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EMBU UNIVERSITY COLLEGE

(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF NAIROBI)

SECOND SEMESTER EXAMINATIONS 2013/2014

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SPH 202: ELECTRICITY AND MAGNETISM II

DATE: APRIL 9, 2014 **TIME: 11.00AM – 1.00PM**

INSTRUCTIONS:

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.

CONSTANTS

Electronic charge, e	=	1.602×10^{-19} C
Velocity of light, c	=	3.0×10^{8} m/s
1 eV	=	1.602×10^{-19} J
Mass of electron, m_e	=	9.11×10^{-31} kg
Mass of proton, m_p	=	1.67×10^{-27} kg
Permittivity of free space, ε_0	=	8.85×10^{-12} C^2/Nm^2

Acceleration due to gravity, g = 10 m/s^2

Density of water = 1 g/cm^3

QUESTION ONE (30 MARKS)

a) What is Hall effect. (2 marks)

i.) Consider a metal slab carrying a current. Show how to find the magnitude of hall voltage. (3 marks)

ii.) Why is Hall Effect higher in semiconductors as compared to metals? (2 marks)

iii.) In a certain conductor whose number of electrons per unit volume is 10^{25} per m^3, $B = 1T, t = 10^{-3}\ m, e = 1.6 \times 10^{-19}\ C$. Find the hall voltage for this semiconductor. (3 marks)

b) Differentiate between magnetic susceptibility and permeability. (2mks)
Differentiate between diamagnetism and paramagnetism. (4mks)

c) A capacitor C of $1\mu f$ is used in a radio circuit where the frequency is $1000Hz$ and the current flowing is $2mA$ (r.m.s.). Calculate the voltage across the capacitor, C. (3 marks)

d) Explain one application of Gauss law. (2 marks)

e) The maximum continuous magnetic fields that can be produced in a laboratory are approximately $20T$. If the breakdown strength of air is $1 \times 10^6 V/m$, calculate the maximum magnetic energy density that can be created in air. (3mks)

f) What is a lossless transmission line? (2 marks)

g) Give the characteristics of transmission line terminated in purely reactive impedance.

(2 marks)

h) Explain the relevance of Maxwell's equation. (2 marks)

QUESTION TWO (20 MARKS)

a) Explain the use of halls effect to measure magnetic induction in a semiconductor wafer.

(3 marks)

Calculate the strength of the electric and magnetic fields due to:

i.) The incident solar radiation at earth's surface of magnitude $500Wm^{-2}$ (10 marks)

ii.) Explain applications of gauss law. (7 marks)

QUESTION THREE (20 MARKS)

a) A 50Ω cable is joined to a piece of 100Ω cable and 100Ω cable is terminated by an impedance of 50Ω. What is the reflection coefficient for an incident signal travelling along the 50Ω cable at the frequency for which the length of the 100Ω cable is ¼ of a wavelength? (10 marks)

b) Consider a charge density $\rho(x,t)$ and current density $D(x,t)$ in a otherwise empty space. In coulombs gauge $\nabla.A = 0$, write down the wave equation for the vector potential $A(t,x)$ and a closed form expression for scalar potential $\varphi(t,x)$. (10 marks)

QUESTION FOUR (20 MARKS)

a) A long solenoid of 1000 turns and cross-sectional area $2 \times 10^{-3} m^2$ carries a current of $2A$ and produces a flux density of $5 \times 10^{-3} T$ in the middle of the coil. Assuming this value of flux density at all sections of the solenoid, calculate the self-inductance, L. (5 marks)

b) A small coil x is now placed in the middle of the solenoid so that the flux links its turns normally. x has 10 turns and a mean area $4 \times 10^{-5} m^2$. Calculate the mutual inductance M between x and the solenoid. (5 marks)

c) Derive the energy conservation law of electromagnetic field (10 marks).

QUESTION FIVE (20 MARKS)

a) Starting from Maxwell's equations, show how they reduce to two wave equations by using scalar and vector potentials. (20 marks)

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