يمكن إستخدام الكتاب ودفتر الملاحظات ولا يسمح بإستخدام الهواتف الذكية

الامتحان النهائي لمادة كهرومغناطيسية I

الزمن ساعتان و نصف

أجب عن جميع الأسئلة التالية:

السؤال الأول: (الدرجة 50%)

1- أوجد الشحنة الكهربية الناتجة من المجال **E** :

$$\mathbf{E} = \mathbf{a}_r 12r + \mathbf{a}_\theta 5r\sin\theta + \mathbf{a}_\varphi 10r^2$$

2- أوجد التيار الكهربي الناتج من الفيض المغناطيسي **B** والمار في سلك مساحة مقطعه A:

$$\mathbf{B} = \mathbf{a}_\rho 5\rho z\cos\varphi + \mathbf{a}_\varphi 10\rho z\sin\varphi$$

3- أوجد زوايا السقوط للمجال **E** عندما تكون $r = 1$ و $\theta = 20^\circ$، ثم أوجد متجه الوحدة.

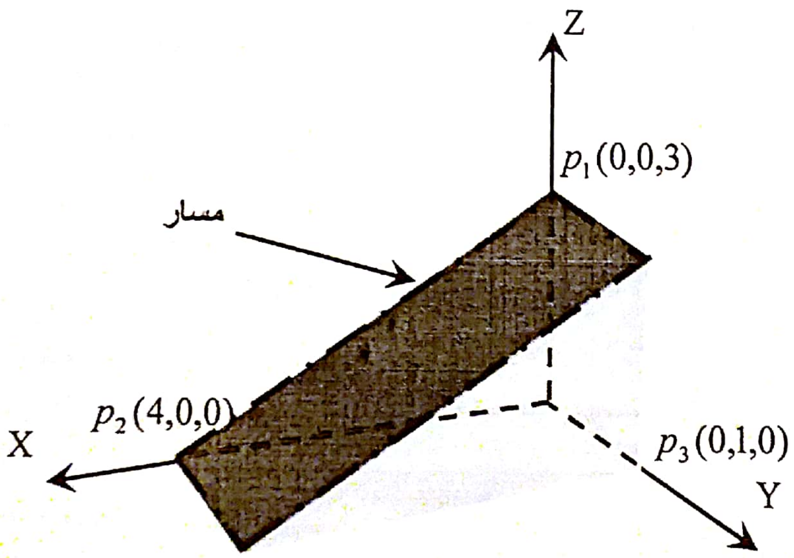
السؤال الثاني: (الدرجة 50%)

1- إذا كان التغير في المجال الكهربي ∇E يعطى بالعلاقة $\nabla E = 10x\mathbf{a}_x + 6\mathbf{a}_y$ ، أوجد دالة المجال E .

2- إذا كان المجال الكهربي يعطى بالعلاقة: $\mathbf{H} = Ky\mathbf{a}_y$ ، أثبت أن نظرية التدرج (Divergence Theorem) صحيحة بأستخدام الشكل 1.

3- استخدم المسار الموضح في الشكل 1 لإثبات نظرية ستكوس (Theorem of Stokes).

بالتوفيق والنجاح



الشكل 1

COLLEGE OF ELECTRONICS TECHNOLOGY – TRIPOLI

Final Exam of Electromagnetic I CM 321

Fall- 2018 **Time 2:00 Hrs**

Q1:

I. If $z = 3 - j5$, Find the value of ln (z). (5 points)

II. Express the following complex number in rectangular form $\sqrt{3}\, e^{j3\pi/4}$ (10 points)

Q2: Given vectors $A = a_x + 2a_y - 3a_z$ and $B = 2a_x - 4a_y$.

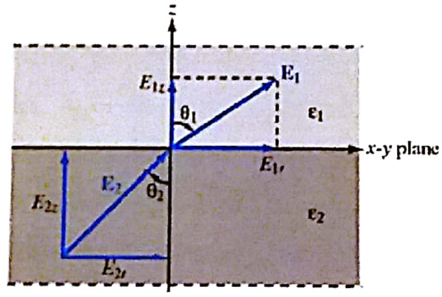
I. Magnitude of A, and the unit vector of A. (5 points)

II. θ_{AB}, (5 points)

III. $(A \times a_y).a_z$ (5 points)

Q3: Find E_1 in the Fig below if $E_2 = 2a_x - 3a_y + 3a_z$ V/m if

$\varepsilon_1 = 2\varepsilon_0$, $\varepsilon_2 = 8\varepsilon_0$, and the boundary is charge free. (15 points)



Q4: Suppose a scalar function in the cylindrical domain is given as :

$$p = \rho^2 \sin\varphi + 2\rho z$$

i. Find the Gradient of P, Show your work, is the Gradient a scalar or a vector? (7 points)

ii. Now find the curl of the above gradient, what do you observe? (7 points)

$$\mathbf{curl\ F} = \frac{\mathbf{a}_1}{h_2 h_3}\left[\frac{\partial(F_3 h_3)}{\partial u_2} - \frac{\partial(F_2 h_2)}{\partial u_3}\right] + \frac{\mathbf{a}_2}{h_3 h_1}\left[\frac{\partial(F_1 h_1)}{\partial u_3} - \frac{\partial(F_3 h_3)}{\partial u_1}\right] + \frac{\mathbf{a}_3}{h_1 h_2}\left[\frac{\partial(F_2 h_2)}{\partial u_1} - \frac{\partial(F_1 h_1)}{\partial u_2}\right]$$

$$\mathbf{div\ F} = \frac{1}{h_1 h_2 h_3}\left[\frac{\partial(F_1 h_2 h_3)}{\partial u_1} + \frac{\partial(F_2 h_1 h_3)}{\partial u_2} + \frac{\partial(F_3 h_1 h_2)}{\partial u_3}\right]$$

$$\mathbf{grad}\ f = \mathbf{a}_1 \frac{1}{h_1}\frac{\partial f}{\partial u_1} + \mathbf{a}_2 \frac{1}{h_2}\frac{\partial f}{\partial u_2} + \mathbf{a}_3 \frac{1}{h_3}\frac{\partial f}{\partial u_3}$$

