Department of Electrical Engineering
Assignment
B.tech(E)
Date: 14/04/2020

Course Details

Course Title:	Electromagnetic Fields	**Module:**	4th
Instructor:	Perniya akram	**Total Marks:**	30

Student Details

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Q1.	(a)	State the relationship between potential and electric field intensity with relevant example.	Marks 5
	(b)	Consider a point A(1,-2,2), Find a unit vector extending from point A.	Marks 5
Q2.	(a)	Three charged particles are arranged in a line as shown in figure below. Charge A = -3 μC, charge B = +8 μC and charge C = -9 μC. Calculate the net electrostatic force on particle B due to the other two charges. 	Marks 10
Q3.	(a)	a) A uniform electric field E = 6000 N/C passing through a flat square area A = 10 m^2. Determine the electric flux. 	Marks 5
	(b)	'Electric flux density is a function of charge'. Comment how and explain the effect of charge on flux density.	Marks 5

Question 1 part (a)

Electric potential	Electric field
(1) The work per unit of charge required to move a charge from a reference point to a specified point is known at as electric potential.	(1) The electric force per unit charge as known as electric field.
(2) the unit of electric potential is joules per colloumb or volts	(2) The unit of electric field is Newton's per Coulomb.
(3) Electric potential is a scalar quantity.	(3) An electric field is a vector quantity.

Question 1 part (b)

Given data: Point: $A(1, -2, 2)$

Required data: unit vector $\vec{a}_A = ?$

Solution: first we construct the vector extending from the origin to point A

$$A = a_x - 2a_y + 2a_z$$

Now we have to find magnitude of A

so

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

$$|A| = \sqrt{1 + 4 + 4}$$

$$|A| = \sqrt{9}$$

$$\boxed{|A| = 3}$$

Now unit vector

$$\vec{a}_A = \frac{A}{|A|} \quad \text{-- (i)}$$

$$\vec{a}_A = \frac{a_x - 2a_y + 2a_z}{3}$$

$$\vec{a}_A = \frac{1}{3}a_x - \frac{2}{3}a_y + \frac{2}{3}a_z$$

$$\boxed{\vec{a}_A = 0.333a_x - 0.667a_y + 0.667a_z}$$

Question (2.)

Given data:

Charge A ; $q_A = -3\mu C = -3\times10^{-6}C$

Charge B ; $q_B = 8\mu C = 8\times10^{-6}C$

Charge C ; $q_C = -9\mu C = -9\times10^{-6}C$

$r_{AB} = 6cm = 0.06m$

$r_{BC} = 4cm = 0.04m$

$K = 9\times10^{9}$

Required data:

Net electrostatic force on partical B due to the other charges ; $F_B = ?$

Solution:

We know that

$F_B = F_{AB} - F_{BC}$ — (A)

first we have to find F_{AB} & F_{BC} so

$$F_{AB} = \frac{K\ q_A \times q_B}{(r_{AB})^2} \quad \text{— (1)}$$

put value in equat (1)

$$= \frac{9\times10^{9} \times -3\times10^{-6} \times 8\times10^{-6}}{(0.06)^2}$$

$$F_{AB} = \frac{-216 \times 10^{-3}}{0.0036}$$

$$F_{AB} = -60,000 \times 10^{-3}$$

$$\boxed{F_{AB} = -60\ N}$$

Now

$$F_{BC} = \frac{K\, q_B \times q_C}{(r_{BC})^2} \quad \text{--- ②}$$

put value in equation ②

$$F_{BC} = \frac{9 \times 10^{9} \times 8 \times 10^{-6} \times -9 \times 10^{-6}}{(0.04)^2}$$

$$F_{BC} = \frac{-648 \times 10^{-3}}{0.0016}$$

$$\boxed{F_{BC} = -405\ N}$$

put value of F_{AB} & F_{BC} in equation A.

$$F_B = F_{AB} - F_{BC} \quad \text{--- (A)}$$

$$F_B = -60 - (-405)$$

$$F_B = -60 + 405$$

$$\boxed{F_B = 345\ N}$$

Question 3 (a)

Given data:

electric field ; $E = 6000\ N/C$

Area ; $A = 10\ m^2$

Angle $\theta = 0$.

Required data:

electric flux ; $\phi = ?$

Solution:

We know that

$$\phi = EA\cos\theta \quad -(1)$$

put value in (1)

$$\phi = 6000\ N/C \times 10m^2 \cos(0)$$

$$\phi = 6000 \times 10 \times 1 \qquad \because \cos(0) = 1$$

$$\phi = 60{,}000\ Nm/C$$

$$\boxed{\phi = 60 \times 10^3\ Nm/C}$$

Answer:

electric flux $\phi = 60 \times 10^3\ Nm/C$

Question 3 part (B):

Electric flux density

Electric flux density 'D' is a vector field and is a member of the flux density "class of vector field" as opposed to the "force field" class, which includes the electric filed intensity (E). So electric flux density is a function of charge. it is in radial direction and have value.

$$D = \frac{Q}{4\pi r^2} a_r - (1)$$

* Effect of charge on flux density:

electric flux density is effected by charge (Q) because flux density is directly proportional to charge.

So when charge increase the flux density will also increase and vice versa.