BE4-R3: PRINCIPLES OF MODELLING AND SIMULATION

NOTE:

1. **Answer question 1 and any FOUR from questions 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) You are asked to simulate an Inventory System. Discuss how you would identify some entities, attributes, activities, events, and state variables for such a system.

b) Is it possible to carry out discrete event simulation for all kind of systems? Explain your answer.

c) Why are models required for carrying out simulation? Differentiate between a static model and a dynamic model.

d) What do you mean by the "frequency test" of randomness? How is it conducted?

e) Describe Monte Carlo simulation to estimate π from a set of 2^n uniformly distributed random numbers from (0, 1).

f) Which language would you prefer for carrying out discrete event simulation – a special-purpose simulation language or a general-purpose language such as JAVA?

g) What do you mean by the "face validity" of a simulation model?

(7x4)

2.

a) Outline a procedure to generate interarrival pattern of an M/M/1 queue when the mean arrival rate is λ.

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

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

(4+6+8)

3.

a) What are pseudo-random numbers? How can they be generated using a multiplicative congruential generator? Describe algorithm for generating random variate with distribution function

$$F(x)=\begin{cases} \dfrac{x^{\alpha}}{b} & \text{if } 0\le x\le 1 \\ 1-\dfrac{\alpha e^{-x}}{b} & \text{if } x>1 \end{cases}.$$

b) Give a method for generating normally distributed random numbers with mean 2 and variance 1. Discuss the procedure to compute $E[e^X]$ where X ~ N(2, 1).

(9+9)

4. A buying and selling company trades in an automobile part. The part is procured and sold by the company every week. The procurement and sale of the part follow the probabilities given in the following table:

Weekly Procurement	Probability		Weekly Consumption	Probability
3	0.20		5	0.30
5	0.30		7	0.40
8	0.50		9	0.30

Random Numbers for weekly procurement : 42, 67, 19, 45, 24, 35, 71, 78, 26, 23
Random Numbers for weekly sale : 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 sales of the part.
b) In **a)** above simulate the stock held of the part for the next 10 weeks. The beginning stock of the part is 15 units. Always assume that the procurements precede the sales of the part. In case of stock-out, the part that could not be supplied will not be sold next week.
c) Find out the stock of the part 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) For the state independent M/M/1 queue, obtain mean queue size and utilization when λ=1.0 and μ=2.0. How will you obtain p_{100}?
b) In a petrol pump with a single counter, there are berths for four arriving cars including the one in service. On an average, 12 cars arrive per hour as per Poisson distribution and the service time is exponentially distributed with an average of 4 minutes for a car. Find the following:
   i) the probability that an arriving car will find at least one berth free,
   ii) the probability that an arriving car will have to wait outside the petrol pump, and
   iii) the expected waiting time of a car in the queue.

(6+12)

6.
a) Bring out the need for identification of probability distribution which characterizes the input models in simulation studies. Discuss the situation when such characterization is needed.
b) Are the output data from simulation normally distributed? Justify your answer with an example.
c) Explain how antithetic sampling can help in variance reduction in discrete event simulation. Give an example.

(5+5+8)

7.
a) Discuss difference between verification and validation of a simulation model
b) Why is statistical analysis of simulation output necessary? Describe the methodology.
c) Develop a GPSS model of a telephone system. The system is one in which a series of calls come from a number of telephone lines and the system is to connect the calls by using one of a limited number of links. Only one call can be made to any one line at a time and it is assumed that calls are lost if the called party is busy or no link is available. Each line is represented by a logic switch whose number is line number. The line is considered busy if the switch is set.

(6+6+6)