

OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2020 /2021 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER MAIN EXAM

FOR THE DEGREE OF BACHELOR OF EDUCATION
SCIENCE

COURSE CODE: PHY 434

COURSE TITLE: ELECTROMAGNETIC THEORY

DATE: 21/07/2021

TIME: 0800 – 1100 HRS

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 4 PRINTED PAGES

PLEASE TURN OVER

REGULAR –MAIN**PHY 434 ELECTROMAGNETIC THEORY****STREAM: BED (Science)****DURATION: 3 HOURS****INSTRUCTIONS TO CANDIDATES**

- i. Answer **TWO** questions in section A and any other **THREE** questions in section B.

Question One (14 Marks)

- (a) Write down the four Maxwell's equations (4 Marks)
 (b) Derive the Poisson's and Laplace equations (4 Marks)
 (c) A monochromatic source of 60 W is radiating equally in all directions in a vacuum as a function of the distance. Calculate the amplitude at the distance 2m from source. (6 Marks)

Question Two (14 Marks)

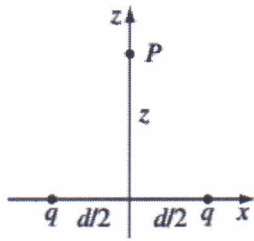
- (a) Show that $\nabla \cdot \mathbf{J} + \frac{\partial \rho}{\partial t} = 0$ is contained in Maxwell's equation (5 Marks)
 (b) Write down the expression for calculating electric and magnetic force (2 Marks)
 (c) What's the force on a 0.1 C charge moving at velocity $\mathbf{v} = (10\hat{j} - 20\hat{k})\text{ms}^{-1}$ in a magnetic field $\hat{\mathbf{B}} = (-3\hat{i} + 4\hat{k}) \times 10^{-4}\text{T}$ (5 Marks)
 (d) Define a magnetic vector potential (2 Marks)

Question Three (14 Marks)

- (a) List the four properties of electromagnetic waves (4 Marks)
 (b) With aid of a diagram describe the spectrum of electromagnetic radiation with respect to order of frequency and wavelength (4 Marks)
 (c) Calculate the magnitude and direction of the magnetic field when $\vec{E} = 750 \text{ N/C}$ and is in the y direction (3 Marks)
 (d) Sketch the electromagnetic wave showing the \vec{E} and \vec{B} components (3 Marks)

Question Four (14 Marks)

- (a) State Coulomb's Law of electrostatic in mathematical form (1 marks)
 (b) Determine the force electric field If we have several point charges q_1, q_2, \dots, q_n , at distances r_1, r_2, \dots, r_n from Q. (4 Marks)
 (c) Find the electric field a distance z above the midpoint between two equal charges (q), a distance d apart Figure below. (4 Marks)



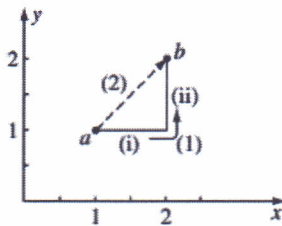
(d) State and prove the First uniqueness theorem of boundary condition (5 Marks)

Question Five (14 Marks)

(a) Find the gradient of $r = \sqrt{x^2 + y^2 + z^2}$ (the magnitude of the position vector) (3 Marks)

(b) Find the energy of a uniformly charged spherical shell of total charge q and radius R (4 Marks)

(d) Calculate the line integral of the function $v = y^2\hat{x} + 2x(y + 1)\hat{y}$ from the point $a = (1,1,0)$ to the point $b = (2,2,0)$, along the path (1) and (2) shown in figure below



What is $\oint \mathbf{V} \cdot d\mathbf{l}$ for the loop that goes from a to b along (1) and return to a along (2)? (7 Marks)

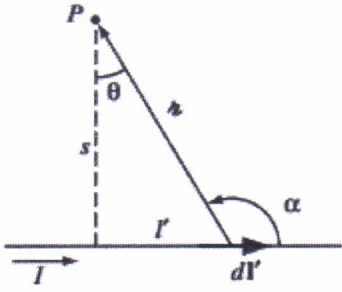
Question Six (14 Marks)

(a) What is the significance of Clausius-Mossotti relation? (1 Mark)

(b) With aid of a diagram describe the hysteresis loop formation (3 Marks)

(c) (i) Write a mathematical statement for Biot-Savart law (1 Mark)

(ii) Estimate the magnetic field a distance S from a long wire carrying a steady current I . (5 Marks)



(d) Derive the equation for estimating the retarded potentials (4 Marks)

Question Seven (14 Marks)

- (a) Define the term Poynting vector (2 Mark)
- (b) Write and proof the mathematical statement of Poynting theorem (10 Marks)
- (c) Explain the reflection coefficient and transmission coefficients (2 Marks)
