KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2016/2017 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR

BACHELOR OF SCIENCE
AND
BACHELOR OF EDUCATION (SCIENCE)

COURSE CODE: SPH 210

COURSE TITLE: ELECTRICITY AND MAGNETISM

DURATION: 2 HOURS

DATE: 19TH SEPTEMBER 2017 TIME: 8 – 10AM

INSTRUCTIONS TO CANDIDATES

- Answer question **ONE** and any other **THREE** questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **5** printed pages. Please Turn Over

The following constants may be used;

Mass of an electron, $M_e=9.11\times10^{-31}kg$

Electronic charge, $e=1.602\times10^{-19}C$

Permeability of free space, $\mu_0=4\pi\times10^{-7}N/Am$

Permittivity of free space, $\varepsilon_0=8.85\times10^{-12}F/m$

QUESTION ONE(30MARKS)

(a). State Ampere's law. **(1mark)**

(b). An ideal infinitely long solenoid has n turns per unit length and carries a current I. Use Ampere's law to find the magnetic field at the centre of the solenoid.**(4marks)**

(c).(i) A cell of e.m.f,ε and internal resistance r is connected to a resistor R. For what value of R will the power supply to the load resistor be maximum? **(3marks)**

(ii) Give one practical application of the condition stated in c (i)? **(1mark)**

(d). State kirchoff's voltage law. **(1mark)**

(e). A galvanometer for which 15mA gives a full scale deflection and has resistance of 5.0Ω. It is required to convert it into an ammeter of full scale deflection of 1.5A.Calculate the value of the shunt. **(3marks)**

(f). Consider a rectangular coil of length $\boldsymbol{l}$ and breadth $\boldsymbol{b}$ in a magnetic field $\vec{\boldsymbol{B}}$at an angle $\boldsymbol{\phi}$ to the coil and carrying a current $\boldsymbol{I}$. Show that such a coil of $\boldsymbol{N}$ turns experiences a torque, $\boldsymbol{\tau}$ given by;

$\boldsymbol{\tau = NAIBcos\phi}$where$\boldsymbol{A}$ is cross section area the coil. **(4marks)**

(g). Three identical positive charges of charge Q are placed at the corners of an equilateral triangle of side a as shown in figure 1.Show that the net force on Q_1 is given by;$\boldsymbol{F = \frac{\sqrt{3}KQ^2}{a^2}}$. **(5marks)**

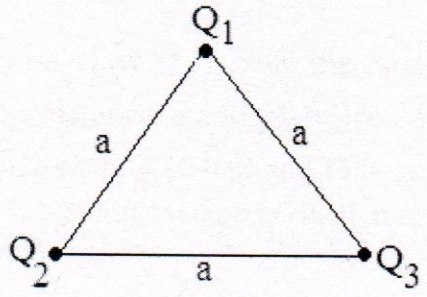


Fig 1

(h). A $5\mu F$ capacitor is charged to a p.d of 200V and isolated.It is then connected in parallel to a$10\mu F$ capacitor. Find the resultant p.d of the parallel connection and the energy stored before connection. **(5marks)**

(i). Show that the electric force field given by $\vec{F} = by^3\hat{\imath} + 3bxy^2\hat{\jmath} + cz^2\hat{k}$ is conservative. **(3marks)**

QUESTION TWO (20 MARKS)

(a) Define magnetic field intensity, $\vec{B}$. **(1mark)**

(b) A positive charge of mass m is shot into a magnetic field with velocity $v$as shown in figure 2. It is observed that it moves in a circular path. Show that its period of rotation is given by;

$T = \frac{2\pi m}{qB}$where$B$ is the magnetic field strength. **(5marks)**

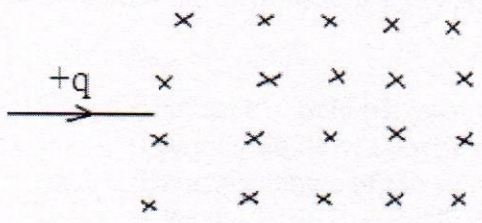


Fig.2

(c) The heating element of a heater is rated 1kW when operating at 240V.Determine the current through it. Also calculate its power consumption when the p.d drops to 120V. **(3marks)**

