

Fourth Semester B.E. Degree Examination, Dec.08 / Jan.09

Field Theory

Time: 3 hrs.

Max. Marks:100

Note : Answer any FIVE full questions.

- 1
 - a. State and explain Coulomb's law of force. (05 Marks)
 - b. Two point charges of magnitudes $3 \mu\text{C}$ and $-8 \mu\text{C}$ are located at places $P_1(-3, 5, -7)$ and $P_2(-4, 2, 9)$ respectively in free space. Evaluate the electric field and also its magnitude at the point $P(2, -6, 5)$. (07 Marks)
 - c. Derive the relationship between electric field and electric potential. (08 Marks)
- 2
 - a. State and prove Gauss theorem. (07 Marks)
 - b. Given the potential field, $V = 50x^2yz + 20y^2$ volts in free space
Find: i) Voltage at a point $P(1, 2, -3)$ ii) Field strength at P iii) \vec{a}_r at P (07 Marks)
 - c. In a certain region of space, $\vec{D} = 2xy\hat{a}_x + 3yz\hat{a}_y + 4zx\hat{a}_z$
Evaluate the amount of electric flux that passes through the portion bounded by $-1 \leq y \leq 2$ and $0 \leq z \leq 4$ in the $x = 3$ plane. (06 Marks)
- 3
 - a. Derive Laplace's equation, verify whether the potential field given below satisfies Laplace's equation $V = 2x^2 - 3y^2 + z^2$. (07 Marks)
 - b. What is Divergence of a vector? Obtain point-form of Gauss law. (07 Marks)
 - c. Obtain the boundary conditions at the interface between two dielectrics of different permittivities. (06 Marks)
- 4
 - a. State and explain Biot-Savart's law. (04 Marks)
 - b. Find the magnetic field strength at the point $(1, 3, 2)$ caused by a current element $2\pi(0.6\hat{a}_x - 0.8\hat{a}_y) \mu\text{A/m}$ situated at $(4, -2, 3)$. (04 Marks)
 - c. Arrive at an expression for vector magnetic potential. (06 Marks)
 - d. Show that the magnetic field intensity at the end of a long solenoid is one half of that at the centre. (06 Marks)
- 5
 - a. State Faraday's law and obtain point and integral forms of Faraday's law of EMI. (05 Marks)
 - b. Find the force per meter length between two long parallel wires separated by 10 cm in air and carrying a current of 10 A in the same direction. Derive any formula used. (05 Marks)
 - c. Derive the equation for energy density in a magnetic field. (05 Marks)
 - d. Obtain an expression for the equation of continuity. (05 Marks)
- 6
 - a. List Maxwell's equations in integral forms for i) Static fields ii) Time-varying fields. (08 Marks)
 - b. What is the inconsistency of Ampere's law with equation of continuity? Derive the modified form of Ampere's law by Maxwell. (06 Marks)
 - c. Justify that for the case of a parallel plate capacitor the displacement current is equivalent to conduction current. Comment on the ratio of magnitudes of conduction current density to displacement current density. (06 Marks)
- 7
 - a. Derive the wave equations for \vec{E} and \vec{H} in a general medium. (07 Marks)
 - b. What are uniform plane waves? Show that a UPW is transverse in nature. (07 Marks)
 - c. For damp soil at a frequency of 1 MHz given that $\epsilon_r = 12$, $\mu_r = 1$ and conductivity $a = 20\text{m S/m}$. Determine i) Attenuation constant ii) Phase constant iii) Propagation constant iv) Wavelength v) Phase velocity vi) Intrinsic impedance. (06 Marks)
- 8
 - a. What do you mean by depth of penetration? (05 Marks)
 - b. State and prove Poynting theorem. (05 Marks)
 - c. Discuss linearly polarized wave. (05 Marks)
 - d. Write a note on Brewster angle. (05 Marks)