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Cource Title : Electromagnetic field

Q(1)
(a) Transform the vector $B = yi(x+Z)j$

Ans

$B = yi(x+Z)j$
point $(-2, 6, 3)$

Then

$B = yi(xj + Zj)$

$B = yxij + yzij$

$= \sqrt{x^2+y^2}$

$\phi = \tan^{-1}(y/x)$

$\rho = \sqrt{(-2)+(6)^2}$ $\boxed{5.83}$

$\phi = -71.565$

$Z = 3$

$B = (5.83, -71.56, 3$

Q1

(b) point (3, 4, 5)

Solution

for spherical we have to find

r, ϕ, θ

$r = \sqrt{x^2+y^2+z^2}$

$r = \sqrt{3^2+4^2+5^2} = 7.07$

$\boxed{r = 7.07}$

$\phi = \tan^{-1} y/x$

$= \tan^{-1}(4/3)$

$\boxed{\phi = 53.13^\circ}$

$\theta = \cos^{-1}\frac{z}{r}$

$\theta = \cos^{-1}\frac{z}{7}$

$= \cos^{-1}\frac{5}{7.07}$

$\boxed{\theta = 45^\circ}$

$(r, \theta, \phi)\ (7.07, 45^\circ, 53.13$

Q1 (c) A(2, 3, -1)

Solution $r = \sqrt{x^2+y^2+z^2}$

$= \sqrt{2^2+3^2+(-1)^2}$

$\boxed{r = 3.74}$

$\theta = \cos^{-1} \frac{z}{r}$

$= \cos^{-1}\left(\frac{-1}{3.74}\right)$

$\phi = \tan^{-1}(y/x)$

$\phi = \tan^{-1}(y/x)$

$\boxed{\phi = 56.3°}$

Q1 (D) B(4, 25, 120)

Convert to cartesian

Solution: point B is actually given in spherical ie (r, θ, ϕ)

we have to find

(r, θ, ϕ)

$x = r \sin\theta \sin\theta$

$= 4 \sin 25 \sin 120$

$y = 1.46$

$Z = r\cos\theta = 4\cos 25$

$Z = 3.62$

$(x, y, Z) = (-0.84, 1.46, 3.62)$

Q1 (E)

e)

Sol:

$F = k \frac{q_1 q_2}{r^2}$

where $k = \frac{1}{4\pi\varepsilon_0}$

$F = \frac{2\times 10^{-9} \times -1\times 10^{-9}}{4\pi \times 8.85\times 10^{-12} \times (4\times 10^{-2})^2}$

$F = -1123 \times 10^{-5}$

Then

$F = -11.23\ \mu N$

Q1 (F) pageNo5

Data

find E_1 and E_2.

$q_1 = -2c$ and $q_2 = -1c$

$r = 1m$.

<u>solution:</u>

$E_1 = \frac{q_1}{4\pi \varepsilon_0 r^2} = \frac{-2}{4\pi \times 8.85 \times 10^{-12} + 1^2}$

$E_1 = 1.798 \times 10^{10}$ N/C

$E_2 = \frac{-1}{4\pi \varepsilon_0 \times 1^2} = -8.9 \times 10^9$ N/C

Q1 (G) $q = ?$

<u>Solution</u>

$E = 40$ V/cm $= 40$ V/10^{-2} m

$E = 4000$ V/m

$r = 30 \times 10^{-2}$ m

find $q = ?$

$q = E \times 4\pi \varepsilon_0 r^2$

$= 4000 \times 4 \times 3.14 \times 8.85 \times 10^{-12} \times (30 \times 10^{-2})^2$

$\boxed{q = 4 \times 10^{-8} C}$

Q1 (h)

find = r

$q_1 = 2\times10^{-7}$ and

$q_2 = 4.5\times10^{-7}$

where $f = 0.1N$

So: $F = \dfrac{q_1 q_2}{4\pi \varepsilon_0 r^2}$

$r = \sqrt{\dfrac{q_1 q_2}{4\pi \varepsilon_0 F}}$

$\boxed{r = 0.09\,m}$

Q(2) part (a)

