

Indian Statistical Institute Bangalore
MS-QMS (Semester II) Operations Research - II
End-Term - 2025-26

Time: 3 Hours Date: 29/04/2026

Answer all questions and score 50 marks; the value at the end of the question within the bracket represents the maximum marks.

Scientific calculator is allowed.

Q1. A hospital pharmacy dispenses medicines through two service counters. The patients arrive randomly at an average rate of one every 4 minutes. Each pharmacist takes on average 2 minutes to serve a patient. Assume arrivals follow a Poisson process and service times are exponentially distributed. Determine the following: [6=2 + 2 + 2]

- i) The probability that a patient has to wait for the service.
- ii) The expected waiting time of a patient who actually waits.
- iii) The total expected waiting time for all patients on a 12-hour operating day.

Q2. A distributor handles a specialty chemical with the following details: Annual demand = 2,400 units, Ordering cost = Rs. 200 per order, Purchase price = Rs. 50 per unit, Inventory carrying cost = 25% of the unit value per year. The distributor estimates that the annual cost of backordering will be Rs. 15 per unit. Determine: [8=2 + 2 + 2 + 2]

- i) The Economic order quantity.
- ii) The total annual cost of the system.
- iii) The time between orders.
- iv) The maximum number of backorders allowed.

Q3. A factory must supply 5,000 gears per day to a machinery manufacturer. The factory operates 250 days a year. When production begins, the factory can produce 20,000 gears per day. The annual holding cost of one gear is Rs. 3, and the setup cost of a production run is Rs. 2,000. Determine the optimum batch size and the total annual cost of the system. [6=3 + 3]

Q4. What is a random number? How do we generate it? Generate 3 random numbers between 0 and 1 using any of the methods taught in your OR-II course. [6]

Q5. A decision-making entity is faced with optimizing three objectives: maximize profit, minimize environmental impact, and improve social wel-

fare. The objectives are weighted as follows: 0.4 for profit, 0.3 for environmental impact, and 0.3 for social welfare. If the profit is projected to be 100,000, the environmental impact is estimated to be 20 units and the social welfare is anticipated to be 50 units, formulate a weighted goal model for this optimization problem. Explain the steps. [6]

Q6. You are given the task of selecting an investment portfolio for a client. You have selected a set of five alternatives with estimated values of the rate of return (annually) and risk as follows:

Alternatives	Rate of return (annual, in %)	Risk
Government bonds	6.0	1.3
Corporate bonds	8.0	1.5
Stocks	5.0	1.9
Mutual funds	7.0	1.7
Real estate	15.0	2.7

You must maximize the average annual rate of return in the portfolio. However, you must simultaneously ensure that the average risk of the portfolio is not greater than 2; and the investment in real estate should be less than 20%.

(a) Formulate a multiobjective mathematical model for this problem with your own priority in this situation. [5]

(b) Explain the Pareto front. If you have a Pareto front, how would you choose a preferred solution from that? [3]

Q7. The Indian Statistical Institute wants to select the best candidate for a faculty position. The decision must balance multiple criteria beyond academic qualifications. The selection committee agrees on four main criteria: Academic Qualifications (AQ) – degrees, publications, research impact; Teaching Ability (TA) – student feedback, demo lectures, communication skills; Research Potential (RP) – grants, future projects, innovation; and Community Engagement (CE) – outreach, collaboration, service to institution. Three candidates were shortlisted for one vacancy. Candidate A – Strong research background, moderate teaching skills, Candidate B – Excellent teaching record, moderate research output, and Candidate C – Balanced profile with good community participation. Apply AHP to help the committee select a promising profile. [10]