JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE WITH IT

2ND YEAR 1ST SEMESTER 2016/2017 ACADEMIC YEAR

MAIN CAMPUS

COURSE CODE: SPH 202

COURSE TITLE: ELECTRICITY AND MAGNETISM II

EXAM VENUE: **STREAM: (BED Sc.)**

DATE: 20/04/16 **EXAM SESSION: 9.00 – 11.00 AM**

TIME: 2 HOURS

Instructions:

1. **Answer question 1 (compulsory) and ANY other 2 questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

INSTRUCTIONS TO CANDIDATES

Answer all questions in section A and any **TWO** questions from section B.
Question **ONE** carries **30** marks while all the other questions carry **20** marks each.

You may use the following constants:
$\varepsilon_o = 8.85 \times 10^{-12}$ F/m; $\mu_o = 4\pi \times 10^{-7}$Tm/A; $c = 3.0 \times 10^8$ m/s; $Z_o = 377\Omega$, Electron charge, $e = 1.6 \times 10^{-19}$C;
Rest mass of an electron, $M_e = 9.1 \times 10^{-31}$kg, Rest mass of a proton $M_p = 1.672 \times 10^{-27}$kg ;
Resistivity of copper $\rho = 1.7 \times 10^{-8}$, $\mu_0 = 4\pi \times 10^{-7}\text{TmA}^{-1}$,

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SECTION A

a) Define pointing vector **1mk**

b) Define the term 'resonance frequency' **1mk**

c) State the Lorentz force law for a charged particle moving in a magnetic field only **1mk**

d) Distinguish between hard and soft magnetic materials **1mk**

e) Calculate the amplitude of the household 240V supply. **2mks**

f) Distinguish between Faradays Law and Ampere's Law **2mks**

g) State any three properties of electromagnetic waves **2mks**

h) State Lenz's law. **2mks**

i) An electron in the ground state of the hydrogen atom has an orbital angular momentum of 4.10×10^{-34} J·s. Find the orbital magnetic moment. **3mks**

j) A square loop of wire 75mm on a side lies with its plane perpendicular to a uniform magnetic field of 0.8 T.

i) Find the magnetic flux through the loop **2mks**

ii) If the coil is rotated through 90^0 in 0.015s in such a way that there is no flux through the loop at the end, find the average e.m.f induced during the rotation. **3mks**

k) Sunlight strikes earth with an average intensity of $1400 W/m^2$. Find the peak electric and magnetic fields. **4mks**

l) As shown in the figure 1, a metal rod makes contact with a partial circuit and completes the circuit. The circuit area is perpendicular to a magnetic field with B = 0.15T. If the resistance of the total circuit is 3Ω, how large a force is needed to move the rod as indicated with a constant speed of 2m/s? **6mks**

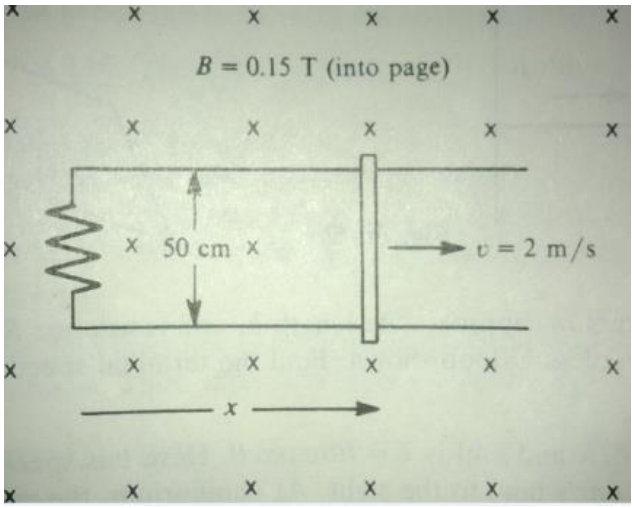

Figure 1

SECTION B

QUESTION TWO (20 MARKS)

a) An AC voltage source has an output of $\Delta v = (2.00 \times 10^2 \text{ V}) \sin 2\pi ft$. This source is connected to a 1.00×10^2 Ω resistor. Find the r.m.s voltage, r.m.s current in the resistor and the average power delivered to the circuit. **4mks**

b) A 240V, 700Hz a.c. generator is in series with a 15Ω resistor, a 10μF capacitor and a 0.01H inductor (of negligible internal resistance).

