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**EMBU UNIVERSITY COLLEGE**

**(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF NAIROBI)**

**SECOND SEMESTER EXAMINATIONS 2013/2014**

**SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACELOR OF SCIENCE**

**SPH 102: ELECTRICITY AND MAGNETISM I**

**DATE: APRIL 4, 2014** **TIME: 2.00 - 4.00PM**

**INSTRUCTIONS:**

**ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.**

**CONSTANTS**

| | | |
|---|---|---|
| Electronic charge, e | = | $1.602 \times 10^{-19}$ C |
| Velocity of light, c | = | $3.0 \times 10^{8}$ m/s |
| 1 eV | = | $1.602 \times 10^{-19}$ J |
| Mass of electron, $m_e$ | = | $9.11 \times 10^{-31}$ kg |
| Mass of proton, $m_p$ | = | $1.67 \times 10^{-27}$ kg |
| Permittivity of free space, $\varepsilon_0$ | = | $8.85 \times 10^{-12}$ $C^2/Nm^2$ |

Acceleration due to gravity, g $= 10\ m/s^2$

Density of water $= 1\ g/cm^3$

**QUESTION ONE (30 MARKS):**

a) Two spheres charged with equal but opposite charges experience a force of $170.5\ N$ when they are placed $20\ mm$ apart in a medium of relative permeability 3. Determine the charge on each sphere. (3 marks)

b) Show that the amount of work done in bringing a charge $dq$ a unit distance in an electric field is equivalent to: - $W = \frac{1}{2}CV^2$. (3 marks)

c) Three capacitors are connected in series across a $75\ V$ supply. The voltages across them are $20\ V$, $25\ V$ and $30\ V$ respectively and the charge on each is $3 \times 10^{-3} C$. Find the capacitance of the combination. (3 marks)

d) Two rails of a railway track insulated from each other and the ground are connected to a millivolt-meter. What would be the reading of the millivolt meter when the train travels at a speed of $180\ km/h$ along the track, given that the horizontal component of earth's magnetic field is $0.2\ x\ 10^{-4}\ Wb/m^2$ and the rails are separated by 1 meter. (4 marks)

e) An air cored solenoid has 300 turns, its length is $25\ cm$ and its cross-section is $3\ cm^2$. Calculate its self-inductance. (3 marks)

f) Consider a unit North Pole of strength, m of one weber placed at a point, a distance r, in a magnetic field. Show using unit vector that the magnetic field intensity is given

by $\vec{H} = \frac{m}{4\pi\mu\vec{r}^3} N/Wb$ (3 marks)

g) A galvanometer which requires a current of $I_g$ for full-scale deflection and a galvanometer resistance $G$ is intended for conversion to an ammeter. Taking $S$ to be the shunt resistance to be used, show that: -

$$S = G(\frac{I_g}{1-I_g})$$ (4 marks)

h) Considering a point $A$ in an electric field whose intensity is $\vec{E}$, a unit positive charge is placed at this point and then moved to another point $B$ at a distance $dx$ from point $A$. show that the electric field intensity $\vec{E}$ is equal to the rate of change of potential with distance.

(4 marks)

i) Explain three factors upon which capacitance of a capacitor depend on. (3 marks)

**QUESTION TWO (20 MKS)**

a) Find the capacitance of coaxial cylinder with insulator of permeability $\epsilon_r$, $Q$ is the charge in coulombs per meter and that the potential difference of $V$ is applied between. (7 marks)

b) Three A, B and C charges of $\frac{2}{3}$x $10^{-9}$ $C$, $\frac{8}{3}$x $10^{-9}$ $C$ and $\frac{10}{3}$x $10^{-9}$ $C$ respectively are placed at three corners of an equilateral triangle of side 10 cm. Find the resultant and direction force on the charge of $\frac{10}{3}$x $10^{-9}$ $C$.

(13 marks)

**QUESTION THREE (20 M ARKS)**

a) The resistance of a field coil measures 55 Ω at $25^0C$ and 65 Ω at $75^0C$. Find the temperature coefficient of the conductor at $0^0C$. (8 marks)

b) Two points charges of $12 \times 10^{-10}\ C$ and $8 \times 10^{-10}\ C$ are 10 cm apart. Find the work done in bringing the charges 4 cm closer. (7 marks)

c) Show that the magnetic flux density at a distance x from a long straight wire is given by:

$$- \vec{B} = \frac{\mu_0 I}{2\pi R}$$ (5 marks)

**QUESTION FOUR (20 MARKS)**

a) A wire carrying a current of 100 amperes is bent into the form of a circle of radius 5.08 cm. Calculate the flux density at the center of the coil and flux density perpendicular to the plane of the coil at a distance of 12 cm from the coil. (6 marks)

b) The figure below shows two batteries in opposition to each other. One has an emf of 6V and internal resistance $r_1$ of 2Ω and the other an emf $E_2$ of 4V and internal resistance $r_2$ of 8Ω. Calculate the potential difference $V_{xy}$ across xy. (8 marks)

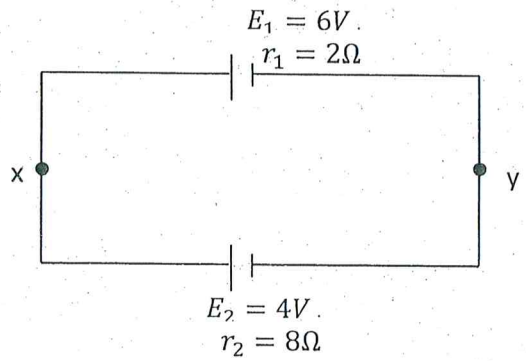


**Figure 4.1: Fig. 4.1**

c) A long straight conductor x carrying a current of 2A is placed parallel to a short conductor y of length 0.05 m carrying a current of 3A. The two conductors are 0.10 m apart. Calculate the flux density due to x at y and the approximate force on y. (6 marks)

## QUESTION FIVE (20 MARKS)

ABCD is a rectangle. At corners B, C and D of the rectangle is placed charges $+10 \times 20^{-12}$C, $-20 \times 10^{-12}$C and $+10 \times 10^{-12}$C respectively. Calculate the potential at the fourth corner A. the side AB=4cm and BC=3cm. (10 marks)

a) A potential difference of 20KV is applied to a parallel plate capacitor with a plate area of $0.01m^2$. The plates are separated by a dielectric 2mm thick. The capacitance of the capacitor is $2 \times 10^{-4}\mu F$. Find : -

i.) Total electric flux. (2)

ii.) Potential gradient. (2)

iii.) Relative permeability of the medium. (6)

iv.) Energy stored. (3)

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