Ministry of Technical Education
College Of Electronic Technology
Department of Communication Engineering

(Fall-2024) 07-09-2024

Electromagnetic Part I (Final Exam)

Time: 2.00 hours

Note: This is an open notes, open book, closed friend, open mind test. On your desk you should have not any internet-enabled devices such as a computer or mobile phone.

Q1: (40 points)

1. Express as a vector function the gradient (maximum directional derivative) of the following scalar fields

$E(\rho,\varphi,z)=15\rho^2\cos\varphi+200\rho\sin\varphi+100z\cos\varphi$

$G(\rho,\varphi,z)=75\rho^2 z\cos\varphi+50\rho\sin\varphi$

Find the magnitude of ∇E and ∇G at $p_1(2,45°,1)$ and determine the expression for the unit vector $\mathbf{a}_{\nabla E}$ and $\mathbf{a}_{\nabla G}$. Find the angle between ∇E and ∇G at $p_1(2,90°,1)$. **(20%)**

2. Figure 1 shows, A spherical shell of charge possesses the constant volume charge density ρ_v between its inner and outer radii a and b. Find the E field for $r<a$, $a<r<b$ and $r>b$. **(20%)**

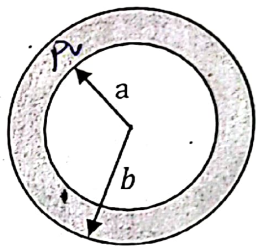


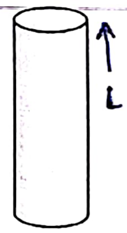
Fig.1

Q2: (30 points)

Assuming the same right circular cylindrical region of radius $\rho=a$ and length L as its shown in Fig.2. Illustrate the correctness of the divergence theorem for this region, given the electric field :

(a) $E(\rho,\varphi,z)=\mathbf{a}_\rho \rho^3/4\varepsilon_o a^2$. **(15%)**

(b) $E(\rho,\varphi,z)=\mathbf{a}_\rho a/4\varepsilon_o\rho$ **(15%)**



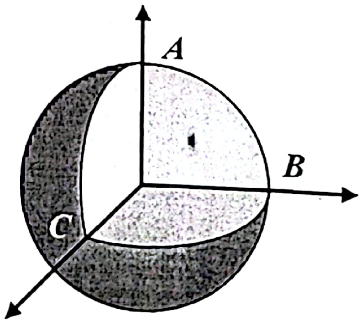
Q3: (30 points)

A φ-directed field is defined by $G(r,\theta,\varphi)=\mathbf{a}_\varphi 5r\sin\theta\sin\varphi$ in a region of space.

a) Find **curl** G at any point. **(10%)**

b) Evaluate the integral $\int G(r,\theta,\varphi)ds$ over the surface S of a sphere of radius $r=R$ appearing within the first octant as shown, bounded by the closed path ABC. **(10%)**

c) Find the answer to (b) another way by use of Stokes's theorem. **(10%)**



-- Good Luck --

By Dr. Saad M. Alhossin