i) Sketch the phase diagram for the circuit **1mk**

ii) What is the Impedance, Z of the circuit **5mks**

iii) The potential difference across each component **5mks**
iv) The phase angle, ϕ **3mks**
v) The resonant frequency of the circuit **2mks**

QUESTION THREE (20 MARKS)

a) Define the term 'self-induction' **2mks**

b) Find the direction of the current in the resistor in the Figure 2
i) At the instant the switch is closed **1mk**
ii) After the switch has been closed for several minutes, **1mk**
iii) At the instant the switch is opened **1mk**

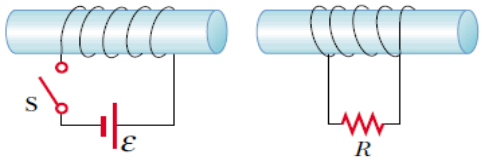

Figure 2

c) Calculate the inductance of an air-core solenoid containing 300 turns if the length of the solenoid is 25.0 cm and its cross-sectional area is 4.00 cm^2 **3mks**

d) Calculate the self-induced e.m.f in the solenoid of (b) above if the current it carries is decreasing at the rate of 50.0 A/s **4mks**

e) A conducting rod of length l moves with a constant velocity v, perpendicular to an infinitely long, straight wire carrying a current I, as shown in the Figure 3 below. What is the e.m.f generated between the ends of the rod? **3mks**

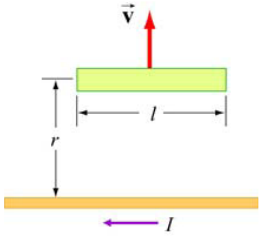

Figure 3

f) Find the inductance of a uniformly wound solenoid having N turns and length l. Assume that l is much longer than the radius of the windings and that the core of the solenoid is air. **5mks**

QUESTION FOUR (20 MARKS)

a) Show that $E = E_m \sin(kz - \omega t)$ is a wave moving in the positive z direction. Express k and w in terms of the wavelength, λ, and the frequency, f and find their relationship to the velocity. **5mks**

b) An alternating voltage is represented by the expression v = 35 sin (314.2t) volt. Determine
i. The maximum value **1mk**
ii. The frequency **2mks**
iii. The period of the waveform **2mks**
iv. The value 3.5ms after it passes through zero, going positive. **2mks**

c) Three alternating currents are specified below. Determine the frequency, and for each current, determine its phase angle, and amplitude. **8mks**

QUESTION FIVE (20 MARKS)

a) A circular loop of wire of radius a is placed in a uniform magnetic field, with the plane of the loop perpendicular to the direction of the field, as shown in Figure 4.

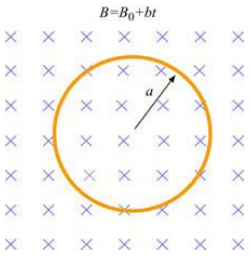

Figure 4

The magnetic field varies with time according to $B = B_o + bt$ where B_o and b are positive constants.

i. Calculate the magnetic flux through the loop at $t = 0$ **3mks**

ii. Calculate the induced e.m.f in the loop. **3mks**

iii. What is the induced current and its direction of flow if the overall resistance of the loop is R? **3mks**

iv. Find the power dissipated due to the resistance of the loop **2mks**

b) A current of 5.00mA flows into a 10.0pF capacitor with circular plates of radius 3.00cm. Find

i. The displacement current, **1mk**

ii. the rate of change of the electric flux, **4mks**

iii. the rate of change of electric field, **2mks**

iv. the magnetic field 3.00cm from the center of the plates **2mks**