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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2017 /2018 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER REGULAREXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: **PHY 122**

COURSE TITLE: **ELECTRICITY AND MAGNETISM I**

DATE: 26th, APRIL, 2018 **TIME: 9AM – 12.00 PM NOON**

INSTRUCTION TO CANDIDATES

- **SEE INSIDE**

THIS PAPER CONSISTS OF 6 PRINTED PAGES **PLEASE TURN OVER**

PHY 122

PHY 122: ELECTRICITY AND MAGNETISM I

STREAM: Bed Sc. **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

i. *Answer Question **ONE** and **TWO** in **SECTION A** and any other **THREE** questions in **SECTION B**.*

ii. *Do not write on the question paper.*

SECTION A (24 Marks)

Question One

a) (i) Write an expression of the magnetic force, experienced by a charge q moving with velocity v, in a magnetic field B. (1 Mark)

(ii) An electron in a television picture tube moves toward the front of the tube with a speed of $8.0 \times 10^6\ m/s$ along the x axis. Surrounding the neck of the tube are coils of wire that create a magnetic field of magnitude 0.025 T, directed at an angle of 60° to the x axis and lying in the xy plane. Calculate the magnetic force (2Marks)

b) For a toroid having N closely spaced turns of wire, mean radius, r and circumference L and $n = \frac{N}{L}$, show that magnetic field in the region occupied by the torus, a distance r from the centre is, $B = \mu_o \frac{N}{2r\pi} L$ (3 Marks)

c)Differentiate between relative permeability, μ_r and magnetic susceptibility, χ_m. Express in form of an equation the relationship between μ_r and χ_m. (3 Marks)

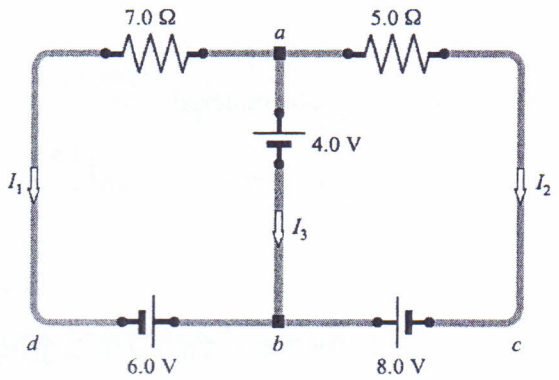
d) A metal rod is 2m long and 8mm in diameter. Compute its resistance, if the resistivity of the metal is $1.76 \times 10^{-8} \Omega.m$ (2 marks)

e) Describe three ways to increase the capacitance of a capacitor? (3 Marks)

Question Two

a) A series RLC circuit has a resistance of 45Ω and an impedance of 75Ω. What average power is delivered in this circuit when $V_{rms} = 210V$ (3Marks)

b) Consider the circuit shown below. Calculate the currents I_1, I_2 and I_3 (3 Marks)



c) Distinguish between intrinsic and extrinsic conduction in semiconductors (2 Marks)

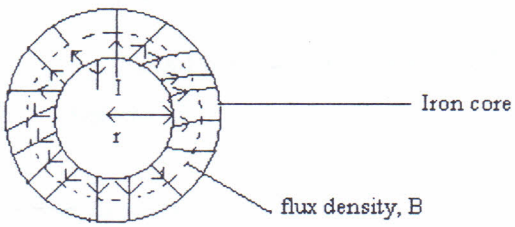
d) Draw a circuit diagram showing a reverse-biased diode and explain why very little current will flow. (2 Marks)

e) State two functions of a cathode ray oscilloscope (2 Marks)

SECTION B (36 Marks)

Question Three

Consider a toroid of length L, as shown: Let the total number of turns = N, mean radius = r, circumference = L and n be the turns per unit length ($n = N/L$),



a) Derive an expression of total flux density **B** in terms of magnetic field vector **H** and Magnetization **M** (6 Marks)

