EC44

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**NEW SCHEME**

# Fourth Semester B.E. Degree Examination, July 2007
## EC / TE / EE / IT / ML / BM
## Field Theory

Time: 3 hrs.] [Max. Marks:100

**Note :** ***Answer any FIVE full questions.***

1 a. State Coulomb's law in complete form. **(05 Marks)**

b. State Guass theorem. Mention nature of Guassian surface. **(05 Marks)**

c. Determine electric flux density D in Cartesian co-ordinates caused at P(6, 8, -10) by

i) A point charge of 30 mC at origin

ii) An infinite line charge with $\rho_l = 40\mu C/m$ on $x = 0 ; y = 0$

iii) A surface charge with $\rho_s = 57.2\mu C/m^2$ on the plane $z = 9$ m. **(10 Marks)**

2 a. Show that $E = -\nabla V$. **(06 Marks)**

b. A total charge of 40 nC is uniformly distributed around a ring of radius 2m, with it's center located at origin (0, 0, 0) and lying in the plane $z = 0$. Determine electric potential at (0, 0, 5) m. Also determine the potential at (0, 0, 5), if all charge of 40 nC were to be concentrated at origin. **(07 Marks)**

c. Determine work done in carrying a charge of –2 C from (2, 1, –1) to (8, 2, –1) in the electric field $E = y\,a_x + x\,a_y$ v/m, (in Cartesian co-ordinates) considering the path along the parabola $x = 2y^2$. **(07 Marks)**

3 a. Using Laplace equation derive an expression for capacitance for concentric spherical capacitor. **(08 Marks)**

b. Find stored energy in a system of four identical charges of 4 nC, at the corners of a square of side 1m. Also determine energy density at the center of the square. **(06 Marks)**

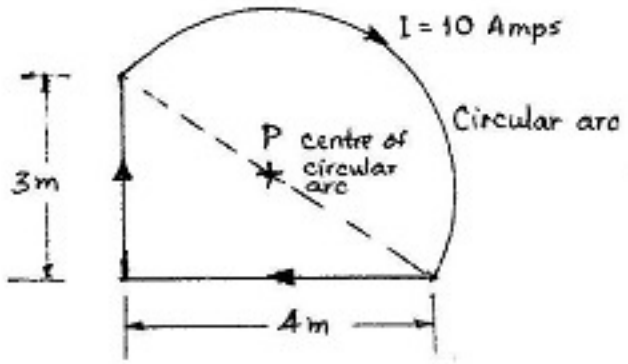
c. With usual notation derive the expression $\nabla . J = -\frac{\partial \rho_v}{\partial t}$. **(06 Marks)**

4 a. Discuss the boundary conditions at the interface between two dielectrics of different permittivities. **(08 Marks)**

b. State and prove uniqueness theorem. **(06 Marks)**

c. The region $z < 0$ is composed of a uniform dielectric material with $\varepsilon_r = 3.2$ and the region $z > 0$ is characterized by $\varepsilon_r = 2$. If $D_1 = (-30a_x + 50a_y + 70a_z)nC/m^2$, determine i) $D_2$ ii) $\theta_1$ iii) $\theta_2$ **(06 Marks)**

5 a. Using Biot Savert's law, determine magnetic flux density at 'P', for the current loop shown in Fig.5(a)




**(08 Marks)**

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b. Clearly differentiate between scalar magnetic potential and vector magnetic potential. **(05 Marks)**

c. Given $H = 20r^2 a_\phi$ A/m i) Determine the current density J ii) Also determine the total current that crosses the surface r = 1m, $0 < \phi < 2\pi$ and z = 0 (in cylindrical coordinates). **(07 Marks)**

6 a. Explain Faraday's laws applied to
   i) Stationary path, changing field and
   ii) Steady field moving circuit.
   Derive necessary relationships. **(10 Marks)**

b. For the Faraday disc generator shown in Fig.6(b), determine open circuit voltage. The circular disc is of radius 'a', rotates at a constant angular velocity 'ω' rad/sec in a magnetic field of $B_{az}$ $\omega b/m^2$. Two brushes are put, at the axis and rim of the disc.

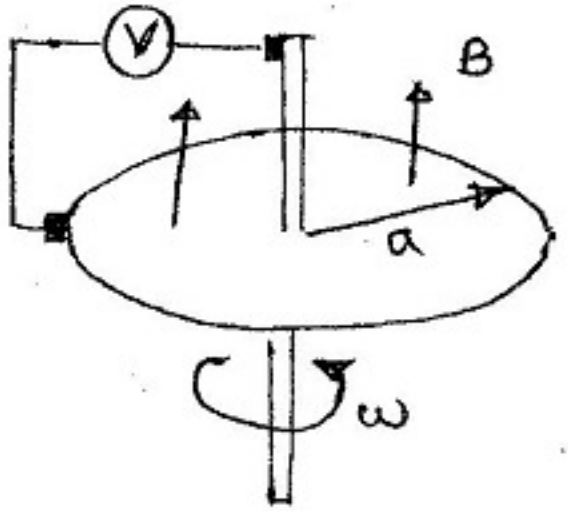


Fig.6(b) **(05 Marks)**

c. Determine inductance of a solenoid carrying N turns on a magnetic core of axial length 'l' meters and cross sectional area of 'A' $m^2$. **(05 Marks)**

7 a. List Maxwell's equations in differential form for both steady fields and time varying fields. **(08 Marks)**

b. State and prove Poynting theorem. **(06 Marks)**

c. Derive electromagnetic wave equation for a homogeneous medium. **(06 Marks)**

8 a. What do you mean by depth of penetration? **(05 Marks)**

b. Explain electromagnetic waves propagation in perfect dielectric. **(07 Marks)**

c. Wet marshy soil is characterized by $\sigma = 10^{-2}$ s/m, $\varepsilon_r = 15$ and $\mu_r = 1$. At frequencies 60 Hz, 1 MHz, 100 MHz and 10 GHz, indicate whether soil be considered a conductor, or a dielectric. **(08 Marks)**