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) What do you mean by simulation? Describe one application of simulation in manufacturing system.

b) Bring out the differences between:
   i) Deterministic vs. Stochastic models
   ii) Continuous vs. Discrete models

c) Customers arrive to a single server service station, in accordance with the Poisson distribution, at the rate of 10 per hour. The exponentially distributed service time in each of the counters is 2 minutes per customer. Find the average time spent by a customer in the system and in the queue.

d) A set of random numbers is generated by using linear congruential method. Why will it be necessary to conduct frequency test?

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

$$f(x) = 5x^4 \ , \ 0 \leq x \leq 1$$

Find its cumulative distribution function. Suggest a procedure to generate random numbers from the given pdf.

f) What is GPSS? Why is it used?

g) Define the terms “factor” and “response” in the context of a simulation experiment. Illustrate them in the case of inventory simulation problem.

(7x4)

2.

a) What are pseudorandom numbers? Why are they called pseudorandom numbers and not simply random numbers?

b) Discuss the Linear Congruential method of generating pseudorandom numbers.

c) What are the different tests to check randomness in pseudorandom numbers? Why are these tests required?

(4+6+8)

3.

a) An algorithm for generating X is as follows:
   i) Generate $U \sim U(0,1)$
   ii) Let $V=F(a)+[F(b)-F(a)]U$
   iii) Return $X=F^{-1}(V)$

Show that X defined by this algorithm has the distribution function F*(x) defined by

$$F^*(x) = \begin{cases} 0 & \text{if } x<a \\ \dfrac{F(x) - F(a)}{F(b) - F(a)} & \text{if } a \le x \le b \end{cases}$$

b) Briefly outline the Box and Muller technique for generating normal variates.

c) Discuss how will you obtain random variates from an ERLANG distribution with the help of convolution.

(8+6+4)

4. A vendor buys cakes at Rs. 4 each and sells them at Rs. 5 each. Cakes not sold at the end of the day are discarded fetching only 50 p. each. There could be any one of the three possible market scenarios each day – good, fair, and poor – with probabilities 0.30, 0.40, and 0.30 respectively. The distribution of the demand of the cakes each day is given below.

Demand	Demand Probability Distribution		
	Good	Fair	Poor
500	0.00	0.20	0.50
600	0.15	0.45	0.25
700	0.25	0.20	0.15
800	0.35	0.10	0.10
900	0.15	0.05	0.00
1000	0.10	0.00	0.00

a) Find the random digit assignments for the following:
   i) Daily Market Scenarios
   ii) Daily Cake Demand

b) If the vendor purchases 700 cakes a day, conduct a simulation experiment for 10 days using the random digit assignments as given in **a)** above to find out the following:
   i) The number of occasions for which the vendor will have excess demand, lower demand, and demand of exactly 700 cakes.
   ii) His total profits for the period of 10 days.
   iii) His lost profits during the period due to excess demand.

   Use the following random digits:
   Random digits for Daily Market Scenario: 14, 72, 41, 92, 23, 38, 67, 02, 85, 56
   Random digits for demand: 80, 27, 15, 54, 98, 62, 36, 73, 92, 61

(6+12)

5.

a) Differentiate between continuous and discrete event system simulation. Do we require pseudorandom numbers in continuous simulation?

b) What are distributed lag models? Give an example. Also discuss, how a distributed lag model can be simulated over time.

c) What is Monte Carlo Simulation? Suggest a procedure to compute approximate value of π using uniformly distributed random numbers over [0, 1].

(6+8+4)

6.

a) Why is it necessary to carry out output analysis of data generated in simulation experiments?

b) Are output data from simulation experiments normally distributed? Justify your answer.

c) Discuss briefly Variance-reduction techniques in simulation experiments. How is it carried out?

(4+6+8)

7.

a) Bring out the difference between calibration of a system and validation of a system in discrete event simulation.

b) Outline how level equations are modelled in system dynamics framework?

c) As full factorial design is often prohibitive from the resource requirement viewpoint, discuss what other alternative does one have.

(6+8+4)