



THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

JANUARY – APRIL 2015 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCES (PHYSICS)

PHY 102: ELECTRICITY AND MAGNETISM I

Date: April 2015

Duration: 2 Hours

Instructions: Answer Question ONE and any other TWO Questions

Physical Constants

Electronic Charge, $e = 1.6 \times 10^{-19} \text{C}$

Mass of Electron, $m_e = 9.11 \times 10^{-31} \text{Kg}$

Permittivity of Vacuum; $\epsilon_0 = 8.85 \times 10^{-12} \text{Fm}^{-1}$

Permeability of Vacuum; $\mu_0 = 4\pi \times 10^{-7} \text{Hm}^{-1}$

- Q1
- a) Distinguish between the following terms;
- i) Conductance and conductivity **(2 marks)**
 - ii) Shunt and multiplier resistors **(2 marks)**
- b) Define the following;
- i) Current density **(1 marks)**
 - ii) Ohm **(1 marks)**
 - iii) Coulomb **(1 marks)**
- c) Calculate the number of electrons passing through a wire per second if the current is 1mA. **(3 marks)**
- d) A DC Voltage supply gives 50V on open circuit and has an internal resistance of $1\text{K } \Omega$. What reading will a voltmeter give when connected to the terminal of this supply if the resistance of the voltmeter is only 4Ω . **(4 marks)**
- e) A parallel plate capacitor of area 0.03m^2 has a 2mm gap between its two plates. The gap is filled with air. If a sheet of insulating material 1.5mm thick and of relative permittivity 6 is placed between the plates, calculate its capacitance. **(6 marks)**

- g) Calculate the flux density in the middle of a solenoid having 10 turns per centimeter and carrying a current of 0.50A given that the medium within the Solenoid is air. **(3 marks)**
- h) State Kirchoff's Laws for circuit networks. **(2 marks)**
- i) State the laws of Electromagnetic Induction. **(2 marks)**
- Q2. a) Derive an expression for the current density, J , in terms of free electron density, n , drift velocity, v and electronic charge, e . **(5 marks)**
- b) A cell of EMF 1.5V and internal resistance 0.50Ω is joined by its positive terminal to the positive terminal of a 1.0V cell having internal resistance 1.0Ω . The free terminals of the cells are then connected by a 3.5Ω resistor. Calculate: -
- i) The current through the 3.5Ω resistor **(2 marks)**
- ii) The power dissipated in the 3.5Ω resistor **(2 marks)**
- iii) The power dissipated in each cell. **(2 marks)**
- c) A coil wire has resistance of 6.00Ω at 60°C and 5.25Ω at 15°C . Determine its temperature coefficient of resistance. **(5 marks)**
- Q3. a) Briefly describe how a moving coil meter with a full scale deflection (FSD) of 10mA and a coil resistance of 5Ω is to be used as
- i) An ammeter with a FSD of 2.0A **(5 marks)**
- ii) A Voltmeter with a FSD of 20V **(5 marks)**
- b) State THREE advantages and THREE disadvantages of a potentiometer. **(6 marks)**
- c) Calculate the value of resistance needed in series with a driver cell of negligible internal resistance and approximately 2V Emf to be arranged such that $\frac{3}{4}$ of the 4Ω slide wire is required to balance a PD of 1V. **(4 marks)**
- Q4. a) i) Calculate the value of the turns ratio needed for an ideal transformer to provide 12 VRMS when connected to 240V RMS mains supply. **(3 marks)**
- ii) If the transformer is loaded with a non-inductive 12V, 60W heater, what current would flow in the mains supply? **(3 marks)**
- iii) If the transformer in practice gives 11.8V RMS and 4.5A RMS when the primary current is 0.26A RMS. Calculate the efficiency of energy conversion by the transformer. **(4 marks)**

- b) i) A $5\ \mu\text{F}$ capacitor is charged to 4.0V and is removed from the voltage supply. Calculate the energy stored. **(3 marks)**
- ii) The $5\ \mu\text{F}$ capacitor is now connected in parallel with a $3\ \mu\text{F}$ capacitor. Determine the new energy stored in the capacitor combination. **(5 marks)**
- iii) Calculate the amount of energy converted to heat by the movement of Charge through the wires between the two capacitors. **(2 marks)**
- Q5. a) A $5.0\ \text{V RMS}$, 50Hz Voltage is obtained from a transformer connected to the mains supply and is fed to the Y-plates of a CRO. If the Y sensitivity is set at 10V cm^{-1} and the time base at 10ms Cm^{-1}
- i) Determine the total peak-to-peak height of the trace. **(3 marks)**
- ii) The number of complete cycles of the voltage displayed and if the trace is 4cm wide. **(3 marks)**
- b) An electron is accelerated in a uniform electric field between two electrodes 2.0mm apart in a vacuum. It starts off from rest at the Cathode. Calculate.
- i) The time of flight **(8 marks)**
- ii) The final velocity if the PD between the electrodes is 20V . **(2 marks)**
- c) Currents of 5A and 15A respectively flow down two long, straight vertical wires which are 10cm apart. Draw a diagram to show the form of the magnetic field in a plane perpendicular to these wires assuming there is no other magnetic field present hence locate where the Zero Magnetic field is situated. **(4 marks)**

END