



COLLEGE OF ENGINEERING & TECHNOLOGY
 Department: Electronics and Communications Engineering
 Lecturer: Associate Prof. Dr. Hussein Hamed Mahmoud Ghouz
 Course: Electromagnetics (EM_I)
 Course Code: EC341
 Date : Sat. 10, Jan., 2015

Time : 120 Min
 Total Marks : 40

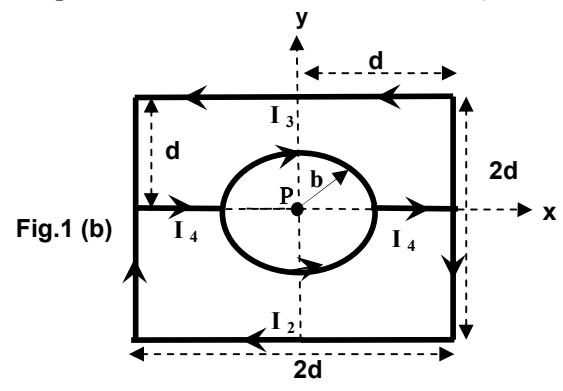
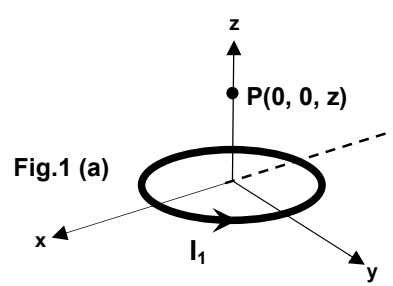
Answer All Questions (Fall 2014/2015)

Question No-1 (8-Mark):

- (a) State Gauss's law of electrostatic field, and then verify it for a point charge located in free-space (2-Mark)
- (b) State and prove ampere's law of magnetostatic field, and then verify it for an infinite conducting wire carrying a stationary current. (2-Mark)
- (c) Consider two parallel long wires having equally radii ($r_1=r_2=b=5.0\text{mm}$) and separated by a distance $R=1.0\text{m}$. The current in each wire has constant and equal value ($I_1=I_2=30\text{mA}$) and opposite in direction. Find the following: (4-Mark)
 1. Capacitance and mutual inductance
 2. Electric and magnetic forces
 3. Electric and magnetic fields at any point between the wires

Question No-2 (8-Mark):

- (a) Consider a small circular loop of radius $b=0.25\text{m}$ carrying a stationary current $I_1=30\text{mA}$ as shown in the Fig.1 (a). Find the magnetic field intensity at the point $P(0, 0, z)$ (3-Mark)
- (b) State Biot-Sevart's law of magnetostatic field for a finite conducting line (2-Mark)
- (c) A group of conducting lines forms two closed loops, upper and lower (square loop plus half circular loop), carrying constant currents as shown in Fig.1 (b), assume: $I_2=I_3=30\text{mA}$, $d=0.8\text{m}$, and $b=d/4$, find the magnetic field at the point P (3-Mark)



Question No-3 (12-Mark)

- (a) Derive the equations of the boundary conditions between two dielectric materials. (2-Mark)
- (b) Two lossy materials ($\epsilon_1=4.4\epsilon_0$, $\sigma_{d1}=3 \times 10^{-3}$ & $\mu_1=\mu_0$, and $\epsilon_2=2.2\epsilon_0$, $\sigma_{d2}=5.0 \times 10^{-3}$ & $\mu_2=\mu_0$) are used to fill the space between the inner and outer conductors of a coaxial cable as shown in Fig.2. The inner conductor is kept with a positive voltage $V_0=5.0$ volt and the outer conductor is grounded (zero voltage). Assume, the radius of inner conductor and thickness of the outer conductor can be neglected, find the following:
 1. The capacitance C and the inductance L per unit length (2-Mark)
 2. The conductance $G=1/R$ per unit length (2-Mark)
 3. Draw the equivalent circuit (2-Mark)

—————> **P.T.O.**

- (c) Given two isolated and infinite conducting planes form a sector of a convex angle as shown in Fig.3. One of the conducting planes is kept at constant potential V_0 while the other is grounded. Solve the Laplace equation to find the potential and the electric field distributions between the conducting planes. (4-Mark)

Question No-4 (12-Mark)

