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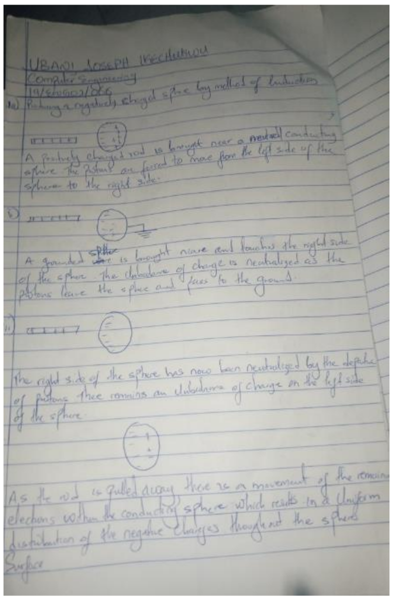
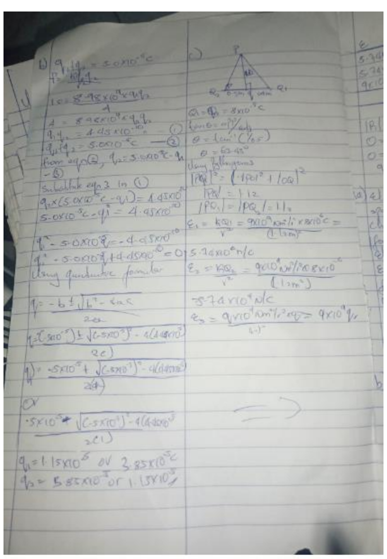
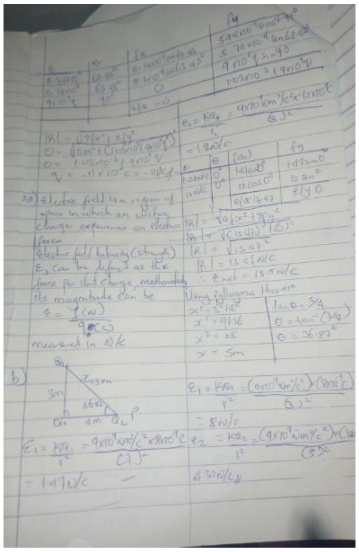
19/ENG02/066

Computer Engineering







3a) Electric field is a region of space in which an electric charge experiences an electric force.
Electric field intensity (strength) E, can be defined as the force per unit charge, mathematically its magnitude can be

$E = \frac{F(N)}{q(C)}$

measured in N/C

b)

$E_1 = \frac{KQ_1}{r^2}$

$= 1.47 N/C$

Using Pythagoras theorem

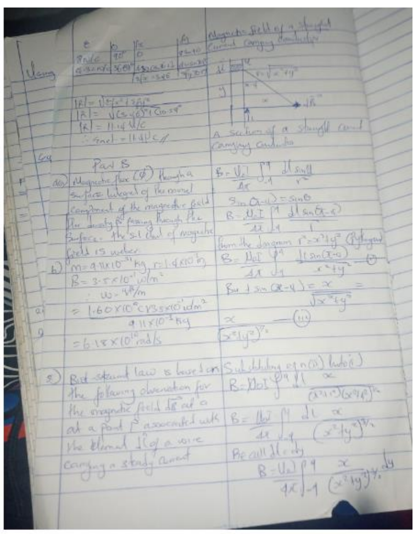
$x^2 = 9 + 16$

$x^2 = 25$

$x = 5m$

$\theta = 36.87°$

$E_{net} = 13.5 N/C$



Magnetic field of a straight current carrying conductor

A section of a straight current carrying conductor

Part B

4a) Magnetic flux (ϕ) through a surface integral of the normal component of the magnetic field flux density passing through the surface. The S.I unit of magnetic field is weber.

b) $m = 9.11 \times 10^{-31} kg$, $r = 1.4 \times 10^{-7} m$

$= 6.18 \times 10^{10} rad/s$

5) Biot-Savart law is based on the following observation for the magnetic field dB at a point P associated with the element dl of a wire carrying a steady current

From the diagram $r^2 = x^2 + y^2$ (Pythagoras)

Substituting eqn (ii) into (i)

Recall $dl = dy$

$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{x}{(x^2+y^2)^{3/2}} dy$

Using special Integrals:

~~$\int \frac{\mu_0 I}{4\pi} \int_{-a}^{a}$~~

$$\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x^2} \frac{y}{(x^2+y^2)^{1/2}}$$

Eqn (iii) therefore becomes

$$B = \frac{\mu_0 I x}{4\pi} \left[\frac{y}{x^2(x^2+y^2)^{1/2}} \right]$$

$$B = \frac{\mu_0 I}{4\pi x} \left(\frac{2a}{(x^2+a^2)^{1/2}} \right)$$

when the length 2a of the conductor is very great in comparison to its distance x from point P, we consider it infinitely long. That is, when a is much larger than x.

$$(x^2+a^2)^{1/2} \simeq a, \text{ as } a \rightarrow \infty$$

$$\therefore B = \frac{\mu_0 I}{2\pi x}$$

$$B = \frac{\mu_0 I}{2\pi x}$$

This defines the magnetic field of flux density B near a long straight current carrying conductor.