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

Course Details

Course Title: Electromagnetic Fields **Module:** 4th
Instructor: Engr.Perniya Akram **Total Marks:** 30

Student Details

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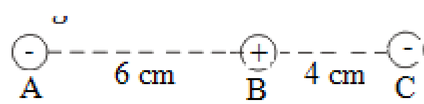
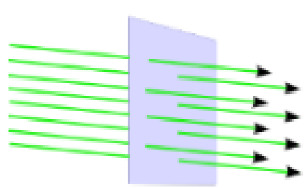
Q1.	(a)	State the relationship between potential and electric field intensity with relevant example.	Marks 5
	(b)	Consider a point A(1,-2,2), Find a unit vector extending from point A.	Marks 5
Q2.	(a)	Three charged particles are arranged in a line as shown in figure below. Charge A = -3 μC, charge B = +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

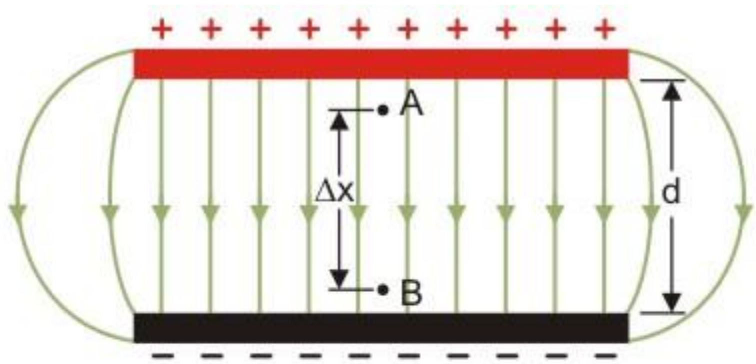
Answer Sheet

Q1: (a)

Ans:

The Relation between Potential Difference and Electric Field Intensity:

For mathematical simplicity, we will consider a *uniform* field (as exists near the center of the space between two parallel, oppositely charged metal plates).



Consider a moving small positive charge q, from point A to B.

Let the magnitude of the potential difference between points A and B be ΔV.

In moving a positive charge from A to B work is done by the field so the potential at B is less than the potential at A.

We will therefore represent the potential difference between A and B as -ΔV.

Work done, w moving the charge q is given by

$$w = F\Delta x$$

Now, work done per unit charge is the potential difference, -ΔV and force per unit charge is the electric field strength, E

Therefore, the relation between potential difference and field strength is found by simply dividing the above equation by q.

$$\frac{w}{q} = \frac{F\Delta x}{q}$$

$$-\Delta V = E\Delta x$$

which is usually written as:

$$E = -\left(\frac{\Delta V}{\Delta x}\right)$$

and the term in brackets is called the potential gradient, as it represents the slope (gradient) of a graph of potential against distance.

This equation shows that alternative units for measuring field strength are Volts per meter, Vm-1

This means that the magnitude of the field strength between the two parallel plates is simply given by

$$E = \frac{V}{d}$$

Q1: (b)
Consider a point A (1,-2,2), Find a unit vector extending from point A.

Solution:

Let suppose

A = 1ax -2ay -2az

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

Magnitude of A

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

= $\sqrt{9}$ = 3

Find unit vector

aA= $\frac{A}{|A|}$ = $\frac{ax-2ay-2az}{3}$

= $\frac{1}{3}$ax - $\frac{2}{3}ay$ $\frac{2}{3}az$

aA = 0.333ax – 0.666ay – 0.666az

Q2:

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.

Solution:

Charge A = QA = -3μC = -3 $\times 10^{-6}$c

Charge B QB = 8μC = 8$\times$ 10^{-6}C

Charge C = QC = -9μC = -9×10^{-6}C

Required:

$F_{AB} = k\ \frac{qA\ qB}{rAB}$

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

$= \frac{9\times10^{9}(-24\times10^{-12})}{36\times10^{-4}}$

$F_{AB} = \frac{-216\times10^{-3}}{36\times10^{-4}}$

F_{AB} = - 6×10^{-3} × 10^{4}

F_{AB} = - 6×10^{1}

= -60 NEWTON

$F_{Bc} = k\ \frac{qb\ qc}{rBc}$

$F_{Bc} = 9\times10^{9}\ \frac{8\times10^{-6}(-9\times10^{-6})}{(4\times10^{-2})^{2})}$

$F_{Bc} = \frac{9\times10^{9}(-72\times10^{-12})}{16\times10^{-4}}$

$F_{Bc} = \frac{-648\times10^{-3}}{16\times10^{-4}}$

F_{Bc} = - 40.5 ×10^{-3} × 10^{4}

F_{Bc} = -40.5× 10^{1}

F_{Bc} = -405Newton

The net electrostatics force on particles B

Fb = Fab – Fbc =

(-60) – (-405) = 345 N

Q3: (a) A uniform electric field E = 6000 N/C passing through a flat square area A = 10 m^2. Determine the electric flux.

Solution:

Given data:

E = 6000 N/C

A = $10m^2$

Formula:

$\Phi c = EA \cos\theta$

Φ= electric flux (Nm^2/C),

E = electric field (N/C)

A = Area (m^2),

θ = angle between electric field

We know that;

$\Phi c = EA \cos\theta$

Putting values in formula

Φc = (6000) (10) (cos θ) =

= (6000) (10) (1)

= 6×10^4 Nm^2/C

Q3 (b);

Electric flux density is a function of charge', Comment how and explain the effect of charge on flux density.

Ans:

Electric flux density is a measure of the strength of an electric field generated by a free electric charge, corresponding to the number of electric lines of force passing through a given area. Electrical flux density D, is a conceptual/graphical vector field that we use to get a feel for a complicated electric field made by source charges; it ignores alternations made to the electric field caused by the presence of matarial subjects.

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

First, what is electric flux density? Recall that a particle having charge q gives rise to the electric field intensity=R^ q 14πR2 E=R^ q 14πR2 1ϵ

where R is distance from the charge and R^ points away from the charge. Note that E is inversely proportional to 4πR2 indicating that E decreases in proportion to the area of a sphere surrounding the charge. Now integrate both sides of Equation over a sphere S of radius R

Factoring out constants that do not vary with the variables of integration, the right-hand side becomes:

Note that ds=R^ds in this case, and also that R^=1 Thus, the right-hand side simplifies to:

q 14πR2 1ϵ ∮S ds