



MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

DECEMBER SESSION EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SPH 201: ELECTRICITY AND MAGNETISM II

DATE: SCHOOLBASED

TIME:

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

Constants

Acceleration due to gravity, $g = 9.81 \text{ m/s}^2$

Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

Constant of Coulombs law $k = 9 \times 10^9$

Electron charge, $e = 1.6 \times 10^{-19} \text{ C}$

Electron mass, $m_e = 9.1 \times 10^{-31} \text{ kg}$

Planck's constant, $h = 6.6 \times 10^{-34} \text{ Js}$

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

- a) Define the following terms as used in *RLC* circuits
- (i) Resonance (2 marks)
 - (ii) Q-Factor (2 marks)
- b) (i) State the law of conservation of charges. (2 marks)
- (ii) Two similarly and equally charged spheres A and B repel each other with a mutual force of 2×10^{-5} N. A third identical uncharged sphere C is touched with A and then placed at the midpoint between A and B. what is the electric force on C? (4 marks)
- c) State the Biot-Savart law and give its mathematical statement (4 marks)
- d) An alpha particle accelerated between a pair of parallel plates in a vacuum tube acquires a kinetic energy of 10^3 eV. What is the potential difference between the plates? (4 marks)
- e) State the following laws of electromagnetic induction giving an illustration in each or a mathematical relation.
- (i) Faradays law (3 marks)
 - (ii) Lenz's law (3 marks)
- f) Identify three factors that affect resistance of conductor. (3 marks)
- g) An AC main supply is given to be 220 V. What is the average e.m.f during appositive half cycle? (3 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTIONS

QUESTION TWO (20 MARKS)

- a) Define the following terms
- (i) Magnetic field (2 marks)
 - (ii) Magnetic flux (2 marks)
- b) Write down the expressions for the following situations:
- (i) The magnetic field B at a distance r from a long straight wire carrying a current I . (2 marks)
 - (ii) The force on a straight wire of length l placed perpendicular to a magnetic field B and carrying current I . (2 marks)

- c) The relative permittivity of mica is 6. What is its absolute permittivity? (2 marks)
- d) An electrical network is arranged as shown in Figure 1. Find the current in the branch AF. (10 marks)

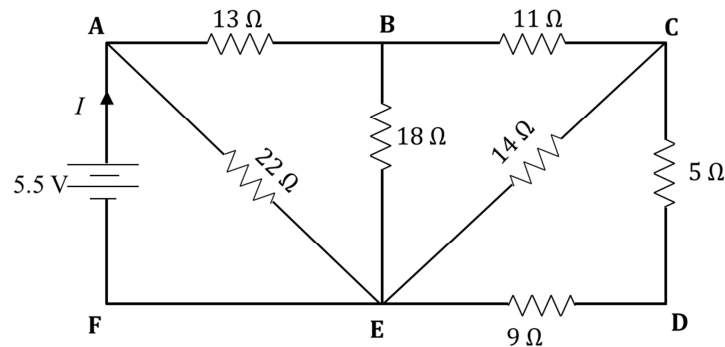


Figure 1

QUESTION THREE (20 MARKS)

- a) A coil of radius 10 cm and having 20 turns carries a current of 12 A in clockwise directions when seen from the right. The coil is in a vertical plane. Find the magnetic field at the center of the coil. (5 marks)
- b) If a variable frequency e.m.f. is applied to a series RLC circuit consisting of $R = 5 \Omega$, $L = 200 \text{ mH}$ and $C = 0.05 \mu\text{F}$, determine the values of angular frequency ω for which the current will
- be in-phase with applied voltage (3 marks)
 - lead the applied voltage by 30° (3 marks)
- c) A series RLC circuit consists of a 100Ω resistor, an inductor of 0.318 H and a capacitor of unknown value. When this circuit is energized by $\sqrt{2} \times 230 \sin 314t$ volts AC supply, the current is found to be $\sqrt{2} \times 2.3 \sin 314 t$. Find
- the value of capacitor in microfarad (3 marks)
 - the voltage across the inductor (3 marks)
 - the total power consumed (3 marks)

QUESTION FOUR (20 MARKS)

a) An alternating current of frequency 60 Hz has a maximum value of 120 A.

- i) Write down the equation for the instantaneous value (2 marks)
- ii) Find the instantaneous value of current after $1/360$ s from the instant the current was zero and becoming positive. (3 marks)
- iii) Find the time taken for the current to reach 96 A (3 marks)

b) Figure 2 represents a cylindrical aluminum bar AB resting on two horizontal aluminum rails which can be connected to a battery to drive a current through AB. A magnetic field, of flux density 0.1 T acts perpendicularly to the paper and into it. Explain how you can predict the direction in which the rod AB moves if the current flows from A to B.

- i) State the direction of the bar AB. (2 marks)

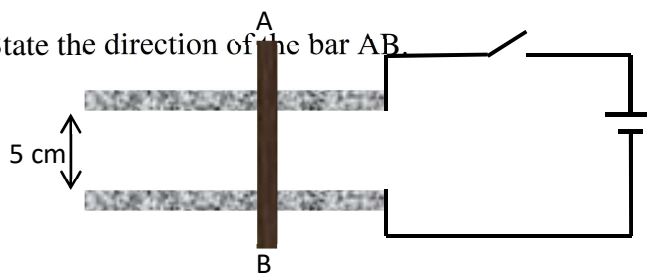


Figure 2

- ii) Calculate the angle to the horizontal to which the rails must be tilted to keep AB stationary if its mass is 5.0 g, the current in it is 4.0 A and the direction of the field remains unchanged. (4 marks)

c) A $100 \mu\text{F}$ capacitor in series with a 40Ω resistance is connected to a 110 V, 60 Hz supply.

- i) What is the maximum current in the circuit? (3 marks)
- ii) What is the time lag between current maximum and voltage maximum? (3 marks)

QUESTION FIVE (20 MARKS)

- a) Two small spheres, each having a mass of 0.1 g are suspended from a point by threads 20 cm long. They are equally charged and they repel each other to a distance of 24 cm. What is the charge on each sphere? (4 marks)
- b) Two capacitors A and B are connected in series across a 200 V dc supply. The p.d. across A is 120 V. This p.d. is increased to 140 V when a $3\ \mu\text{F}$ capacitor is connected in parallel with B. Calculate the capacitance of A and B. (8 marks)
- c) Three point-charges of $+8 \times 10^{-9}\ \text{C}$, $+32 \times 10^{-9}\ \text{C}$ and $+24 \times 10^{-9}\ \text{C}$ are placed at the corners A, B, and C of a square ABCD having each side 4 cm as shown in Figure 3. Find the electric field intensity at the corner D. Assume that the medium is air. (8 marks)

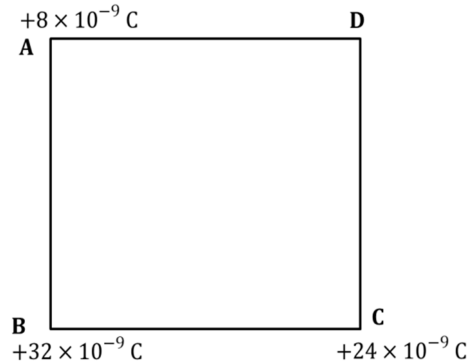


Figure 3