



NATIONAL OPEN UNIVERSITY OF NIGERIA  
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA  
FACULTY OF SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCE

2021\_ 1 EXAMINATIONS

**COURSE CODE:** PHY 404

**COURSE TITLE:** ELECTRODYNAMICS III

**CREDIT UNIT:** 3

**TIME ALLOWED:** (2½ HRS)

**INSTRUCTION:** *Answer question 1 and any other four questions*

**QUESTION 1**

- (a) What is the mathematical expression for a magnetic field oscillating on the y-axis?  
(1½ Marks)
- (b) Write down the differential form of Faraday's law and explain the symbols.(3½ Marks)
- (c) Using the differential form write down the Maxwell's equations of electromagnetic (E-M) fields in free space and explain the symbols. (8 Marks)
- (d)State Mathematically, the four electric and magnetic boundary conditions. (4 Marks)
- (e)State the boundary conditions for reflection and refraction of waves at normal incidence.  
(3 Marks)
- (f)Write down the energy density of the magnetic field and explain the symbols.(2 Marks)

**QUESTION 2**

- (a)Write down the representation of circular polarization of plane wave. (6 marks)
- (b) How many components does circular polarization of plane wave have? (2 Marks)
- (c) What results if the amplitude components of circular polarization of plane wave are unequal?  
(2marks)
- (d) What does it mean when we say that the electric and magnetic fields are orthogonal?  
(2 Marks)

**QUESTION 3**

- (a) What are the Maxwell's equations outside a region of charging charge and current distribution.(4marks)
- (b) Consequent to the resulting equation in (a), obtain the wave equation for E-field and show that  $\epsilon_0\mu_0 = 1/c^2$  (8 marks)

**QUESTION 4**

- (a) Define (i) skin depth (2 marks) (ii) skin effect.(2 Marks)
- (b) Calculate the skin depth in copper for a wave of frequency (i) 50Hz (ii) 1 MHz given that  $\mu_0 = 4\pi \times 10^{-7} Hm^{-1}$ ,  $\sigma = 5.9 \times 10^7 S/m$  and  $\mu_r = 1$  (8 marks)

**QUESTION 5**

- (a) Write down the energy density of the electromagnetic wave.(2 Marks)
- (b) Given that the refractive index, n, of water for waves of frequency 100MHz is 9.  
Calculate: (i) the reflection (5 marks) and  
(ii) transmission coefficients of the medium. (5 marks)

**QUESTION 6**

- (a) What is the reflection coefficient and transmission coefficient in terms of the poynting vector? (4marks)
- (b) With the reflection and transmission coefficients in terms of the refractive index show that the sum of the two is equal to 1. (8 marks)