# Department of Electrical Engineering

## Assignment

## B.tech(E)

## Date: 14/04/2020

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## Course Details

**Course Title:** Electromagnetic Fields  **Module:** 4th

**Instructor:** Perniya akram  **Total Marks:** 30

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## 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 = -9μC. 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(a)

### Relationship between Potential and Electric field Intensity

* Electric field is a vector quantity while Electric potential is a Scaler quantity

* Electric field is described as the amount of force per charge while the electric potential is described as the amount of energy or work per charge

* Electric field is measured in Newton's per Coulomb or volt per meter while electric potential is measured in unit volts or joules per coulomb.

# Question 1 (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

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

we can first find magnitude of A

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

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

$$|A| = 3$$

unit vector $\vec{a}_A = \frac{A}{|A|} \rightarrow (A)$

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

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

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

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# Question 2

## Given data

charge A = $-3\mu C$ = $-3\times10^{-6}$ C

charge B = $+8\mu C$ = $8\times10^{-6}$ C

charge C = $-9\mu C$ = $-9\times10^{-6}$ C

Distance between point A and B = 6 cm = 0.06 m

Distance between point B and C = 4 cm = 0.04 m


## Required data

Net electrostatic force on particle B due to the other two charges = ?

## Solution

As we know

$$F_B = F_{AB} - F_{BC} \rightarrow 1)$$

Now we 1st find $F_{AB}$ and $F_{BC}$

$$F_{AB} = \frac{k\, q_A \times q_B}{(r_{AB})^2} \rightarrow A)$$

Put value in equation A)

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

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

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

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

So

$$F_{BC} = \frac{k\, q_B \times q_C}{(r_{BC})^2} \rightarrow (B)$$

put value in equation B

$$F_{BC} = \frac{9\times10^{9} \times 8\times10^{-6} \times -9\times10^{-6}}{(0.04)^2}$$

$$= \frac{-648\times10^{-3}}{0.0016}$$

$$= -405\ N$$

put value of $F_{AB}$ and $F_{BC}$ in Equation

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

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

$$= -60 + 405$$

$$= 345\ N$$

# Question 3(a)

**Given Data**

$E = 6000 \, N/C$

$A = 10 \, m^2$

**Required data**

Electric flux = ?

**Solution**

The formula of electric flux

$\phi = E A \cos\theta$

$\phi$ = electric ~~flux~~ flux ($Nm^2/C$)

$E$ = Electric field ($N/C$)

$\theta$ = angle between electric field line with the normal line.

Now putting value in formula

$\phi = E A \cos\theta$

$= (6000)(10)(\cos 0)$

$\phi = 60{,}000 \, Nm^2/C$

or

$\phi = 6 \times 10^4 \, Nm^2/C$

# Question 3(b)

## Answer

Electric flux density assigned the symbol D is an alternative to dielectric field intensity (E) is a way to quantify an electric field. This alternative description offers some actionable insights as we shall point out at the end of this section.

first what is electric flux density? Recall that ~~charge and $\hat{R}$ points~~ particle charge q give rise to the electric field intensity = $\hat{R}q / 4\pi R_2 E = \hat{R}q / 4\pi R_2 \epsilon$

R is distance from charge. $\hat{R}$ point away from charge. E is inversly proportional to $4\pi R_2$. integrating both side of Equation over a Spher S and R.

we Now that $ds = \hat{R} ds$ in this case and also that $\hat{R} = 1$ R.H.S simplifies

$$q / 4\pi R_2 \epsilon \oint_s ds$$