UNIVERSITY OF GHANA

B.Sc. FIRST SEMESTER EXAMINATIONS: 2016/2017

PHYS 225: ELECTROMAGNETISM I (RE-SIT) (2 Credits)

ANSWER QUESTION 1 AND TWO OTHER QUESTIONS.

TIME ALLOWED: *TWO HOURS*

VALUES OF CONSTANTS
Permittivity of free space, $\epsilon_o = 8.85 \times 10^{-12}\ \mathrm{C^2\ N^{-1}\ m^{-2}}$
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}\ \mathrm{Wb\ A^{-1}\ m^{-1}}$
Coulomb's force constant, $k = 9.00 \times 10^{9}\ \mathrm{N\ m^2\ C^{-2}}$
Electronic Charge, $e = 1.60 \times 10^{-19}\ \mathrm{C}$

1.
(a) Distinguish between the following: paramagnetic materials, diamagnetic materials and ferromagnetic materials. (9 marks)

(b) An inductor and a capacitor are connected in parallel such that the circuit can sustain free oscillations of alternating current. Determine the resonance frequency if the inductance $L = 5$ mH and the capacitance $C = 3\ \mu$F. (5 marks)

(c) State the Faraday and Lenz laws and explain their significance. (5 marks)

(d) Calculate the electric flux passing through the surface of a sphere containing four point charges $-q, -2q, 5q,$ and $+q$. (6 marks)

(e) Using Ampere's law, calculate the magnetic field at a distance 4 cm from a long, thin wire carrying current of 4π amperes. (5 marks)

2.

(a) Calculate the electric force on a charge of 3×10^{-9} C at the point **p** in Figure 1. The value of $q = 2.0 \times 10^{-9}$ C. (10 marks)

(b) Calculate the electric potential at the point **p** in Figure 1. The value of $q = 2.0 \times 10^{-9}$ C. (10 marks)

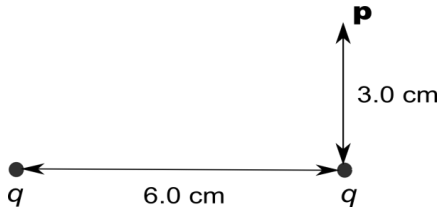

Figure 1

3.

(a) Use Ampere's law to find an expression for the magnetic field at a point distant *z* from a long, straight conductor carrying current *I*. (8 marks)

(b) Two very long parallel conductors, carrying equal current I = 0.1 A in opposite directions, are separated by a distance 4 cm. Calculate the total magnetic field at a point midway between the wires. (12 marks)

4.

(a) State the Faraday and Lenz laws and explain their significance. (6 marks)

(b) A rod of resistance *R* is placed on conducting rails as shown in Figure 2, with a constant magnetic field acting upwards.

(i) Derive an expression for the induced EMF if the rod is made to move along the rails.

(ii) If a current *I* is made to flow along the rails thereby completing a circuit with the rod, determine the velocity with which the rod will move.

(14 marks)

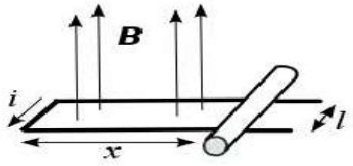

Figure 3

5.

(a) The electric field in between two large, parallel plates in vacuum is σ/ε_0, where the symbols have their usual meanings.

(i) Derive an expression for the capacitance of a parallel-plate capacitor in vacuum.

(8 marks)

(ii) Suppose that such a parallel plate capacitor is fully charged. Discuss, with equations, the effect of inserting a material with dielectric constant κ between the plates on (1) the voltage across the capacitor, (2) the capacitance, and (3) the energy storage capacity of the capacitor.

(12 marks)