Solution

$$A = \sqrt{3}\, i_x + i_y$$

$$|A| = 2$$

$$B = 2 i_x$$

$$|B| = 2$$

So

$$A \cdot B = 2\sqrt{3}$$

Now

$$A \cdot B = |A||B| \cos \phi_{AB}$$

$$\cos \theta_{AB} = \frac{A \cdot B}{|A||B|}$$

$$\theta_{AB} = \cos^{-1}\left(\frac{\cancel{2}\sqrt{3}}{\cancel{2} \times 2}\right)$$

$$\boxed{\theta_{AB} = 30^\circ}$$

Q2 (b)

$f = ax^2 + by^3 z$

Solution: (i) find gradient

$f = ax^2 + by^3 z$

$\Delta f = \left(\frac{\partial i}{\partial x} + \frac{\partial}{\partial y} j + \frac{d}{dz} k \right)(ax^2 + by^3 z)$

$\Delta f = \frac{d}{dx} ax^2 i + \frac{d}{dy} by^3 z j + \frac{d}{dz} by^3 z k$

$\Delta f = 2axi + 3bzy^2 j + by^3 k$

$\Delta f = 2axi + 3\sin\theta + 3bzy^2 j + by^3 k$

(ii) $F = ar^2 \sin\theta + brz\cos 2\theta$

Sol:- Gradient in Case of spherical

$\nabla f = \frac{df}{dr} \hat{r} + \frac{1}{r}\frac{\partial f}{\partial \phi} \hat{\phi} + \frac{1}{d\sin\theta} \frac{df}{d\theta} \hat{\phi}$

$\nabla f = \frac{d}{do}(ar^2 \sin\phi + brz\cos 2\phi)\hat{r} + \frac{1}{o}\frac{d}{d\theta}$

$(ar^2 \sin\theta + brz\cos\theta\phi)\,\theta + \frac{1}{r\sin\phi}\frac{a}{d\theta}$

$(ar^2 \sin\phi + brz\cos 2\phi)\hat{\phi}$

then Now

$\Delta f = (2ar\sin\theta + bz\cos 2\phi)\hat{r} + \frac{1}{o}(o) + \frac{1}{\sin\phi}$

(PTO)

$(ar^2 \cos\phi - 2brz \sin\theta)\hat{\theta}$

So

$\Delta f = (2ar \sin\phi + bz \cos 2\theta)\hat{r}$

$+ \frac{1}{r \sin\phi}(ar^2 \cos\phi - 2brz \sin\theta)\hat{\phi}$

Now the case of cylindrical

$$\Delta f = \frac{\partial f}{\partial \rho}\hat{\rho} + \frac{1}{\rho}\frac{\partial f}{\partial \phi}\hat{\phi} + \frac{\partial A}{\partial z} =$$

