



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

DEPARTMENT OF PURE AND APPLIED SCIENCE

2020_2 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*

CONSTANTS

Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$

Permeability of free space, $\mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$

Velocity of light in vacuum, $c = 3.00 \times 10^8$

QUESTION 1

- a. Give three properties of electromagnetic waves and three applications of Maxwell's equations. **(6marks)**
- b. Write the Maxwell's equations in Point form in free space set. **(5 marks)**
- c. What is Circular Polarization? Obtain an expression for the circular polarization of an Electric field in a plane wave. **(5 marks)**
- d. Calculate the Skin depth in copper of a wave frequency:(i) 70Hz (ii) 5GHz.
Given $\mu_r = 1$ and $\sigma = 5.9 \times 10^7$ **(6 marks)**

QUESTION 2

- a. Explain the following :(i) Resonance (ii) Resonant cavity **(4 marks)**
- b. Briefly discuss how radiation is generated by moving charges. **(3 marks)**
- c. Write the expressions for the Electric field components of a Rectangular Cavity Resonator **(5 marks)**

QUESTION 3

- a. Explain the following terms:
(i) Dipole (ii) Hertzian dipole (iii). Dipole moment **(3 marks)**

- b. Briefly explain how radiation emanates from an Oscillating dipole. (3 marks)
- c. Write the expressions for the magnetic field component of an oscillating dipole. (6 marks)

QUESTION 4

- a. What is transmission line? Mention three different types of transmission lines. (3 marks)
- b. Show that for a parallel wire transmission line, the characteristic impedance z_o is given as:

$$Z = \sqrt{\frac{L}{C}} = \left(\frac{\mu_0\mu_r}{\epsilon_0\epsilon_r}\right)^{\frac{1}{2}} \ln \frac{2y}{x} \quad (9 \text{ marks})$$

QUESTION 5

(a) Define the following terms:

- i. Transverse Electric field (TE) modes (1 mark)
- ii. Transverse Magnetic field (TM) modes (1 mark)
- iii. Transverse Electromagnetic wave (TEM) modes (1 mark)

(b). What are wave guides used for? (3 marks)

(c). Outline the Electric field components in TE waves for a pair of parallel conducting planes (6 marks)

QUESTION 6

(a) Explain the following terms:

- i. Poynting Vector (1 mark)
- ii. Reflection Coefficient (1 mark)
- iii. Transmission Coefficient (1 mark)

(b). Given that the refractive index n , of water for waves of frequency 200GHz is 7. Calculate the reflection and transmission coefficients of the medium. (6 marks)

(c). Write the expression for the wave equations of voltage and current (3 marks)