

Indian Statistical Institute Bangalore

Statistical Quality Control & Operation Research Unit

MS (QMS) First Year [Batch 2024-2025]

Second Semester – **Operation Research-II**

Exam: Endterm

Maximum Marks: 50

Date: 28th April 2025

Duration: 3 hours

**Figure in the right hand margin indicates full marks for the questions
(Question no. 1, 2, & 3 are compulsory, any one full question from Questions 4 & 5)**

- 1** An office equipment manufacturer produces two kinds of products i.e. chairs and lamps. The production of either, a chair or a lamp, requires 1 hour of production capacity in the plant. The plant has a maximum production capacity of 10 hours per week. Because of the limited sales capacity, the maximum number of chairs and lamps that can be sold are 6 and 8 per week, respectively. The gross margin from the sale of a chair is Rs. 80, and from the sale of a lamp is Rs 40. The plant manager has set the following goals, arranged in order of importance: **15**

P1: He wants to avoid any underutilization of production capacity.

P2: He wants to sell as many chairs and lamps as possible. Since the gross margin from the sale of a chair is set at twice the amount of profit from a lamp, he has twice as much desire to achieve the sales goal for chairs as for lamps.

P3: He wants to minimize the overtime operation of the plant as much as possible.

Formulate the goal programming problem and then solve it by the simplex method so that the plant manager makes a decision that will help him achieve his goals as closely as possible.

- 2 a)** A company distributes its products by trucks loaded at its only loading station. Both, company's trucks and the contractor's trucks are used for this purpose. It was found out that on an average, every five minutes, one truck arrived, and the average loading time was three minutes. 50% of the trucks belong to the contractor. Determine the following: **5**

i) The probability that a truck has to wait

ii) The waiting time of truck that waits and

iii) The expected waiting time of contractor's trucks per day assuming a 24-hour shift.

- b)** Customers arrive at a box office window, being manned by a single individual, according to a Poisson input process with a mean rate of 30 per hour. The time required to serve a customer has an exponential distribution with a mean of 90 seconds. Find the average waiting time of a customer. Also determine the average number of customers in the system and the average queue length. **5**

- 3 a)** Two persons X and Y, work on a two-station assembly line. The distributions of activity at their stations are. **12**

Time (in seconds)	10	20	30	40	50	60	70	80
Time Frequency for X	4	7	10	15	35	18	8	3
Time Frequency for Y	2	3	6	8	12	9	7	3

(a) Simulate the operation of the line for eight items.

(b) Assuming Y must wait until X completes the first item before starting work, will he has to wait to process any of the other seven items? What is the average waiting time of items? Use the following random numbers :

For X: 83, 70, 06, 12, 59, 46, 54, and 04. For Y: 51, 99, 84, 81, 15, 36, 12, and 54.

(c) Determine the inventory of items between the two stations.

(d) What is the average production rate?.

- b)** What is Monte Carlo simulation, and explain briefly its steps. **3**

- 4 a) A broker supplies the following information about a product that he deals in: Annual demand = 1,000 units; Ordering cost = Rs 160 per order; Price = Rs 100 per unit; Inventory carrying cost is 20% of the value of inventory per year. The broker is considering the possibility of allowing some backorder (stock-out) to occur. He has estimated that the annual cost of backordering will be Rs. 10. Compute the following: 5
- Minimum cost order quantity
 - Time between orders
 - Maximum number of back orders
 - Overall annual cost.

- b) A contractor has to supply 10,000 bearings per day to an automobile manufacturer. Assuming 300 working days in a year. He finds that when he starts the production run, he can produce 25,000 bearings per day. The cost of holding a bearing in stock for a year is Rs 2, and the set-up cost of a production run is Rs. 1,800. Determine the following: 5
- Optimum order quantity
 - Frequency of production runs
 - Overall annual cost

- 5 a) Solve the following Integer LP problem using the cutting plane method 5
- $\text{Max } Z = 3x_1 + 12x_2$
 subject to the constraints
 $2x_1 + 4x_2 \leq 7$
 $5x_1 + 3x_2 \leq 15$
 and $x_1, x_2 \geq 0$ and are integers.

- b) A small project involves 9 tasks, and their time estimates are listed in the following table. 5

Task	Estimated Duration		
	Optimistic	Pessimistic	Most likely
A	3	15	6
B	2	14	5
C	6	30	12
D	2	8	5
E	5	17	11
F	3	15	6
G	3	27	9
H	1	7	4
I	2	8	5

- Draw the network diagram of the tasks in the project.
- Find the expected duration and variance for each task.
- The probability of an event occurring at the proposed completion date if the original contract time of completing the project is 27 days.

-----Best off Luck-----