CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST YEAR SPECIAL EXAMINATIONS FOR THE AWARD OF MASTERS OF SCIENCE IN APPLIED COMPUTER SCIENCE. 2023.

COSC 811: MODELING AND SIMULATION **TIME: 3 HOURS**

Answer Any Three Questions

QUESTION ONE

a. Differentiate the following giving examples
   i. An iconic model and a symbolic model: 2mks
   ii. Deterministic Models and Stochastic models. 2mks

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

c. Define the term reliability and state the mathematical description. 3mks

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 7mks

QUESTION TWO

a. Describe the four main classes of a system and state five main features of a system 9mks

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

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

QUESTION THREE

a. Describe the four main advantages of modeling/ simulation over direct experimentation. 8mks

b. Highlight the at least four Requirements of the Conceptual Model 4mks

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. 3mks

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 5mks

QUESTION FOUR

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

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

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

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) . 7mks

c. Highlight at least five methods of model simplification 6mks

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 4mks

ii. The Exponential distribution 4mks

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 10mks

c. Differentiate between Exogenous variable and endogenous variable. 2mks