

LAIKIPIA



UNIVERSITY

## UNIVERSITY EXAMINATIONS

SECOND SEMESTER 2023/2024 ACADEMIC YEAR

FOURTH YEAR EXAMINATION FOR THE DEGREE  
BACHELOR OF EDUCATION (SCIENCE) AND  
BACHELOR OF SCIENCE

**PHYS 423: ELECTROMAGNETIC THEORY**

***STREAM: R***

***TIME: 2 HRS***

***DAY: FRIDAY [8.30A.M – 10.30A.M]***

***DATE: 12/04/2024***

**THIS QUESTION PAPER CONSISTS OF THREE (3) PAGES**

**PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.**



**INSTRUCTIONS:**

- Read the question paper carefully.
- Answer Question **ONE** and any other **TWO** Questions.

**SECTION A: (Compulsory) TOTAL MARKS FOR THIS SECTION IS (40 MARKS)****QUESTION ONE (40 MARKS)**

- a) Explain two applications of electromagnetic forces **(4 Marks)**
- b) Explain the detection of electromagnetic waves. **(3 Marks)**
- c) State Maxwell's equations in differential form? **(2 Marks)**
- d) Give three operators used to study the properties of electromagnetic fields. **(3 Marks)**
- e) State Gauss's law in integral form. Define all the terms used. **(2 Marks)**
- f) If  $U = \frac{1}{r}$ , show that  $\nabla^2 U = 0$ . **(3 Marks)**
- g) Distinguish between Poisson's and Laplace equations. **(2 Marks)**
- h) Write down Maxwell's equations in the absence of free charges in isotropic media. **(4 Marks)**
- i) Define refractive index of a dielectric medium. **(2 Marks)**
- j) Explain the difference between dielectric and metal wave guides structures. **(2 Marks)**
- k) Explain three features of electromagnetic waves. **(6 Marks)**
- l) Discuss three properties of a one dimensional Laplace equation. **(6 Marks)**

**QUESTION TWO (15 MARKS)**

- a) Explain two theoretical implication of electromagnetic theory. **(4 Marks)**
- b) Explain physical interpretations of the Maxwell's equations. **(5 Marks)**
- c) Describe the properties of electromagnetic waves. **(6 Marks)**

**QUESTION THREE (15 MARKS)**

- a) Derive the differential form of Gauss's law. **(6 Marks)**
- b) Show that both the electric field, E and the magnetic field B execute wave motion. Hence or otherwise, show that light is an electromagnetic wave. **(9 Marks)**



**QUESTION FOUR (15 MARKS)**

- a) Derive Laplace equation. **(8 Marks)**
- b) Consider a one dimensional world with two point conductors located at  $x= 0$  and at  $x = 10$  m. the conductor at  $x = 0$  m is grounded ( $V= 0$  V) and the conductor at  $x = 10$  m is kept at a constant potential of 200 V. Determine V. **(2 Marks)**
- c) Describe the Drude – Lorentz harmonic oscillator model. **(5 Marks)**

**QUESTION FIVE (15 MARKS)**

- a) Explain three factors considered when choosing a structure for a wave guide. **(6 Marks)**
- b) Explain the difference between the two basic types of waveguides. **(4 Marks)**
- c) Derive the equation of continuity and give its physical meaning. **(5 Marks)**

