KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

INSTITUTE OF OPEN LEARNING – (IOL)

EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCE) AND BACHELOR OF SCIENCE

SPH 101: ELECTRICITY AND MAGNETISM I

DATE: Tuesday, 13th December, 2011 TIME: 8.00 a.m. – 10.00 a.m.

INSTRUCTION: Answer question one and any other two questions.
Question 1 carry 30 marks and the others 20 marks each.

Apply the following constants might where necessary

$\varepsilon_o = 8.854 * 10^{-12}\ F.m^{-1}$
$\mu_o = 4\pi * 10^{-7}\ TmA^{-1}$
$1eV = 1.6 * 10^{-19} J$
mass of proton $= 1.7 * 10^{-27} kg$
charge of a proton $= 1.6 * 10^{-19} C$

Q1. a). What is meant by time constant in discharging a capacitor. (2 mark)

b). (i) Define the term conductivity (1 mark)

(ii) Show that the current density (J) is given by

$J = \sigma \mathbf{E}$ where σ is conductivity and $\mathbf{E}$ is the electric intensity. (3 marks)

c) (i). State Coulombs law both in words and mathematically (2 mark)

(ii). Three charges each of 20 μC are equally spaced along a straight line, successive charges being 3 m apart. Calculate the force on one of the end charges and the force on the central charge. (4 marks)

d) Use a sketch to show the variation of electric field strength due to a hollow charged conductor of radius "a" (3 marks)

e). State the advantage and disadvantages of a potentiometer. (2 marks)

f). Name two basis of the generation of emf by mechanical means. (2 marks)

g). A certain meter movement has a resistance of 40 Ω and deflects full scale for a voltage of 200 mV across its terminals. How can it be converted into a 3 A ammeter?
(3 marks)

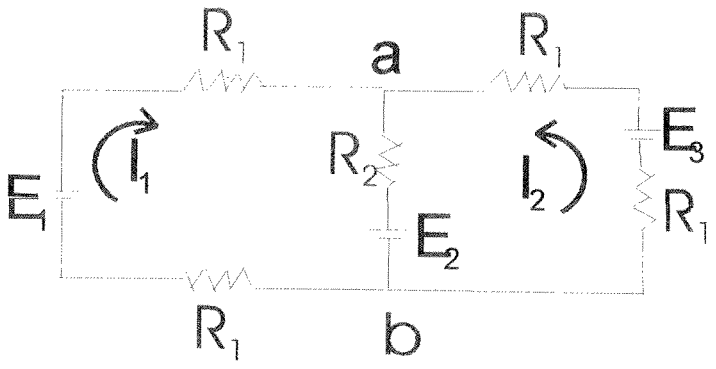
h). State Kirchhoff's laws (2 marks)

(i). (i). Which are the factors which influence the magnitude of the force experienced by a current carrying conductor in a magnetic field. (3 marks)

(ii). Calculate the magnetic force acting per unit length of two infinitely long parallel wires each carrying a current of 2A and placed a distance of 1m apart. (3 marks)

Q2. a). In the figure below,

(i). find the current through each branch of the network given that, $R_1 = 1.0\ \Omega$, $R_2 = 2.0\ \Omega$, $E_1 = 2.0V$, $E_2 = E_3 = 4V$. (10 marks)



ii). Calculate V_{ab} (2 marks)

b). The resistance between the ends of a metal rod at 20°C is $2.87*10^{-3}\Omega$. If this rod is 1.0m long and 0.5 cm in diameter, calculate the resistance between the opposing round traces of a disk 2.0cm in diameter and 1.0 mm thick made of this metal. (4 marks)

c). A current of 0.2 A exists in a 10 Ω resistor for 2 minutes. Find the following

(i). the amount of charge (2 marks)

(ii). number of electrons that pass through a cross-section of the resistor in this time. (2 marks)

Q3. a) (i) . State the laws of electromagnetic induction. (3 mark)

(ii) A solenoid is 4 cm long and has 10 turns per cm. Each turn of solenoid has an area of 50 cm^2. Calculate the value of self-inductance in the solenoid. (3 marks)

