COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electronics and Communications Engineering
Lecturer: Prof. Dr. Hussein Hamed Mahmoud Ghouz
Course: Electromagnetic-I
Course Code: EC341 **Time : 60 Min.**
Date : Sat. Oct., 10, 2014 **Total Marks:30**

7TH Exam Fall 2014/2015

Answer the Following Questions

Question No. 1:(6-Mark)

(a) Given a vector field $\mathbf{A} = (\rho^2 Z \cos(\varphi))\, \mathbf{a}_\rho + Z^2 \rho \sin(\varphi)\, \mathbf{a}_\varphi + Z \cos(\varphi)\, \mathbf{a}_z$, verify the divergence theorem for a half cylinder defined by $0 \le \rho \le 4$, $0 \le \varphi \le \pi$, and $0 \le Z \le 6$ **(3-Mark)**

(b) Given a vector field $\mathbf{B} = \rho z^2\, \mathbf{a}_\rho + z\rho^2\, \mathbf{a}_z$, evaluate the scalar line integral $\int_{path} \overline{B}.\overline{d\ell}$ from the point $P_1(2, 0, 2)$ to the point $P_2(0, 4, 4)$ along the shortest path **(3-mark)**

Question No. 2:(10-Mark)

A point charge $\mathbf{Q_1}$ (10 mc) is located inside a closed room at the point $\mathbf{P_1}$ (0, 0, z_o=4.0) as shown in **Fig.1.** This room having an internal uniform electric field vector given by: $\mathbf{E}=4\mathbf{a}_x + 3\mathbf{a}_y + 8\mathbf{a}_z$ **(V/m)**. Find the electric force **F** acting on the given charge $\mathbf{Q_1}$, the electric field $\mathbf{E_{P0}}$ at the point $\mathbf{P_0}$, and the work done to move $\mathbf{Q_1}$ from the point $\mathbf{P_1}$ to the point $\mathbf{P_2}$ along the given path (assume x_o=4.0 and y_o=6.0). If an additional charge $\mathbf{Q_2}$ (5 mc) is located at the point $\mathbf{P_0}$, find the electric force acting on the charge $\mathbf{Q_1}$ and the electric **energy** in this case. **(2-Mark for each)**

Question No. 3:(8-Mark)

Show that the electrostatic potential $\mathbf{V_p}$ of a charge disk having a radius **b** and a uniform charge density $\boldsymbol{\rho_s}$ shown in **Fig.2** is given by: $V_p = \frac{\rho_s}{2\varepsilon_o}\left((b^2 + z^2)^{1/2} - z\right)$ **(4-Mark)**. Find the electric field intensity **E** if $b \to \infty$, then, verify the result using **Gauss' Law (4-Mark)**

Question No. 4:(6-Mark)

(b) A cross section view of two infinite empty charged concentric cylinders having radii **"a"** and **"b"** and the space surrounding the two cylinders is the vacuum as shown in **Fig.3**. Assume the first cylinder (inner cylinder) has a positive charge density $+\rho_\ell$, the second cylinder (outer cylinder) has a negative charge density $-\rho_\ell$, and **b=10.0a** (**a**=10.0 mm). **Using gauss law**, find the electric field intensity **E** vector in each region and then, plot the magnitude of both **E** versus the radial distance **ρ** **(6-Mark)**

GoodLuck

Formula Sheet

$k = 1/(4\pi\varepsilon_o) = 9x10^{+09}$

$$\int \frac{x\,dx}{(x^2+a^2)^{1/2}} = \sqrt{x^2+a^2}$$

$$\int \frac{x\,dx}{(x^2+a^2)^{3/2}} = \frac{-1}{\sqrt{x^2+a^2}}$$

$$\int \frac{dx}{(x^2+a^2)} = \frac{1}{a}\tan^{-1}\frac{x}{a}$$

$$\int \frac{dx}{(x^2+a^2)^{3/2}} = \frac{x}{a^2\sqrt{x^2+a^2}}$$

$$A = \nabla V = \frac{\partial V}{h_1 \partial u_1} a_{u1} + \frac{\partial V}{h_2 \partial u_2} a_{u2} + \frac{\partial V}{h_3 \partial u_3} a_{u3}$$

$$\nabla \cdot \overline{A} = \frac{1}{h_1 h_2 h_3}\left(\frac{\partial}{\partial u_1}(h_2 h_3 A_{u_1}) + \frac{\partial}{\partial u_2}(h_1 h_3 A_{u_2}) + \frac{\partial}{\partial u_3}(h_1 h_2 A_{u_3})\right)$$

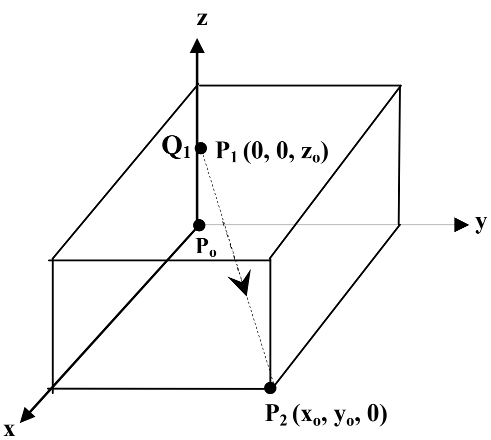

Fig.1

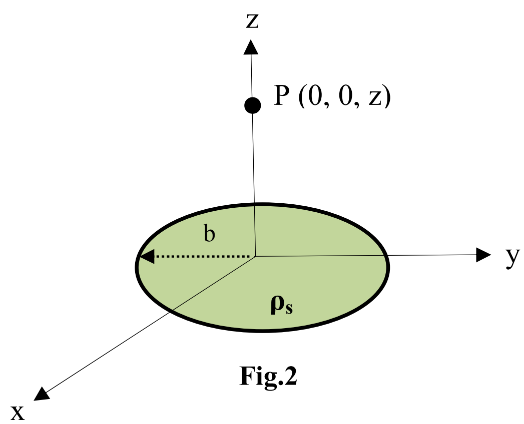

Fig.2

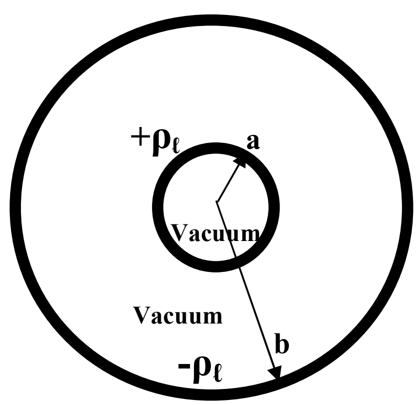

Fig.3