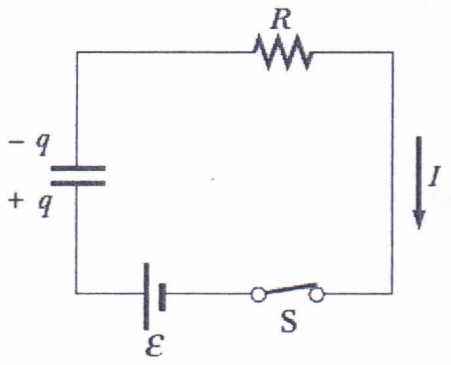
b) A toroid core has $N = 1200$ turns, length $L = 80$cm, cross-sectional area $A = 60\text{cm}^2$, current $I = 1.5$A. Compute B and H. Assume an empty core. ($\mu_o = 4 \times 10^{-7} T.m/A$)

(2Marks)

c) Differentiate between soft magnetic materials and hard magnetic materials. Give an example of each of the materials. (4 Marks)

Question Four

a) Consider a series RC circuit shown below for which $R = 1.00M\Omega$, $C = 5.0\mu F$ and $\varepsilon = 30.0V$



i) What is the time constant of the circuit (1 Mark)

ii) Find maximum charge on the capacitor (1 Mark)

iii) Determine maximum current in the circuit (1 Mark)

iv) Express charge and current as a function of time (4 Marks)

b) Derive an expression for the energy stored in capacitor C when there is a potential difference V between the plates (5 Marks)

Question Five

a) An RLC circuit consists of 150Ω resistor, a $120\mu F$ capacitor and $460mH$ inductor connected in series with $V_{max} = 120V$, 60Hz power supply.

Calculate the

(a) (i) inductive reactance, (2Marks)

(ii) capacitive reactance, (2Marks)

(iii) Impedance (2Marks)

(b) What is the phase angle between current and applied voltage. (2 Marks)

(d)Find:

(i) maximum current (1Mark)

(ii) maximum voltage across each element (3 Marks)

Question Six

a) Explain with the aid of labelled circuit diagrams how half-wave rectification and full-wave rectification maybe achieved using a diode. (4 Marks)

b)Describe the structure of a p-n junction diode (2 Marks)

c) A 5.00Ω resistance is in series with 0.2H pure inductance and a $4\times10^{-8}F$ pure capacitance. The combination is placed across 30.0V, 1780Hz power supply.

Find:

i) Current in the circuit (4 Marks)

ii) Phase angle between voltage and current (1 Mark)

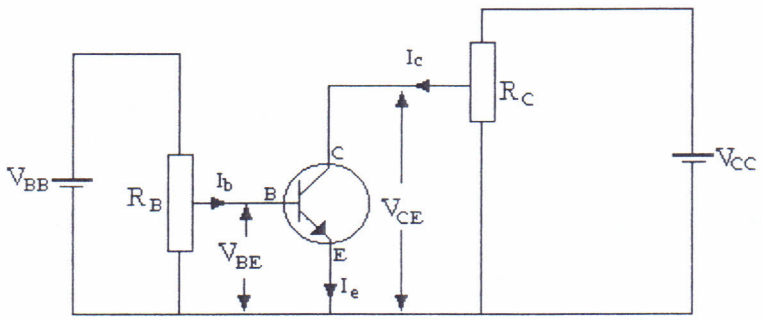
iii) Comment on the answers in part (a) and (b) (1 Mark)

Question Seven

a) What is a transistor? (1Mark)

b) Draw a sketch of n-p-n transistor used in (i) a common-base (CB) and (ii) a common-emitter (CE)connection, showing the polarities of the batteries and direction of the currents. (4 Marks)

c) (i) Sketch a curve of the input and output characteristics of a common emitter transistor circuit in active mode shown below. (4 Marks)



(ii) From the common emitter circuit shown in c (i) above, deduce from Kichoff's current law that $\alpha_{dc} = \frac{\beta_{dc}}{1+\beta_{dc}}$, where β_{dc} is the current gain (3 Marks)

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