnetic fields. **(8)**

ii) The electric field intensity of a linearly polarized uniform plane wave propagating in the +z direction in seawater is $\vec{E} = 100\cos(10^7 \pi t)\hat{i}$ V/m at z = 0. The constitutive parameters of seawater are $\varepsilon_r = 72$, $\mu_r = 1$ and conductivity $\sigma = 4$ S/m. Determine the attenuation constant, phase constant, intrinsic impedance, phase velocity, wavelength and skin depth. Also find the distance at which the amplitude of E is 1% of its value at z = 0. **(8)**

(OR)

b) i) Analyze the wave behaviour at boundaries under oblique incidence and derive the Brewster's angle. **(12)**

ii) Prove that a linearly polarized wave can be resolved into a right hand circularly polarized wave and a left hand circularly polarized wave of equal amplitude. **(4)**