BE4-R3: PRINCIPLES OF MODELLING AND SIMULATION

NOTE:

1. **Answer question 1 and any FOUR questions from 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Time: 3 Hours **Total Marks: 100**

1.

a) Give two examples of large-scale application of simulation in real-life systems.

b) Differentiate between Fixed time incrementing and Next event incrementing in discrete event simulation.

c) Suggest a procedure based on Monte-Carlo Simulation to obtain an approximate value of $\sqrt{13}$ with the help of 10000 random numbers from a uniform distribution over (0,1).

d) What do you mean by random sampling? Give mathematical formula for sample mean, sample variance, and sample covariance.

e) Consider a random variable X with the following probability density function:

$$f(x) = 4x^3 \quad , \qquad 0 \le x \le 1$$

Suggest a procedure for generating values $x_1, x_2, \ldots$ from uniformly distributed random numbers over (0, 1).

f) What are the advantages and disadvantages of using a special-purpose simulation language over a general-purpose language such as JAVA?

g) Arrivals to an airport are all directed to the same runway. At a certain time of the day, these arrivals are Poisson distributed at a rate of 30 per hour. The time for an aircraft to land is a constant 90 seconds. Find the runway utilization.

(7x4)

2.

a) Show the classification of different types of models in the form of a hierarchical tree. Which type of models can be simulated?

b) What do you mean by discrete event systems? Give some examples.

c) Consider a single finite buffer single server system with arrival and service rates such that equilibrium probabilities of state are

n	0	1	2	3	≥ 4
P(n)	0.415	0.277	0.185	0.123	0.0

Calculate mean throughput and mean number of customers in queuing system and mean delay. Take $\mu = 10$.

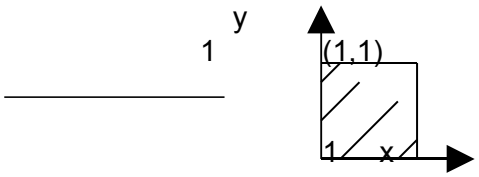
(5+5+8)

3.

a) What are pseudorandom numbers? Why are they called so?

b) A sequence of random numbers has two important statistical properties – uniformity and independence – discuss. Also compute the expected value and variance of a set of random numbers.

c) The diagram below shows a quarter-circular area enclosed in a unit square. Using Monte-Carlo Simulation, outline a procedure to estimate the area of the quarter-circle. Also comment on how this method can be utilized to estimate the value of π.



(6+6+6)

4. A car company requires an important consumable component for its assembly operations. The component is procured every week. The procurement and consumption of the component follow the probabilities given in the following table:

Weekly Procurement	**Probability**		**Weekly Consumption**	**Probability**
4	0.20		4	0.30
5	0.30		6	0.40
7	0.50		9	0.30

Random Numbers for weekly procurements: 42, 67, 19, 45, 24, 35, 71, 78, 26, 23
Random Numbers for weekly consumption: 50, 34, 06, 95, 42, 21, 78, 13, 81, 27

a) Using random numbers, find the random digit assignments for the weekly procurements and weekly consumption of the component.

b) Using the random digit assignments in a) above simulate the stock held of the component for the next 10 weeks. The beginning stock of the component is 10 units. Always assume that the procurements precede the consumption of the component. In case of stock-out, the component that could not be consumed will not be issued next week.

c) Find out the stock of the component at the end of 10 week. What is the highest closing stock during the period? What is the average stock? Is there any stockout?

(6+6+6)

5.

a) Do you agree with the statement that if the number of arrival of customers to a facility follows the Poisson distribution, then the inter-arrival time of the customers must follow the exponential distribution? Justify your answer.

b) The life of a fan belt is exponentially distributed with a failure rate of one failure in every 3000 hours on the average. Find out the probability that the fan belt will last longer than its mean life of 3000 hours. Also find the probability that the fan belt will last between 2000 and 3000 hours.

c) Find probability of 2 or more arrivals in one hour when the number of arrivals are Poisson distributed with an arrival rate of 3 per hour.

(8+5+5)

6.

a) Why is it necessary to carry out output analysis of simulation models?
b) Are the output data from simulation normally distributed? Justify your answer with an example.
c) Discuss briefly some useful Variance-reduction techniques for carrying out output analysis.

(4+6+8)

7.

a) As an aid in the validation process, a three step approach is widely followed. Explain the need for validation.
b) Build a model that high face validity. How will you validate model assumptions?
c) Bring out the importance of model verification.

(6+6+6)