UNIVERSITY OF EMBU

2016/2017 ACADEMIC YEAR

FIRST SEMESTER EXAMINATION

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION SCIENCE

SPH 202: ELECTRICITY AND MAGNETISM II

DATE: DECEMBER 8, 2016 **TIME: 11:00AM-1:00PM**

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

Constants:

$c = 3.0\times10^{8}$ m/s

$e = 1.6 \times 10^{-19}$ C

$m_e = 9.1 \times 10^{-31}$ kg

Plank's constant $h = 6.6 \times 10^{-34}$ JS

$\varepsilon_0 = 8.86 \times 10^{-12}$ C^2/Nm^2

QUESTION ONE (30 MARKS)

a) A hollow sphere of radius 200 mm was charged with a charge of 30×10^{-3} μF. Find the potential at its surface at a distance of 50 cm from the sphere center.

(2 marks)

b) A uniform magnetic field $\vec{B}$, of magnitude 3 mT was directed vertically upwards throughout a test channel. A particle with kinetic energy of 6.2 MeV was ejected in the channel, moving horizontally from south to north. Neglecting the earth's magnetic field, find the magnetic deflecting force that acts on the positive charge as it enters the channel. (4 marks)

c) An alternating voltage e = 100 sin 628 t is applied to a device which offers ohmic resistance of 10 Ω to the flow of current in one direction while entirely preventing the flow in the opposite direction. Calculate the r.m.s value. (4 marks)

d) For a resistor and capacitor only series circuit, find the impedance, Z of the circuit. (4 marks)

e) Differentiate between transient response and steady state response of an a.c circuit. (2 marks)

f) An α-particle travelled in a circular path of radius 2.5 m in a magnetic field with B = 2.1 weber m^{-1}. Determine its speed. (3 marks)

g) Briefly explain how an external magnetic field affects the strength of a magnetic material placed within the field. (4 marks)

h) Calculate the highest potential to which an isolated conducting sphere of 60 cm diameter can be raised given that break down strength of air is 3000 KVm^{-1}. (4 marks)

i) A solenoid of 1200 turns is wound uniformly in a single layer on a glass tube 2 m long and 0.2 m in diameter. Find the strength of the magnetic field at the center of the solenoid when a current of 2 A flows through it. (3 marks)

QUESTION TWO (20 MARKS)

a) Consider a RLC circuit where the inductor and resistor are in parallel with the capacitor.

i) Suppose L = 1H, R = 100Ω and C = 0.01μF, find the impedance when:

$$\omega = 1/\sqrt{LC}$$

(9 marks)

ii) Find the phase angle between the voltage $\vec{V}$ and $\vec{\imath}$ at resonance (6 marks)

iii) Find the phase angle at ω = 10^5 $rads^{-1}$ considering that $\vec{V}$ is the voltage between the RLC setup. (5 marks)

QUESTION THREE (20 MARKS)

a) Show that for a parallel plate capacitor with a dielectric medium between the plates, the Gauss law is given by:

$$\varepsilon_o \oint k\vec{E} \, . dA = q$$

Symbols have usual meaning. (13 marks)

b) A proton and an alpha particle were accelerated through the same potential difference and entered into a region of uniform magnetic field moving at right angles to $\vec{B}$. If the radius of the protons circular path is 10 cm, find the radius of the α-particle's path. (7 marks)

QUESTION FOUR (20 MARKS)

a) A coil **p** of diameter 5.1 cm has 300 turns per centimeter and carries a current of 2.0 A. At its center, a small coil **Q** of 100 turns/cm and a diameter of 2.0 cm was placed. The current in coil **p** was reduced to zero at a steady rate of 10 ms. Find the emf induced in coil **Q** When the current in **P** is changing. (6 marks)

b) Show that the power produced by an inductor a.c circuit is given by:

(9 marks)

$$P_L = -\frac{1}{2} V_{max} I_{max} \sin 2 \ cot$$

c) Three charges were placed at corners A,C and D of a square ABCD of side 2 cm, If the charges were +4/3 x 10^{-9} C, -4/3 x 10^{-9} C and 8/3 x 10^{-9} C respectively. Find the electric field at point B. Assume the medium is air. (5 marks)

QUESTION FIVE (20 MARKS)

a) Using vector and scalar potentials A and Φ respectively, show that Maxwell's equations reduce to two coupled equations. (10 marks)

b) Explain the characteristics of high pass and low pass filters for RC circuits.

(10 marks)

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