NATIONAL OPEN UNIVERSITY OF NIGERIA

University Village, Plot 91, Cadastral Zone, Nnamdi Azikwe Express Way, Jabi-Abuja

FACULTY OF SCIENCES

Department of Mathematics

November 2021_2 Examinations

Course Code: MTH308

Course Title: Introduction to Mathematical Modeling

Credit Unit: 3

Time Allowed: 3 Hours

Total: 70 Marks

Instruction: Answer Question One (1) and Any Other 4 Questions

1. (a) What do you understand by the term "Mathematical modeling"? **(5 marks)**

   (b) Differentiate between the following:

   i. Static and dynamic model **(5 marks)**

   ii. Discrete and continuous model **(5 marks)**

   (c) State and discuss two limitations of mathematical modeling. **(7 marks)**

2. (a) Why is it necessary to formulate a mathematical model? **(5 marks)**

   (b) Differentiate between linear and non-linear model. **(7 marks)**

3. (a) Show that the solution of $\frac{dQ}{dt} = -kQ \; is \; Q(t) = Q_0 e^{-kt}$, where $Q(0) = Q_0$ **(5 marks)**

   (b) State and discuss the steps you will follow when developing a model. **(7 marks)**

4. (a) A raindrop beginning at rest falls from a cloud 705.6m above the ground. How long does it take to reach the ground? **(7 marks)**

(b) Define the following:

i. Supply of a commodity **(2 marks)**

ii. Production lag **(2 marks)**

iii. The demand for a commodity **(1 marks)**

5. (a) Suppose the demand functions D_i for period t are given as follows:

$$D_i = aPt + b$$

$$St = APt + B$$

Where a, b, A, B are all constants.

Derive the Equilibrium price. **(6 marks)**

(b) Water enters a cylindrical tank at a constant rate, a hole at the bottom of the tank allows water to escape at a rate proportional to $V^{2/3}$ where $V(t)$ is the volume of water at any time t. Write out the differential equation describing the process and compute equilibrium volume. **(6 marks)**

6. (a) Define the following:

i. Dynamic model **(2.5 marks)**

ii. Theoretical model **(2.5 marks)**

iii. Empirical model **(2.5 marks)**

(b) Using Elliptic Integral, find T_0 if $\theta_0 = 20^0$, given that $l = 20cm$ and $g = 980cm/\sec^2$.

(4.5marks)