In the Cartesian h1=h2=h3=1

in spherical coordinates $h_1 = 1$, $h_2 = r$, and $h_3 = r\sin\theta$,

$h_1 = 1$, $h_2 = \rho$, $h_3 = 1$ Circular cylindrical

Dr.Tarig Algadey

Good Luck

Electromagnetic II الإجابة النموذجية لمادة

Q1: (I) $z = 3 - j5$, Find $\ln(z)$

$$|z| = \sqrt{3^2 + 5^2} = 5.83, \quad \theta = \tan^{-1}\frac{-5}{3} = -59^\circ$$

$$z = |z| e^{j\theta} = 5.83\, e^{-j59^\circ}$$

$$\ln(z) = \ln(5.83\, e^{-j59}) = \ln(5.83) + \ln(e^{-j59})$$
$$= 1.76 - j\frac{59^\circ}{180^\circ}\pi = 1.76 - j1.03$$

II) $z = \sqrt{3}\, e^{j\frac{3\pi}{4}}$

$$= \sqrt{3}\left(\cos\frac{3\pi}{4} + j\sin\frac{3\pi}{4}\right) = -1.22 + j1.22$$
$$= 1.22(-1 + j)$$

Q2) $A = a_x + 2a_y - 3a_z$ & $B = 2a_x - 4a_y$

$$|B| = \sqrt{4 + 16} = \sqrt{20}$$

1. $|A| = \sqrt{1 + 4 + 9} = \sqrt{14}$, $\hat{a}_A = \frac{a_x + 2a_y - 3a_z}{\sqrt{14}}$

II. $\theta_{AB} = \cos^{-1}\frac{A \cdot B}{AB} = \frac{2 - 8}{\sqrt{14}\sqrt{20}} = \frac{-6}{\sqrt{14}\sqrt{20}}$

III. $(A \times a_y) \cdot a_z$

$$((a_x + 2a_y - 3a_z) \times a_y) \cdot a_z =$$
$$(a_z + 3a_x) \cdot a_z = \boxed{1}$$

a_x a_z a_y

Q3 Find E_1 if $E_2 = 2a_x - 3a_y + 3a_z$ V/m

Given that the x-y plane is the boundary between the two media, so $E_{1x} = E_{2x} = 2$

$$E_{1y} = E_{2y} = -3$$

Emag I and II

قوانين مهمة

$$\text{Curl } F = \frac{a_1}{h_2 h_3}\left[\frac{\partial(F_3 h_3)}{\partial u_2} - \frac{\partial(F_2 h_2)}{\partial u_3}\right] + \frac{a_2}{h_3 h_1}\left[\frac{\partial(F_1 h_1)}{\partial u_3} - \frac{\partial(F_3 h_3)}{\partial u_1}\right] + \frac{a_3}{h_1 h_2}\left[\frac{\partial(F_2 h_2)}{\partial u_1} - \frac{\partial(F_1 h_1)}{\partial u_2}\right]$$

$$\text{Div } F = \frac{1}{h_1 h_2 h_3}\left[\frac{\partial(F_1 h_2 h_3)}{\partial u_1} + \frac{\partial(F_2 h_1 h_3)}{\partial u_2} + \frac{\partial(F_3 h_1 h_2)}{\partial u_3}\right]$$

$$\text{grad } f = a_1 \frac{1}{h_1}\frac{\partial f}{\partial u_1} + a_2 \frac{1}{h_2}\frac{\partial f}{\partial u_2} + a_3 \frac{1}{h_3}\frac{\partial f}{\partial u_3}$$

In the Cartesian, $h_1 = h_2 = h_3 = 1$, in spherical coordinates $h_1 = 1$, $h_2 = r$, $h_3 = r\sin\theta$

and $h_1 = 1$, $h_2 = \rho$, $h_3 = 1$ cylindrical.

$$\nabla \times E = -j\omega\mu H$$

$$\nabla \times H = J + j\omega\epsilon E$$

$$\nabla \cdot E = \rho_v/\epsilon$$

$$\nabla \cdot H = 0$$

For the z component

$\epsilon_1 E_{1z} = \epsilon_2 E_{2z} \quad (\rho_s = 0)$

$E_{1z} = \frac{\epsilon_2}{\epsilon_1} E_{2z} = \frac{8\epsilon_0}{2\epsilon_0} \times 3 = \boxed{12}$

$\boxed{E_1 = 2a_x - 3a_y + 12a_z}$ V/m

Q4) $P = \rho^2 \sin\phi + 2\rho z$

$\nabla P = a_\rho \frac{\partial f}{\partial \rho} + a_\phi \frac{1}{\rho}\frac{\partial f}{\partial \phi} + a_z \frac{\partial f}{\partial z}$

$= a_\rho (2\rho \sin\phi + 2z) + a_\phi \frac{1}{\rho} \rho^2 \sin\phi + 2\rho\, a_z$

$\nabla \times \nabla P = a_\rho (0 - 0) + a_\phi (2 - 2) + a_z \left(\frac{1}{\rho} 2\rho \sin\phi - 2\rho \sin\phi\right)$

$= 0 + 0 + 0 = 0$

always $\nabla \times \nabla = 0$ يتماشى مع المتوقع