(d) Using Gauss's law prove that the capacitance of a parallel plate capacitor with plate separation distance, d and plate area A is $C = \frac{\varepsilon_0 A}{d}$. **(4marks)**

(e) Two positive charges 10.0 nc and 15.0 nc are separated by 50 mm. What is the electric field intensity, E, resulting at a point ,P, 40 mm from charge 15.0 nc and 30mm from the charge 10.0 nc?**(7marks)**

QUESTION THREE(20 MARKS)

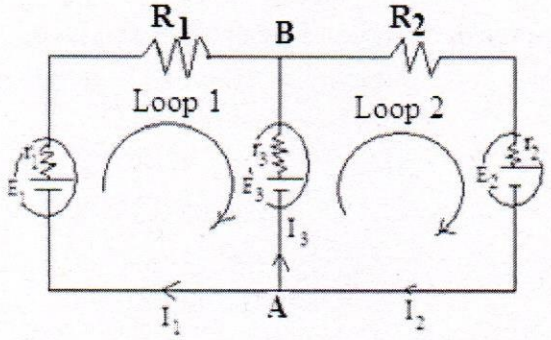


Figure 3

(a)Using the circuit in figure3, determine the currents I_1, I_2, I_3 , given that $r_1 = r_2 = 2\Omega$, $r_3=1\Omega$, $R_1=4\Omega$, $R_2=3\Omega$, $E_1=15V$, $E_2=6V$, $E_3=4V$. **(6marks)**

(b) Compute V_{BA}.. **(2marks)**

(c) Distinguish the following terms; resistance and resistivity, conductance and conductivity. **(2marks)**

(d) . A parallel plate capacitor whose plates have an area 1.0 m^2, which are separated by 2 mm is connected across the terminals of 100V battery. Calculate

i. The electric field between the plates
ii. The magnitude of **charge density** between the plates
iii. The capacitance of the system
iv. Repeat i., ii., iii., above if the space between the plates are filled with a dielectric of relative permittivity 3. **(10marks)**

QUESTION FOUR (20 MARKS)

(a) State the superposition theory of electrostatics. **(1mark)**

(b) A thunder cloud may hold a negative charge of 100C at a mean height of 5km and a similar but positive charge at a mean height of 9km.Estimate the force between the clouds. **(5 marks)**

(c) An elemental charge dQ along a wire of continuous charge distribution exerts a force on an isolated charge **Q** at a perpendicular distance a given by;

$dF = \frac{KQ\lambda dl}{r^2}$ where λ is the line density of charge and r is the distance between a length element dl and the isolated charge. Show that total force on the isolated charge is $F = \frac{2KQ\lambda}{a}$. **(8 marks)**

(d)State and explain three factors on which magnetic force on a current carrying conductor depends on when placed in a magnetic field. **(6 marks)**

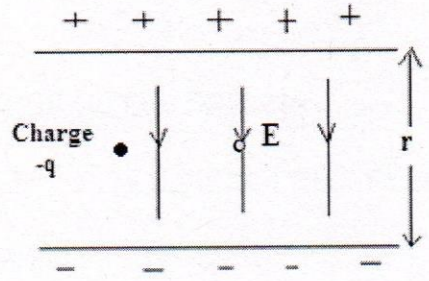
QUESTION FIVE(20 marks)

(a) What are equipotential lines? **(1mark)**

(b) State Gauss's law and give its mathematical expression. **(2marks)**

(c) A potential is given by; $V = 3xyV/m$. Given that $\vec{E} = -\nabla V$, find the components of the electric field $\vec{E}$ **(3marks)**

(d) Consider a uniform electric field inside a parallel plate capacitor as shown below;



If a charged particle of charge q is stationary between the plates, show that the p.d, Vacross the plates is given by $V = \frac{mgr}{q}$ where m is the mass of the charged particle.

Now the particle starts moving with velocity u.Ignoring the effect of gravitational force, show that the vertical displacement y covered is given by;

$y = \frac{1}{2}\left(\frac{q}{m}\right)Et^2$ where t is time taken to reach the plate. **(8 marks)**

(e)A capacitor has 2 dielectric materials of relative permittivity ε_1 and ε_2. If the plate area is A, compute the capacitance of the capacitor in two alternative ways.**(6marks)**