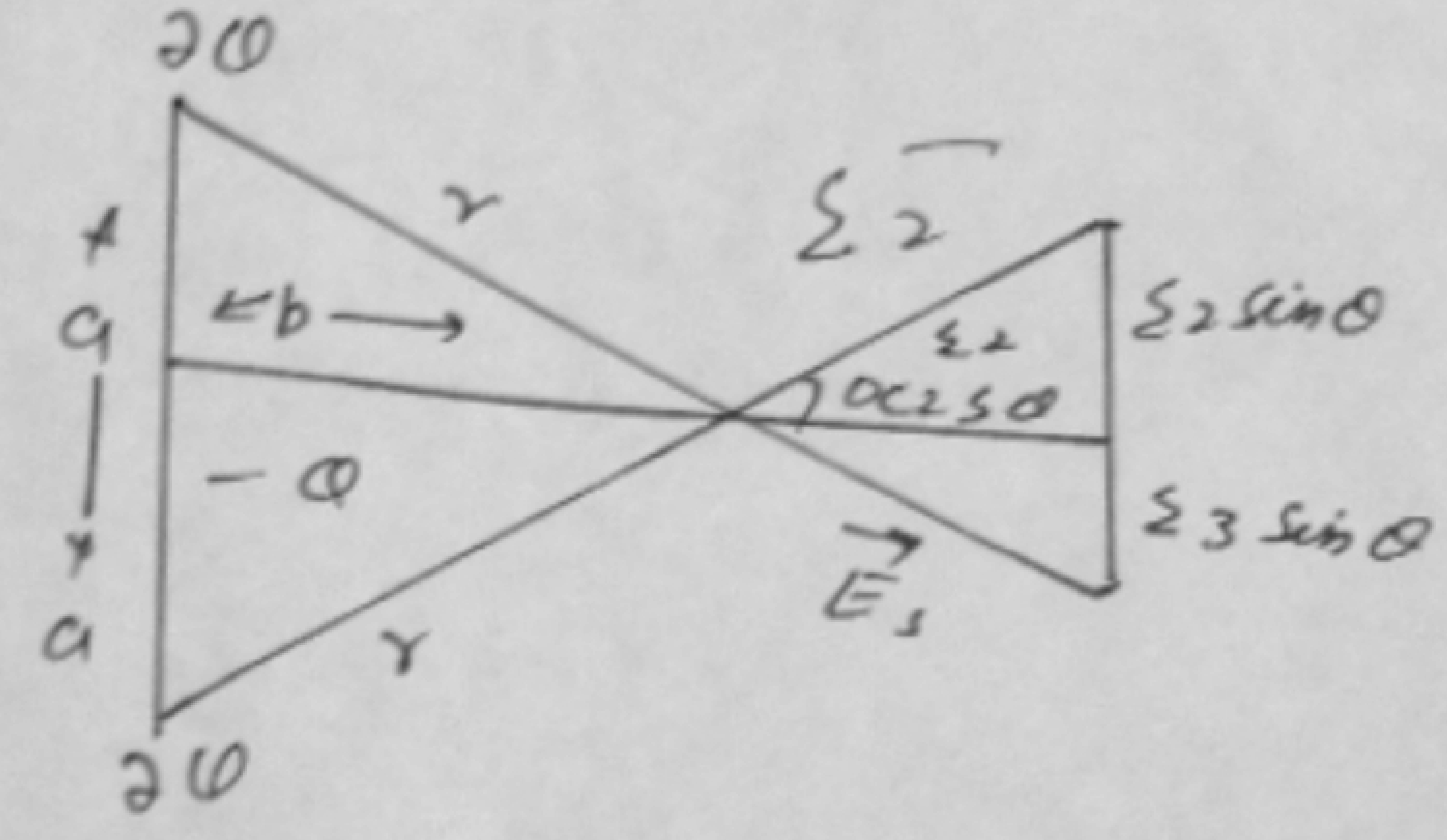
$$\nabla f = 0\hat{\rho} + \frac{1}{\rho}(ar^2 \cos\phi - 2brz \sin 2\theta)\hat{\theta} + (br \cos 2\theta)\hat{z}$$

Then in the first case of (0) zero

$$\Delta f = \frac{1}{\rho}(ar^2 \cos\phi - 2brz \sin 2\theta)\hat{\phi} + (br \cos 2\phi)\hat{z}$$

Q3:

Solution:



$$\vec{E}_{2+3} = 2\vec{E}\cos\theta \rightarrow eq\ ①$$

Now, $E = \dfrac{kQ}{r^2}$

and (r) from phythagorus theorm

$$r = \sqrt{a^2+b^2}$$

$$E = \frac{kQ}{\sqrt{a^2+b^2}}$$

so equation 1 become

$$E_{2+3} = 2\frac{kQ}{\sqrt{a^2+b^2}}\cos\theta$$

Now $\mathcal{E}_1 = -\frac{KQ}{r^2}$

$$\mathcal{E}_1 = -\frac{KQ}{b^2}$$

Total Electric field intensity at that point is :-

$$E = E_1 + E_2 + 3$$

$$= 2\frac{KQ}{\sqrt{a^2+b^2}}\left(\cos\theta - \frac{1}{b^2}\right)$$

where

$$K = \frac{1}{4\pi\varepsilon_0}$$

THE END