NEW SCHEME

EC44

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

Fourth Semester B.E. Degree Examination, January/February 2006

BM/EC/EE/TE/ML/IT

Field Theory

Time: 3 hrs.) (Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Assume the missing data, if any.

1. (a) Explain electric field intensity at a point in an electric field produced by a point charge. Show that the electric field intensity at any point due to an infinite sheet of charge is independent of the distance to the point from the sheet. **(8 Marks)**

   (b) Explain the concept of work and potential as applied to an electric field and hence obtain an expression for the potential difference between two points in an electric field produced by a point charge. **(6 Marks)**

   (c) Find the electric field at the origin due to a point charge of $6.44 \times 10^{-9} C$ located at $(-4, 2, -3)m$ in the Cartesian coordinate system. **(6 Marks)**

2. (a) State and prove Gauss law and determine the field due to an infinite line charge using the same. **(10 Marks)**

   (b) With usual notations establish the relationship between electric field intensity and the electric potential. **(4 Marks)**

   (c) Given the potential field $V = 50 \times X^2YZ + 20Y^2$Volts in free space, find the voltage at a point $P(1, 2, -3)$ and the field strength at P. **(6 Marks)**

3. (a) Using Laplace's equation, prove that the electric potential at any point distant r in the space between 2 charged concentric spheres of radii R_1 and R_2 as $V = V_0 \left[\frac{\frac{1}{r} - \frac{1}{R_2}}{\frac{1}{R_1} - \frac{1}{R_2}} \right]$. **(8 Marks)**

   (b) With usual notations derive boundary conditions at the boundary between a dielectric and a conductor in an electric field. **(8 Marks)**

   (c) Prove that the potential field given by $V = 2x^2 - 3y^2 + z^2$ satisfies Laplace equation. **(4 Marks)**

4. (a) Using the concept of volume energy density in an electric field, find the total energy stored in :

      i) A parallel plate system

      ii) Two concentric spherical conductors. Hence find their capacitances. **(8 Marks)**

   (b) Show that the magnetic field intensity at the end of a long solenoid is one half of that at the center. **(6 Marks)**

   (c) Derive an expression for the equation of continuity. **(6 Marks)**

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5. (a) State and prove Ampere's circuital law and apply it to a straight solid cylindrical conductor to calculate the magnetic field intensity. **(8 Marks)**

   (b) Discuss the concept of vector magnetic potential and hence show that $\vec{A} = \frac{\mu_0}{4\pi} \int \frac{\vec{J}}{r} dv$; where $\vec{A}$ is the vector magnetic potential and $\vec{J}$ is the current density. **(6 Marks)**

   (c) Find the magnetic field intensity at the center of a square of sides equal to 5m and carrying current of 10A. **(6 Marks)**

6. (a) Derive an expression for the force on a differential current element placed in a magnetic field. Also obtain an expression for the emf induced between the two ends of a conductor due to its motion in a steady magnetic field. **(8 Marks)**

   (b) Find the frequency at which the conduction current density and the displacement current density are equal in a medium with

   $$\sigma = 2 \times 10^{-4}\ mho/m \ and\ \epsilon_r = 81$$ **(6 Marks)**

   (c) Starting from Faraday's law of electromagnetic induction derive the Maxwell's equation $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ **(6 Marks)**

7. (a) State and prove Poynting's theorem. **(10 Marks)**

   (b) A radio station transmits power radially around the spherical region. The desired electrical field intensity at a distance of 10 km from the station is 1mV/m. Calculate the corresponding H, P and the station power. **(10 Marks)**

8. Write explanatory note on :

   (a) Divergence theorem

   (b) Biot-Savart's law

   (c) Wave propagation in a good conducting medium

   (d) Inductance of a co-axial cable. **(5×4=20 Marks)**

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