



MACHAKOS UNIVERSITY

University Examinations 2019/2020 Academic year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN TELECOMMUNICATION AND INFORMATION

TECHNOLOGY

SPH 201: ELECTRICITY AND MAGNETISM II

DATE: 29/11/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS TO CANDIDATES

Answer **QUESTION ONE** and **ANY OTHER TWO** questions.

Question 1 carries **30** marks) and the others carry **20** marks) each.

YOU MAY USE:

You may need to use the following constants

$\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$; $K = 1/(4\pi\epsilon_0) = 8.99 \times 10^9$, Electron charge, $q_e = -1.6 \times 10^{-19} \text{ C}$, Proton charge, $q_p = +1.6 \times 10^{-19} \text{ C}$, mass of a proton, $m_p = 1.67 \times 10^{-27} \text{ Kg}$ Mass of an electron, $m_e = 9.11 \times 10^{-31} \text{ Kg}$, $\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$, $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$, $G = 6.67 \times 10^{-11} \text{ N.m}^2.\text{Kg}^{-2}$.

QUESTION ONE (30 MARKS)

- State and write the mathematical expression for Ampere's law. (3 marks)
- Three charges $-3 \mu\text{C}$, $12 \mu\text{C}$ and $-4 \mu\text{C}$ are located on the surface of a sphere of radius $r = 7 \text{ cm}$. Determine the electric field associated with them. (3 marks)
- Derive the expression for effective capacitance when three series capacitors are connected in parallel with a fourth capacitor. (4 marks)
- For a parallel plate capacitor, show that the energy density in any electric field is proportional to the square of the magnitude of the electric field at a given point. (4 marks)

- e) A transmitting circuitry contains a coil with an inductance of 3 mH and is to generate a signal of 2 MHz. Calculate the value of the used capacitor. (4 marks)
- f) A 50 turns coil with a radius of 7cm carries a current of 1.5A.
- What is the magnitude of its magnetic dipole moment? (2 marks)
 - What is a torque on the coil if it is in a uniform magnetic field of 0.2T with an angle of 30° between moment and field? (3 marks)
- g) A circuit consist of an inductor of $200\mu H$ and resistance 10Ω in series with a variable capacitor and a 10V, 2MHz supply. Calculate;
- The capacitance that gives resonance (2 marks)
 - The p.d's across the inductor at resonance (2 marks)
- h) State Gauss's law (3 marks)

QUESTION TWO (20 MARKS)

A sinusoidal voltage of frequency $f=60\text{Hz}$ and peak value 150V is applied to a series R-C-L circuit where $R=0.003\Omega$, $C = 0.004F$ and $L=40\text{mH}$.

- Compute the period T , ω , χ_C , χ_L , Z and ϕ (5 marks)
- Compute the amplitudes I , V_R , V_L and V_C (5 marks)
- Compute the instantaneous values i , V_R , V_L at $t = \frac{T}{6}$. (6 marks)
- Compute the I_{RMS} , V_{RMS} and the average power into the circuit. (4 marks)

QUESTION THREE (20 MARKS)

- Show that the capacitance for a spherical conductor with inner radius a and outer radius b is given by, $C = \frac{ab}{K(b-a)}$ where all the symbols have their usual meanings. (8 marks)
- If the dielectric constant for petrol is 0.015, determine the capacitance in a parallel-plate capacitor of dimensions $6 \times 4 \text{ cm}$ with plate separation distance of 3mm . (3 marks)
- State the Biot-Savat law and write its mathematical expression (2 marks)
- A wire is bent into a square loop of side L and carries current I .

 - Find an expression for the magnetic field at the centre of the square and its direction. (4 marks)
 - If $L = 20 \text{ cm}$ and $I = 5.4 \text{ A}$ compute the magnetic field. (3 marks)

QUESTION FOUR (20 MARKS)

- a) Using Gauss' law, find the electric field due to charges distributed within a sphere of radius R for;
- i. $R \gg r$ (2 marks)
 - ii. $R = r$ (2 marks)
 - iii. $R < r$ (2 marks)
- b) An electron in a television picture tube moves toward the front of the tube with a speed of $2.3.0 \times 10^7$ m/s along the x axis. Surrounding the neck of the tube are coils of wire that create a magnetic field of magnitude 0.35 T, directed at an angle of 50° to the y -axis and lying in the y - z plane. Calculate the magnetic force on the electron and its direction. (5 marks)
- c) Using Gauss' law, show that for a parallel-plate capacitor with area of the plates, A and plate separation d ; (9 marks)

$$C = \epsilon_0 \frac{A}{d}$$

QUESTION FIVE (20 MARKS)

- a) Define rectification . (2 marks)
- b) Using clearly labeled diagrams, describe;
- i. Half-wave rectification (5 marks)
 - ii. Full-wave rectification using a bridge (5 marks)
 - iii. Half-wave output smoothing (4 marks)
 - iv. Full-wave output smoothing (4 marks)