ELIZADE UNIVERSITY ILARA-MOKIN ONDO STATE

FACULTY: Basic and Applied Sciences
DEPARTMENT: Physical and Chemical Sciences
FIRST SEMESTER EXAMINATIONS
2016/2017 ACADEMIC SESSION

**COURSE CODE: PHY 403**
**COURSE TITLE: ELECTROMAGNETIC THEORY 11**
**DURATION: 2 HOURS**
**TOTAL MARKS: 60**
**Matriculation Number:** _____

**INSTRUCTIONS:**

1. Write your matriculation number in the space provided above and also on the cover page of the exam booklet.
2. This question paper consists of 2 pages.
3. Answer all questions in the exam booklet provided.
4. More marks are awarded for problem solving method used to solving problems than for the final numerical answer.
5. Box your final answers.
6. Attempt any (4) of the six (6) questions
7. Each question attracts 15 marks.

**CONSTANTS**

Permittivity of free space, $\epsilon_o = 8.85 \times 10^{-12}\ Fm^{-1}$
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$
Velocity Of light in vacuum, $c = 3.00 \times 10^{8}$
Intrinsic impedance, $\eta = 120\pi\ \Omega$

1. (a) (i) Define the direction of propagation of an Electromagnetic wave? Give reason for your definition.

(ii) Write the Maxwell equations in (a) Point form and (b) integral form in free space set.

(b) Show that for an Electromagnetic wave travelling in in a vacuum
(i) There is a definite ratio between the magnitudes of E and B.

(ii) The speed, $V = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$

1. (a) (i) Describe an Electric charge that is at rest and in motion in the context of Electromagnetic radiation?

(ii) What is Polarization and Magnetization effect in macroscopic media and state their respective effect on Electric and Magnetic field.

(b) (i) Starting from Maxwell equations in a vacuum, show that

$$\nabla^2 B - \frac{1}{C^2}\frac{\partial^2 B}{\partial t^2} = 0 \qquad \text{(Wave equation)}$$

(ii) In free space, $E_{(z,t)} = 10^5 \sin(wt - \beta z)_{ay} V/m$ , Obtain $H_{(z,t)}$

2. (a) (i) State Snell's Laws as applicable to an electromagnetic wave.

(ii) Write short note on (1) Parallel Polarization (2) Perpendicular Polarization.

(b) (i) A perpendicularly polarized wave propagates from region 1 ($\varepsilon_{r1} = 9.5, \mu_{r1} = 1, \sigma_1 = 0$) to region 2 in free space ,with an angle of incidence $30^0$. Given that $E_0^i = 0.2$ V/m. Find $E_0^r, E_0^t, H_0^i, H_0^r, H_0^t$.

4. (a) (i) Explain briefly what is meant by Poynting vector.

(ii) Starting from the Maxwell's equations obtain the expression for the Poynting vector of a region with conductivity $\sigma$.

(b) Show that the intensity $I^1$ of an electromagnetic wave which does not diminish as it propagates through space is equal to the average energy density multiplied by the speed of light.

5. (a) (i) What is the Radiation resistance.

(ii) Show that $R_{rad.} = 790\left(\frac{dl}{\lambda}\right)^2 \Omega$

(b) (i) Find the current required to radiate a power of 10 Kw at 1GHz from a 0.02 m Hertzian dipole . (ii) Find the magnitude of E and H at (100 m , $90^0$,$0^0$ )

6. (a) (i) Define the gain of an antenna

(ii) Explain what is meant by Fresnel region.

(b) (i) Write the expression for the wavelength in a lossy material

(ii) ) To estimate the hazard from a dipole antenna that radiates 2000 Watts of 4000 MHz microwaves from a circular parabolic reflector of 0.65m in diameter, calculate

(i) The mean power density at the aperture

(ii) The maximum power density in near field (nf)

(iii) The distance to the far field (ff)

(iv)The Power density at distance of 320m

(v) The distance at which the power density will be 100mw/cm$^2$ .