NATIONAL OPEN UNIVERSITY OF NIGERIA
University Village, Plot 91, Cadastral Zone, Nnamdi Azikiwe Expressway, Jabi, Abuja.

FACULTY OF SCIENCES
November, 2018 Examinations

Course Code:	**MTH417**
Course Title:	**Electromagnetic Theory**
Credit Unit:	**3**
Time Allowed:	**3 HOURS**
Total:	**70 Marks**
Instruction:	**ATTEMPT NUMBER ONE (1) AND ANY OTHER FOUR (4) QUESTIONS**

1 (a) State the relation expressed by the first Maxwell's equations known as Gauss's law **(4 marks)**

(b) A cube of side L contains a flat plate with variable surface charge density at $\rho = -2xy$. If the plate extends from x = 0 to x= L and from y = 0 to y = L, determine the total electric flux through the walls of the cube. **(6 marks)**

(c) Show that the Lorentz force per unit volume $\rho E + j\ X\ B = \frac{\partial}{\partial t}(D\ X\ B)$ where D is the electric displacement and other quantities take the standard nomenclature. **(6 marks)**

(d) Find the charge density at (x,y) = (3,3) if the electric field in the region (1<x<4 and $2 \leq y \leq 5$)Is given by $\vec{E} = (2x^3 i + 3y^2 j)\frac{V}{m}$? **(6 marks)**

2 (a)Starting from the Faraday's law $\boldsymbol{E} = -\frac{\partial \psi}{\partial t}$ that relates the vector magnetic potential ψ with electric field ***E***, show that $\nabla\ \mathrm{X}\ \boldsymbol{E} = \frac{\partial \boldsymbol{B}}{\partial t}$, where ***B*** is the magnetic field and t is the time. **(6 marks)**

(b) Find the rate of change with time of the magnetic field at a location in which the induced electric field is given by $\boldsymbol{E}(x,y,z) = E_0\left(\left(\frac{z}{z_0}\right)^2 \boldsymbol{i} + \left(\frac{x}{x_0}\right)^2 \boldsymbol{j} + \left(\frac{y}{y_0}\right)^2 \boldsymbol{k}\right)$ **(6 marks)**

(3) (a) Starting from Maxwell equations$\nabla \cdot E = \frac{\partial B}{\partial t}$,derive the three wave equation for each components of the electric field **(6 marks)**

(b) Hence justify the conclusion that light is one form of electromagnetic wave Propagation **(6 marks)**

(4) (a) state the maxwell's equations for electric and magnetic free fields in a charge free vacuum region **(6 marks)**

(b) using the Maxwell equation below, derive the three components of the magnetic field $\nabla \cdot B = \mu_0 \vec{j}(x,t) + \mu_0\ \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$, where, μ_0 is the magnetic permeability, $\vec{j}$ is the conductive current, ε_0 is the dielectric permittivity and $\vec{E}$is the electric field.

(6 marks)

(5) (a) what do you understand by Maxwell's macroscopic equations (6 marks)

(b) Discuss the plane electromagnetic waves in non-conducting media from solution of wave equation of electric field derive from Maxwell's equation. **(6 marks)**

(6) (a) find the charge density at x= 2m and x =5m if the electric field in the medium is given by $\vec{E} = ax^2 i \frac{V}{m}$ for x = 0 to 3m and $\vec{E} = bi \frac{V}{m}$ for x > 3m **(10 marks)**

(b) Define refractive index of the medium? **(2 marks)**