MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MATHEMATICS)

BACHELOR OF ECUCATION (SCIENCE)

SPH 201: ELECTRICITY AND MAGNETISM II

DATE: 7/5/2019 **TIME: 11.00-1.00 PM**

INSTRUCTIONS TO CANDIDATES

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

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

YOUMAYUSE:

You may need to use the following constants

$\varepsilon_O = 8.85\times10^{-12}$F/m, $K=8.99\times10^{9}$, $q_e=-1.6\times10^{-19}$C, $q_p=+1.6\times10^{-19}$C, $\mu_O=4\pi\times10^{-7}$Tm/A, $1eV= 1.6\times10^{-19}$J.

QUESTION ONE (30 MARKS)

a) State and write the mathematical expression for Gauss's law. (2 marks)

b) Three charges $-q_1$, q_2 and $-q_3$ are placed in a sphere of radius r. Determine the electric field associated with them. (3 marks)

c) Sketch a graph of the magnitude of electric charge on either plate of a capacitor versus the magnitude of the potential difference between the plates. What does its slope indicate? And based on this curve, provide the two SI units representing this relationship. (4 marks)

d) Identify any three factors leading to increase to capacitance. (3 marks)

e) Distinguish between impedance and resistance. (2 marks)

f) A 2.0H inductor of resistance 80Ω is connected in series with a 420Ω resistor and a 240V, 50Hz supply. Find;

i) the current in the circuit (3 marks)

ii) the phase angle between the applied voltage and the current. (2 marks)

g) Show that the r.m.s for peak voltage is $0.7071V_{peak}$

h) A 20 turns coil with a radius of 17cm carries a current of 4.5A.

i) What is the magnitude of its magnetic dipole moment? (2 marks)

ii) What is a torque on the coil if it is in a uniform magnetic field of 0.03T with an angle of 30^{O} between moment and field? (3 marks)

i) A capacitor 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? (4 marks)

j) State Ampere's law (2 marks)

QUESTION TWO (20 MARKS)

a) 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)

b) A coaxial cable connecting a TV to an antenna socket is 3 m long. The inner conductor has an outer radius of 0.5 mm, the outer conductor has an inner radius of 3 mm. The space between the conductors is filled with plastic with κ= 0.8. Derive the expression to be used and use it to determine the capacitance of this cable? (8 marks)

c) (i) State Bio-Savart law for a current element (2 marks)

(ii) Determine the magnetic field $\vec{B}$ at the center of a circular coil of N turns and carries a current I in each turn. Assume the coil radius is r. (6 marks)

QUESTION THREE (20 MARKS)

a) Define a ballistic galvanometer and describe how it is calibrated. (5 marks)

b) A sinusoidal voltage of frequency f=10MHz and peak value 30V is applied to a series R-L circuit where R=10Ω and L=40mH.

i. Compute the period T, ω, χ_L, Z and ϕ (5 marks)

ii. Compute the amplitudes I, V_R, V_L (3 marks)

iii. Compute the instantaneous values i, V_R, V_L at $t = \frac{T}{3}$. (3 marks)

iv. Compute the $I_{RMS,} V_{RMS}$ and the average power into the circuit. (4 marks)

QUESTION FOUR (20 MARKS)

a) Using Gauss' law, find the electric field due to a uniformly charged sphere of radius R with a surface charge density of ρ at a point P, distance r;

i. R>>r (2 marks)

ii. R=r (2 marks)

iii. R<<r (2 marks)

b) Using Fleming's left-hand rule, show that the force on a current carrying conductor is given by; (6 marks)

$F_m = I\vec{L} \times \vec{B}$

c) Using Gauss' law, show that for a parallel-plate capacitor with area of the plates, A and plate separation d; (8 marks)

$$c = \varepsilon_o \frac{A}{d}$$

QUESTION FIVE (20 MARKS)

a) Show that for two parallel conductors separated by distance a, carrying currents I_1 and I_2 with lengths L_1 and L_2 respectively, force per unit length, $\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi a}$ (8 marks)

b) An infinite straight solid wire of radius R carries a current I. Find the magnetic field $\vec{B}$ at a distance r from the centre of the wire for;

i. r>R (3 marks)

ii. r<R (3 marks)

iii. r=R (3 marks)

iv. Plot a graph $\vec{B}$ vs r (3 marks)