



University of Fort Hare
Together in Excellence

PHY 222

ADVANCED ELECTRODYNAMICS

SUPPLEMENTARY EXAMINATIONS

DECEMBER 2025

YEAR: 2025



TIME : 3 hours

SUBJECT : Advanced Electrodynamics

MARKS : 100

This paper consists of FOUR pages including the cover page

INTERNAL EXAMINERS

PROF. P. MUKUMBA

MR. P. KWINANA

INSTRUCTIONS

ANSWER **ALL** QUESTIONS

QUESTION 1 [20 Marks]

- 1.1. Show that the magnetic force on a current carrying conductor is given by $dF = IdLB$,
where symbols have their usual meanings. [10]
- 1.2. Show that vector field $F = (2x \sin y + \cos 3y)i + (\sin x - 2z)j + (2x \cos x - 2z \sin y)k$
is solenoidal. [5]
- 1.3. Find the Laplacian of the scalar field $\phi = 5xy^3z^3$ [5]
-

QUESTION 2 [20 Marks]

- 2.1. State:
- 2.1.1. Gauss divergence law
- 2.1.2. Stokes theorem
- 2.1.3. Law of Electrostatics of Coulomb. [6]
- 2.2. Evaluate $\int F \cdot n \, dS$, where $F = (2x^2 + xz)\vec{i} + 2y^2\vec{j} - \frac{z}{2}\vec{k}$ and S is the surface of the cube
bounded by $x = 0, x = 1, y = 0, y = 1, z = 0$ and $z = 1$ [10]
- 2.3. Determine the value of E in a material for which the electric susceptibility is 2.5. [4]
 $P = 2.3 \times 10^{-7} \text{ aC/m}^2$.
-

QUESTION 3 [20 Marks]

- 3.1. Derive Gauss Law from integral to differential form, and show that it reduces to $\nabla \cdot D = \rho$ [10]
- 3.2 Write down Ampere - Maxwell law and show that it reduces to the differential form
 $\nabla \times \vec{H} = \vec{J}_c + \frac{\epsilon \partial E}{\partial t}$ [10]
-

QUESTION 4 [20 Marks]

4.1. State Maxwell's equations in differential form and derive them to integral form. [10]

4.2. Use Maxwell equations to deduce the continuity equation

$$\nabla \cdot \mathbf{J} + \frac{\partial \rho}{\partial t} = 0 \quad [10]$$

QUESTION 5 [20 Marks]

5.1. Show that the wave equation for a Magnetic field is given by

$$\nabla^2 \mathbf{E} = \mu\sigma \frac{\partial \mathbf{E}}{\partial t} + \mu\epsilon \frac{\partial^2 \mathbf{E}}{\partial t^2} \quad [10]$$

5.2. In the free space $\mathbf{D} = D_0 \sin [\omega t + \beta z] \mathbf{e}_x$ and using Maxwell's equations find the magnetic induction ($\mathbf{B}$). [10]



University of Fort Hare
Together in Excellence