(iii). A solenoid has an inductance of 50 henrys and a resistance of 30 Ω. If it is connected to a battery, how long will it take for the current to reach one-half its final equilibrium value? (4 marks)

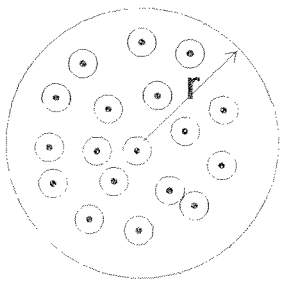
b) A series R-L circuit consists of a 20 mH inductor, a 5 ohms resistor and a 6V battery. The switch is closed at t=0.

i. Find the time constant of the circuit (2 marks)

ii. Calculate the current in the circuit at t = 1.6 ms. (4 marks)

c) A uniform field of magnetic induction **B** points horizontally from south to north; its magnitude is 1.5 Wb/m^2. If a 5.0 MeV proton moves vertically downwards through this field, what force will act on it?. (4 marks)

Q4 (a) The lines of time-varying magnetic flux density, B are directed perpendicular to a circular loop as shown in the figure below.



The radius of the circular loop is $1*10^{-4}$ m. The initial value of the magnetic density, Bo, is $4*10^{-2}$ T, and B decreases at the rate of $2 * 10^{-4}$ Ts^{-1}),

(i). What is the initial magnetic flux (ϕ_o) through the loop? (3 marks)

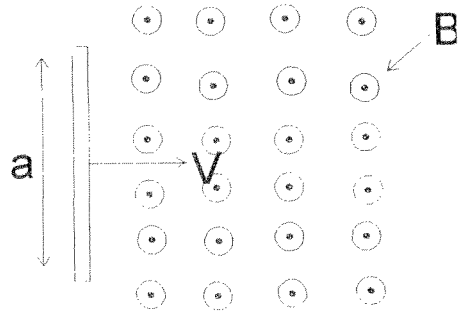
(ii). What is the induced emf in the circular loop? (3 marks)

(iii). Calculate the power dissipated in the loop if its resistance is 0.5 Ω (2 marks)

(iv). Calculate the amount of charge induced in the circuit loop in one second.

(3 marks)

b) A metal rod of length "a" moves with a velocity "V" in a direction perpendicular to its axis and to a constant magnetic field "B" as shown below



(i) What will be the p.d between the ends of the rod for "a" = 20 cm. (3 marks)

(ii) What will be the magnitude and direction of the electric field in the rod set up by the separation of charge due to this motion, if the rod is moving at 200 m/s and B = 1.6 * 10^5 T. (3 marks)

d). A Proton moves in a circular orbit of radius 15 cm perpendicular to a magnetic field whose magnitude is 0.06T. Find:

i) The magnitude of its linear momentum *(1 mark)*

ii) Its kinetic energy in eV. (Proton mass = 1.67 *10^{-27} kg,) (2 marks)

Q5. a). Show that the equivalent capacitance (C_{eq}) of three capacitors (C_1,C_2 and C_3) connected in series is given by the equation below (4 marks)

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

b) (i.) Explain how a dielectric influences the capacitance of a capacitor. (2 marks)

(ii). A capacitor of capacitance C is fully charged by a 200V battery. It is then discharged through a small coil of resistance embedded in a thermally insulated block

of specific heat capacity 2.5 *10^2 J/ka K and of mass 0.1kg. If the temperature of the block rises by 0.4k, what is the value of C? (5 marks)

c). A capacitor charged from a 50V dc supply is discharged across a charge-measuring instrument and found to have carried a charge of 10μC. What was the capacitance of the capacitor and how much energy was stored in it? (3 marks)

d). Two resistors, R_1 and R_2, may be connected either in series or parallel across a battery with emf ε. We desire the thermal energy transfer rate for parallel combination to be five times that for the series combination. If $R_1 = 100\ \Omega$, what is R_2? (6 marks)

.....end.....