CHUKA **UNIVERSITY**

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF MASTERS OF SCIENCE IN APPLIED COMPUTER SCIENCE

COSC 811: MODELING AND SIMULATION

STREAMS: **TIME:3 HOURS**

DAY/DATE: WEDNESDAY 19/04/2023 **2.30 P.M. –5.30 P.M.**

INSTRUCTIONS

Answer Any Three Questions

QUESTION ONE

a. Differentiate the following giving examples

 i. An iconic model and a symbolic model: (2 marks)

 ii. Deterministic Models and Stochastic models. (2 marks)

b. Explain the two main approaches of generating random numbers and state at least four criteria for an acceptable method of generating random numbers (6 marks)

c. Define the term reliability and state the mathematical description. (3 marks)

d. If the time to failure for a random variable has a density function f(t) given as

$f(t)=\sqrt{\frac{2}{\pi}}\left(2e^{-3t}+3e^{-2t}\right)\sin\lambda t$, obtain the reliability function R(t) and find the probability that the system will be successfully operating without failure from time ≥ 0 (7 marks)

QUESTION TWO

a. Describe the four main classes of a system and state five main features of a system(9 marks)

b. State three advantages of the Congruential method of generating random numbers and explain the recursive relationship it uses to generate the random numbers. (7 marks)

c. Use the inverse transformation method to generate random variates with probability density function (4 marks)

QUESTION THREE

a. Describe the four main advantages of modeling/ simulation over direct experimentation. (8 marks)

b. Highlight the at least four Requirements of the Conceptual Model (4 marks)

c. Given that a computing system has three states after each run. The states are perfect, degraded, and failed states denoted by state 1, 2 and 3. The state of the current run will affect the state of the next run and the matrix of one step transition probability is given as

$$P = \begin{bmatrix} 0.7 & 0.2 & 0.1 \\ 0.3 & 0.5 & 0.2 \\ 0.1 & 0.3 & 0.6 \end{bmatrix}$$

i. Obtain the two-step transition matrix according to the Chapman-Kolmogorov model equation. (3 marks)

ii. If the system initially stays at a perfect state, and the probability that the system still stays at that state after 2 runs is given as

$$p_{11}(0,2) = 0.56.$$

Obtain the four-step transition matrix and determine the probability that the system does not stay at the failed state after 4 runs (5 marks)

QUESTION FOUR

a. *Explain the frequency test for testing* randomness of *pseudo-random number hence t*est the randomness of the bit string e = 1011010101 by the frequency test given that n = 10, and the level of significance α = 0.01 (7 marks)

b. Given the probability density function f(x) as

$$f(x) = \begin{cases} 5x & 0 \le x \le 4 \\ x-2 & 4 < x \le 10 \end{cases}$$

Apply the inverse transformation method and devise specific formulae that yield the value of variate x given a random number r. by normalizing f(x) . (7 marks)

c. Highlight at least five methods of model simplification (6 marks)

QUESTION FIVE

a. Define the probability density function of the following methods of generating stochastic variates giving the expressions for the cumulative density function, The expectation and variance for each case.

i. The uniform distribution (4 marks)

ii. The Exponential distribution (4 marks)

b. Test the randomness of the bit string e = 0011011101 by the Serial test given that n = 10 and k = 3. Level of significance α = 0.01 (10 marks)

c. Differentiate between Exogenous variable and endogenous variable. (2 marks)
