(3 Hours) **[Total Marks: 80]**

N.B.: (1) Question **No.1** is **Compulsory**.
(2) Attempt **any three** questions from **remaining** questions.
(3) Assume **suitable** data wherever required but **justify** the same.
(4) **Figures** to the **right** indicate **full marks**.
(5) Answer to each new question to be started on a **fresh page**.

1. (a) Define Simulation. With the help of neat flowchart, explain the steps in simulation study. **(10)**

(b) A sequence of 1000 three-digit numbers has been generated and an analyst indicates that 290 have three different digits, 570 contain exactly one pair of like digits, and 140 contain exactly three like digits. Based on Poker test, check whether these numbers are independent. Use $\alpha = 0.05$ *and* $\chi^2_{0.05,2} = 5.99$. **(10)**

2. (a) The inter-arrival time and the service times of the 10 jobs arriving in the computer system are given as follows: **(10)**

Inter-arrival time (min)	--	0	60	60	120	0	60	120	0	120
Service time (min)	25	50	37	45	50	62	43	48	52	38

Compute the following:
i. Average time job spends in the queue.
ii. Average processing time of the jobs.
iii. Maximum time job spends in the system.

(b) If the inter-arrival time ranges from 2 to 6 minutes with equal probability and the random digits generated are 51, 27, 63, 89, 11, and 45 with a uniform service time of 3 minutes, generate the FEL with primary events. Also calculate the total busy time of the server and the minimum queue length. **(10)**

3. (a) Explain Poisson process and state its properties. Gaurav is quite a popular student. He receives, on the average, four phone calls a night with Poisson distribution. What is the probability that tomorrow night the number of calls received will exceed that average by more than one standard deviation? **(10)**

(b) Design a generator for the discrete distribution whose pmf is given below: **(10)**

$$p(x) = \frac{2x}{k(k+1)}, x = 1,2, \dots, k$$

Generate the random variate for $R_1 = 0.3456$ and $R_2 = 0.8912$

4. (a) Consider the following data for the M/M/1 queue simulation. $R_0 = 10$, d = 2, and S_0^2=25.30. Estimate the long-run mean queue length, L_Q, within ε = 2 customers with 90% confidence. From the table, the value of $Z_{0.05} = 1.645$. How many additional replications are required? **(10)**

(b) What do you understand by calibration and validation of models? How can one increase the face validity of a model and validate the model assumptions? **(10)**

5. (a) Give the equations for steady state parameters of M/G/1 queue and derive M/M/1 from M/G/1. **(10)**

(b) What are the costs associated with inventory system? Describe the inventory system when - **(10)**

i. Lead time is zero.
ii. Lead time is independent of demand.
iii. Lead time is dependent on demand.

6. Write short notes on (**any two**): **(20)**

(a) Goals and Issues in simulation of manufacturing systems.
(b) Multivariate and Time-series Input Models.
(c) Areas of Applications of Simulation.
(d) Output analysis for terminating simulation.
