THE CO-OPERATIVE UNIVERSITY OF KENYA

END OF SEMESTER EXAMINATION DECEMBER -2022

EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE, STATISTICS AND INFORMATION TECHNOLOGY, INFORMATION TECHNOLOGY, BUSINESS AND INFORMATION TECHNOLOGY
(YR IV SEM I)

UNIT CODE: BCSC 4126

UNIT TITLE: SIMULATION AND MODELLING

DATE: FRIDAY, 23TH DECEMBER, 2022

TIME: 9:00 AM – 11:00 AM

INSTRUCTIONS:

- **Answer question ONE (compulsory) and any other TWO questions**

QUESTION ONE – COMPULSORY (30 MARKS)

(a) Define the following terms
  i. Simulation (1 mark)
  ii. System state variable (1 mark)
  iii. Discrete event simulation model (1 mark)
  iv. Poison Arrival Process (1 mark)

(b) Use a multiplicative linear congruential random number generator with

$$a = 16807, c = 0, x_o = 12345, m = 2^{31} - 1$$

to generate the first five random variates on the interval (0, 1) (5 marks)

(c) Differentiate between the following types of models
  i. Deterministic model and Stochastic model (4 marks)

(d) Explain how validation of models is performed? (3 marks)

(e) Describe the procedure for generating samples from Erlang distribution (4 marks)

(f) Consider a single server queuing system. The system starts at time t=0. The arrival time of customers is 0.8, 1.4, 2.7, 3.2, 3.8, 8.0, 8.6, 9.0, 9.2 and 9.8. The departure times are: 2.2, 4.0, 5.0, 6.2, and 10.0. Time is in minutes. The first in first out queuing discipline is followed. Simulate this system for six clients and estimate:
  i. The average delay in the waiting line (3 marks)
  ii. The average number of clients in the waiting line at any time t (5 marks)
  iii. The expected utilization of server (2 marks)

QUESTION TWO (20 MARKS)

(a) Distinguish between the following:
  i. Endogenous and exogenous events (2 marks)
  ii. Discrete model and Continuous model (2 marks)

(b) Define arrival pattern. Explain non-stationary Poisson process (4 marks)

(c) Describe THREE common statistics included in the output report of a simulation programming system (6 marks)

(d) Using the mid-square method obtain the random variables using $Z_0 = 7182$ until the cycle degenerates to zero (6 marks)

QUESTION THREE (20 MARKS)

(a) State ANY FIVE capabilities of simulation language (5 marks)

(b) Explain why animation is appropriate in explaining the behaviour of a model when it is completed (4 marks)

(c) Citing examples, explain what is meant by optimization in simulation study (5 marks)

(d) Using the Linear Congruential Generator (LCG) with a=67, m=31, c=17 and seed Z0 = 117 to generate the first FIVE random variates on [0, 1]. (6 marks)

QUESTION FOUR (20 MARKS)

(a) State why it is necessary to test the properties of random numbers? (2 marks)

(b) State any five ways to perform model verification (5 marks)

(c) With the aid of a flow chart, explain the event-to-event time advance mechanism in a discrete event simulation model (5 marks)

(d) State the procedure to generate samples from Exponential distribution (3 marks)

(e) Perform the simulation of the following inventory system, given daily demand is represented by the random number 4, 3, 8, 2, 5 and the demand probability is given by

Demand	0	1	2
Probability	0.2	0.5	0.3

if the initial inventory is 4 units, determine on which day storage condition occurs (5 marks)

QUESTION FIVE (20 MARKS)

(a) State FOUR main properties of an ideal random number generator (4 marks)

(b) Explain what is performance, citing any two common performance measures (3 marks)

(c) Explain the main goal in the design of experiments (3 marks)

(d) Describe TWO main approaches that can be used to ensure that the experimentation data is correct. (4 marks)

(e) Suppose that the number of major earthquakes occurring per month in a particular geographical area is collected for 100 months and summarized in the table below:

Number of earthquakes per month	**0**	**1**	**2**	**3**	**4**
Number of months	**57**	**31**	**8**	**3**	**1**

Test at 5% level of significance whether the earthquakes occur randomly. Assume a poison distribution. (6 marks)