Department of Electrical Engineering

Electro Magnetic Field Theory

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QUESTION:(1):

Solve the following short Question.

Q (A):

Solution:

ρ = √(x2+y2)

= √40

= 6.325

Φ = tan-1(y/x)

= tan-1(-6/2)

= -71.57

z = 3

(6.325,-71.57,3)

Q (B):

Solution:

r = √(x2+y2+z2)

= √50

= 7.07

Θ = cos-1(z/r)

= cos-1(5/5√2)

= 45º

Φ = tan-1(y/x)

= tan-1(4/3)

= 53º.

(7.07,45º,53º)

Q (C):

Solution:

r = √(x2+y2+z2)

= √14

= 3.74

Θ = cos-1(z/r)

= cos-1(-1/3.74)

= 105.5º

Φ = tan-1(y/x)

= tan-1(3/2)

= 56.31º.

(3.74, 105.5º, 56.31º)

Q (D):

Solution:

x = r sin θ cos φ = 4 sin25º cos 120º = -0.845

y = r sin θ sin φ = 4 sin 25º sin 120º = 1.462

z = r cos θ = 4 cos 25º = 3.625

(-0.845, 1.462, 3.625)

Q (E):

Solution:

Before the charges are brought into contact, F = 11.234 μ N.
After charges are brought into contact and then separated, charge on each sphere is, (q1 + q2)/2
= 0.5nC
On calculating the force with q1 = q2 = 0.5nC,
F = 1.404μN.

Q (F):
Solution:
F = q1q2/(4∏εor2)
= -2 X 9/(10-9 X 12)
= -18 X 109

Q (G):
Solution:
E = Q/ (4∏εor2)
Q = (4000 X 0.32)/ (9 X 109)
= 4 X 10-8
C = 4

Q (H):
Solution:
F = q1q2/(4∏εor2)
substituting q1, q2 and F,
r2 = q1q2/(4∏ ε o F)
We get r = 0.09m.

QUESTION 2: (A)
Answer:

A= √3 ix+iy

$|A| = 2$
$B = 2ix$
$|B| = 2$
$A.B = 2\sqrt{3}$
Now,
$A.B = |A||B| \cos\theta_{AB}$

$\cos\theta_{AB} = A.B \div |A||B|$
$\theta_{AB} = \cos^{-1}(2\sqrt{3})\div(2\times2)$
$\theta_{AB} = 30°$

QUESTION 2: (B)
Answer: (a)

$F = ax^3 + by^3z$

$\Delta f = (\partial i/\partial x + \partial i/\partial y + \partial k/\partial z)(ax^2 + by^3z)$

$\Delta f = (\partial/\partial x\, ax^2 i + \partial/\partial y\, by^3z\, j + \partial/\partial z\, by^3z\, k)$

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

QUESTION 2: (B)
Answer: (b)

In case of cylindrical;

$\Delta = (\partial/\partial r)\, r\hat{} + (1/r)(\partial/\partial\theta)\, \theta\hat{} + (\partial/\partial z)\, z\hat{}$

$\Delta f = \{(\partial/\partial r)\, r\hat{} + (1/r)(\partial/\partial\theta)\, \theta\hat{} + (\partial/\partial z)\, z\hat{}\}\{a r^2 \sin\theta + b r z \cos2\theta\}$

$\Delta f = \partial/\partial r\,(a r^2 \sin\theta + b r z \cos2\theta)\, r\hat{} + (1/r)(\partial/\partial\theta)(a r^2 \sin\theta + b r z \cos2\theta)\, \theta\hat{} + \partial/\partial z\,(b r z \cos2\theta\, z\hat{})$

$(2ar \sin\theta + b r z \cos2\theta)\, r\hat{} + (1/r)(a r^2 \cos\theta - 2brz \sin2\theta)\, \theta\hat{} + b r \cos2\theta z\hat{}$

QUESTION 3:
Answer:
$r = bax + 0.ay + 0.az$
$r1 = 0.ax + 0.ay + 0.az$
$r2 = 0.ax + 0.ay + 0.az$
$r3 = 0.ax + (-a)\, ay + 0.az$

$r - r1 = bax + 0.ay + 0.az$
$r - r2 = bax - a.ay + 0.az$
$r - r3 = b.ax + a.ay + 0.az$

$\left| r - r1 \right| = b$
$\left| r - r2 \right| = \sqrt{(b^2 + a^2)}$
$\left| r - r3 \right| = \sqrt{(b^2 + a^2)}$

Now,
$E = Q / 4\pi\sum_o r$

For change 1,
$E1 = -Q / 4\pi\sum_o (r - r1)/ (\left| r - r1 \right|)$
$= -Q / 4\pi\sum_o \{ bax /b\} \{ 1/b^2 \}$

For change 2,
$E2 = 2Q / 4\pi\sum_o \{ bax - aay /(\sqrt{b^2+a^2})\} \{ 1/(\sqrt{b^2 + a^2}) \}$

For change 3,
$E3 = 2Q / 4\pi\sum_o \{ bax - aay /(\sqrt{b^2+a^2})\} \{ 1/(\sqrt{b^2 + a^2}) \}$

$E = E1 + E2 + E3$

$E = [-Q / 4\pi\sum_o \{ bax /b\} \{ 1/b^2 \}] + [2Q / 4\pi\sum_o \{ bax - aay /(\sqrt{b^2+a^2})\} \{ 1/(\sqrt{b^2 + a^2}) \}] + [2Q / 4\pi\sum_o \{ bax - aay /(\sqrt{b^2+a^2})\} \{ 1/(\sqrt{b^2 + a^2}) \}]$

$E = Q / 4\pi\sum_o [1 / \{ bax /b\} \{ 1/b^2 \}] + [2 / \{ bax - aay /(\sqrt{b^2+a^2})\} \{ 1/(\sqrt{b^2 + a^2}) \}] + [2 / \{ bax - aay /(\sqrt{b^2+a^2})\} \{ 1/(\sqrt{b^2 + a^2}) \}]$

Thank You.