CHUKA UNIVERSITY

Knowledge is Wealth *(Sapientia divitia est)* Akili ni Mali

PHYS 342 ELECTRICITY AND MAGNETISM II Y2:S2 STREAMS: BSC COMPUTER

TIME:2 HOURS

INSTRUCTIONS

You should have the following for this examination:

- *Answer booklet*
- *Scientific calculator*

Where necessary use the following constants

- Velocity of light in vacuum =3 x 10^8 m/s

This paper contains FIVE questions
*Attempt question **ONE** and any other **TWO** questions.*

*Question **ONE** carries **30** marks, all other questions carry **20**marks*

QUESTION ONE (30 MARKS)

a) Write down Maxwell's equations of electromagnetism in their general differential form in a vacuum (4 marks)

b) Considering a series RLC circuit for which R= 400Ω, L=40mH,V=24v and $2\pi f=9000S^1$ .Determine the value of the capacitance for which the rms current is a maximum. (4 marks)

c) Explain any three sources of power loss from a transformer (3 marks)

d) Staring from Gauss's law in a vacuum derive an expression for the Gauss's law in dielectric (4 marks)

e) State TWO properties of electromagnetic waves apart from its velocity (2 marks)

f) A purely inductive Ac circuit has L=45mH and the rms voltage is 240V. Find the Inductive reactance and the rms current in the circuit if the frequency is 60Hz (4 marks)

g) Give ONE theoretical TWO practical applications of Gauss's law (3 marks)

h) Define the following terms as applied to transmission lines (i) Propagation velocity (ii) .Characteristic impedance (2 marks)

i) A series RCL ac circuit has R=400Ω, L=1.6 H and C= 4.5 μF, f=80Hz and V=220V. Calculate the average power delivered to the circuit (4marks)

QUESTION TWO (20 MARKS)

a) Show that the electric field due to infinite line charges with line charge density λ is given by $E = \frac{\lambda}{2\pi\varepsilon_o r}$ where r is the radius of the Gaussian surface? (4 marks)

b) Determine the capacitance and the maximum voltage that can be applied to a Teflon-filled parallel plate capacitor having a plate area of 0.025 m^2 ,charge of 8μ C and insulation thickness of 0.05mm (4 marks)

c) Show that electric charge (q) distribution throughout the volume of a sphere of radius R and total charge (Q) is given by $q=Qr^3/R^3$.Where r is the radius of the Gaussian surface. (4 marks)

d) An electric flux of magnitude 800$N.m^2/C$ passes through a flat horizontal surface that has an area of 0.64m^2.The flux is due to a uniform electric field. What is the magnitude of the field if it points? (i). vertically up? (ii). 60^o above the horizontal (4 marks)

e) Derive the expression $\frac{1}{2Kln\left(\frac{b}{a}\right)}$, for the capacitance C of a cylindrical capacitor of length l, having its inner and outer radii as a and b respectively (4 marks)

QUESTION THREE (20 MARKS)

a) Calculate the inductance of a solenoid containing 600turns if the length of the solenoid is 30 cm

and its cross sectional area is 4cm. (ii) Calculate the self induced emf in the solenoid described
in (i) above if the current through is decreasing at the rate of 30A/s (4 marks)

b) An ac voltage source has an output given by V= (400)sin 2πft. This source is connected to a 60 Ω. Find the r.m.s current through the resistor . (4 marks)

c) An 18μF is connected to the terminal of an ac generator whose rms voltage is 120V and whose frequency is 60Hz. Find the capacitive reactance and the rms current in the circuit. (4 marks)

d) The input to the primary coil of a transformer is 240V while the current in the secondary coil is 0.4A. When 80W of power are delivered to the circuit attached to the secondary coil, what is the voltage across this coil? If the primary coil has 60 turns, how many does the secondary coil have? (4 marks)

e) Define a transmission line and give three types of transmission lines. (4 marks)

QUESTION FOUR (20 MARKS)

a) Calculate the capacitance of capacitor of two co-axial cylinders of inner radius 5cm and outer radius of 15 cm. The spaces between the cylinders are filled with a substance of dielectric constant 4.25 and the length of the cylinders 40 cm. (4 marks)

b) A cable of wire 6×10^{-3} m in diameter and insulated with Neoprene rubber(relative permittivity 6.7) is placed in water. Calculate the capacitance of 10 km length of the cable. Given,$\varepsilon_o=8.85\times10^{-12}$ $C^2/N.M^2$, $\log_{10} 3=0.4771$ $a=3\times10^{-3}$ m and $b=9\times10^{-3}$ m (4 marks)

c) The input to the primary coil of a transformer is 240V while the current in the secondary coil is 0.6A. 84W of power are delivered to the circuit attached to the secondary coil, what is the voltage across this coil? If the primary coil has 40 turns, how many does the secondary coil have? (4 marks)

d) An ac source has internal resistance of 7200Ω, load resistance of 9Ω for maximum power. Calculate the turn's ratio of the transformer (ii) If the output voltage of the transformer is 200 r.m.s, calculate V_2 across the load resistor and r.m.s current (4 marks)

e) From permeability and permittivity of free space, calculate the velocity of an electromagnetic wave (4 marks)

QUESTION FIVE (20 MARKS)

a) Using the relevant vector equalities derive a wave equation that represents the electromagnetic waves. Show that the speed of the electromagnetic waves $=3.0\times10^{8}$m/s (4 marks)

b) An ac voltage used to run the devices in the Physics laboratory is given by; $V=(240)\sin 2\pi f$. The resistance is 5Ω. Determine the i). Peak voltage ii). $I_{r.m.s}$ (4 marks)

c) When astronauts landed on the Moon, radio signals helped them communicate with people on Earth. It took 1.3 s for a signal to travel from the Moon to Earth. Calculate the best estimate of the distance between Earth and the Moon? (4 marks)

d) Show that in a plane travelling electromagnetic waves the average intensity that is the average rate of energy transport per unit area is given by $S_{av}=cB^{2}_{m}/2\mu_{o}$ (4 marks)

e) Describe the electromagnetic spectrum in terms of frequency and wavelength and identify the location of radio waves, microwaves, infrared radiation, visible light, ultraviolet rays, x-rays, and gamma rays on the spectrum. (4 marks)