BE4-R3: PRINCIPLES OF MODELLING & 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) Name three principal entities, attributes and activities to be considered if you were to simulate the operation of a gasoline filling station.

b) The random variables X and Y are distributed as follows:

$X \sim 10 \pm 10$ (Uniform)

$Y \sim 10 \pm 8$ (Uniform)

Suggest a procedure to simulate r.v Z given by Z = XY.

c) The cdf of a continuous random variate is given by

$$F(x) = 2\left(x - \frac{x^2}{2}\right), \qquad 0 \le x \le 1$$

Simulate X_1, X_2, X_3 and X_4 from $U_1 = 0.1009$, $U_2 = 0.3754$, $U_3 = 0.0842$ and $U_4 = 0.1280$.

d) Draw a cobweb model for the following market:

$D = 12.4 - 1.2P$

$S = 8.0 - 0.6\,P_{-1}$

$P_0 = 1.0$

e) A three-step approach is widely used as an aid to validation process. What do you understand by “building a model that has high face validity”?

f) At a small service station, there is place for only two people including the person being served. The arrival rate is Poisson distributed at 5 per hr. The service is exponentially distributed and takes 5 minutes on the average. Find the probability that an arriving person will have to wait outside the service station.

g) Describe an M/M/1 queuing system. What can you say about the arrival pattern?

(7x4)

2.

a) Three points are chosen at random on the circumference of a circle. Using Monte Carlo method, how will you estimate the probability that they all lie on the same semicircle?

b) Suppose it is relatively easy to simulate from the distributions F_i, i = 1, 2, …, n. If n is small, how can we simulate from

$$F(x) = \sum_{i=1}^{n} P_i\, F_i(x), \quad P_i \ge 0, \ \sum_i P_i = 1$$

c) Describe the set of steps to guide a model builder in a through and sound simulation study.

(6+6+6)

3.

a) The inter-arrival time as well as the service time in a single chair barbershop are found to be exponentially distributed. The values of λ and μ are 2 per hr and 3 per hr respectively. The service time average is 20 minutes. Calculate the system utilization and the probabilities for 0, 1, 2, 3, and 4 customers in the shop. Also calculate mean number of customers in the system and the average waiting time.

b) How do you carry out simulation of a discrete event system? What are the important steps? Discuss in detail.

(10+8)

4.

a) In many simulation models, there are periods of high activity separated by periods of inactivity. Between the two approaches based on periodic scan or event scan, which one will you prefer and why? Make a brief comparative study of these two approaches.

b) Explain the purpose of statistical design of experiments in the context of simulation. Describe a system, where a complete randomized design is applicable, and also formulate the statistical model. How do you carry out analysis of variance for the data obtained from a completely randomized design?

(8+10)

5.

a) Discuss the advantages of using a simulation language designed specially for discrete event simulation over a general purpose language.

b) Explain how antithetic sampling can help in variance reduction. Suppose we have generated Y_1 and Y_2 identically distributed random variables having mean θ. State the requirement such that $Var\left(\frac{Y_1+Y_2}{2}\right)$ is reduced.

c) What is the importance of list processing in simulation languages?

(6+6+6)

6.

a) For a G/G/1 queuing system, draw a block diagram and give corresponding GPSS statements.

b) In some simulation studies, it may not be possible to collect data on random variables of interest. Outline the steps to obtain a distribution in the absence of data.

c) Describe a real life application where it is convenient for the software to have capabilities for combined discrete-continuous simulation.

(6+6+6)

7.

a) The linear congruential method produces a sequence of integers according to the following recursive relationship:

$$X_{i+1} = (aX_i + c) \bmod m; \quad i = 1, 2, \ldots$$

How would you generate random numbers between 0 and 1? Why are these referred to as pseudo random numbers?

b) How do you distinguish between deterministic and stochastic systems? Give three examples of each of these systems.

c) In the context of system dynamic models, why many feedback systems respond counter intuitively. Contrast between negative and positive feedback systems.

(5+6+7)