- (a) Given a corner shape of infinite copper conducting planes having a zero potential and an angle α of 90° as shown in Fig.4. Assume a point charge $Q=50$ nC is located at a point between the two conductors. Assume $d=0.8$ m, use the image method to find the following: (5-Mark)

1. The electric potential and electric field at the observation point $P(x, 0, z)$
2. The electric force between ground planes and the point charge Q

- (b) Prove that the Maxwell's curl equations in case of Time-Varying fields are given by: (4-Mark)

$$\nabla \times \bar{\mathbf{E}} = -\frac{\partial \bar{\mathbf{B}}}{\partial t} \quad \text{and} \quad \nabla \times \bar{\mathbf{H}} = \bar{\mathbf{J}} + \frac{\partial \bar{\mathbf{D}}}{\partial t}$$

- (c) A Time-Harmonic electric field of a plane wave having a single component (**x-component**) propagates in a lossless dielectric medium ($\epsilon=\epsilon_0\epsilon_r$ & $\mu=\mu_0$) along the **z-direction**. The electric field intensity has a complex instantaneous form given by:

$$\mathbf{E}(t, z) = 10^{+03} \exp\left\{j\left(2\pi \times 10^9 t - \frac{3\pi}{4} z + \frac{2\pi}{3}\right)\right\} \mathbf{a}_x. \quad \text{Find } \epsilon_r \text{ and } \mathbf{B}(t, z) \quad (3\text{-Mark})$$

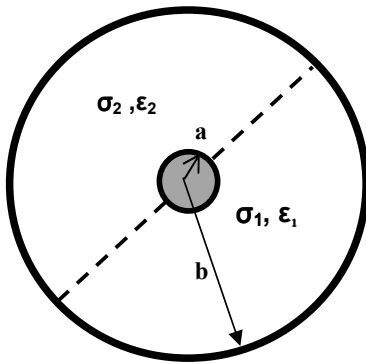


Fig.2

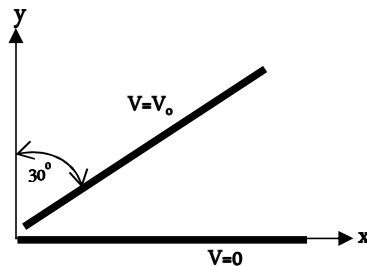


Fig.3

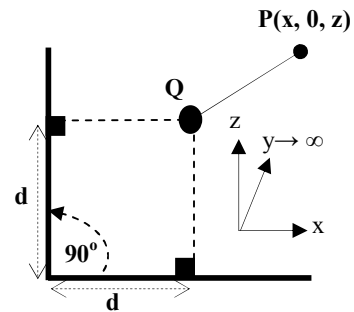


Fig.4

Constants and Formulas

$$1/(4\pi\epsilon_0) = 9 \times 10^9 \text{ m/F}$$

$$\epsilon_0 = 10^{-09} / (36\pi) \text{ F/m}$$

$$\mu_0 = 4\pi \times 10^{-07} \text{ H/m}$$

$$\nabla V = \frac{\partial V}{h_1 \partial u_1} \mathbf{a}_{u1} + \frac{\partial V}{h_2 \partial u_2} \mathbf{a}_{u2} + \frac{\partial V}{h_3 \partial u_3} \mathbf{a}_{u3}$$

$$\nabla^2 V = \frac{1}{h_1 h_2 h_3} \left(\frac{\partial}{\partial u_1} \left(h_2 h_3 \left(\frac{1}{h_1} \frac{\partial V}{\partial u_1} \right) \right) + \frac{\partial}{\partial u_2} \left(h_1 h_3 \left(\frac{1}{h_2} \frac{\partial V}{\partial u_2} \right) \right) + \frac{\partial}{\partial u_3} \left(h_1 h_2 \left(\frac{1}{h_3} \frac{\partial V}{\partial u_3} \right) \right) \right)$$

$$\nabla \times \bar{\mathbf{A}} = \frac{1}{h_1 h_2 h_3} \begin{vmatrix} h_1 \mathbf{a}_{u1} & h_2 \mathbf{a}_{u2} & h_3 \mathbf{a}_{u3} \\ \frac{\partial}{\partial u_1} & \frac{\partial}{\partial u_2} & \frac{\partial}{\partial u_3} \\ h_1 A_{u1} & h_2 A_{u2} & h_3 A_{u3} \end{vmatrix}$$

GoodLuck