PB **5720**

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M.A./M.Sc. (Semester-IV) Examination - June, 2026
Mathematics
Paper- MATH 401
Operations Research- II

Time Allowed: Three Hours **Maximum Marks: 100**

This question paper contains two sections as under :

Section-A **Max. Marks-20**

This section will have 10 questions, having 02 questions from each unit. Answer in about 20 words. All questions will have equal marks. (2×10=20)

Section-B **Max. Marks-80**

This section will have 10 questions, having 02 questions from each unit, one question to be attempted from each unit. Words limit approximately 400 words. Questions may have sub divisions. All questions will have equal marks. (16×05=80)

Section-A

1. (i) Give statement of Bellman's principles of optimality.
   (ii) Write two applications of Dynamic programming.
   (iii) What do you mean by inventory?
   (iv) What are advantages of inventory?
   (v) Show that $3x_1^2 + 4x_1x_2 + 2x_2^2$ is positive definite.
   (vi) Write general form of non-linear programming problem.
   (vii) What is quadratic programming?
   (viii) Write general form of separable programming problem.
   (ix) Write objectives of queuing theory.
   (x) Define steady state of the queuing system.

Section-B

Unit-I

2. Use dynamic programming to find maximum value of product $x_1, x_2, \ldots\ldots x_n$ when $x_1 + x_2 + \ldots\ldots + x_n = b$, $x_1, x_2, \ldots\ldots, x_n \geq 0$

OR

Solve the following LPP by dynamic programming.

Max. $z = x_1 + 9x_2$

Subject to $2x_1 + x_2 \leq 25$

$x_2 \leq 11$

and $x_1 \geq 0$, $x_2 \geq 0$

Unit- II

3. A manufacturer has to supply his customer with 600 units of his product per year. Shortages are not allowed and the storage cost amount to Rs.0.60 per unit per year. The set up cost per run is Rs.80. Find the optimal run size and minimum average yearly cost. Find the following.

(a) EOQ (b) Minimum average yearly cost
(c) Optimum number of orders per year
(d) The optimum period of supply per optimum order.

OR

Derive an economic lot size (EOQ) formula, reorder point and minimum average cost under the following assumptions:

(i) Demand is at uniform rates units of quantity per unit of time.
(ii) Production rate $k(>r)$ finite, uniform.
(iii) Shortages are not allowed.
(iv) Lead time $L = 0$
(v) Holding cost = C_1 per unit quantity per unit time
(vi) Set up cost = C_3 per cycle

Unit- III

4. Use Lagrangian multiplier method to solve NLPP:

Min. $z = 2x_1^2 + 2x_2^2 + 2x_3^2 - 24x_1 - 8x_2 - 12x_3 + 10$

Subject to $x_1 + x_2 + x_3 = 11$

and $x_1, x_2, x_3 \geq 0$

OR

Use Kuhn-Tucker conditions to solve:

Max. $4x_1 + 2x_2 - x_1^2 - x_2^2 - 5$

Subject to $x_1 + x_2 \leq 4$

and $x_1, x_2 \geq 0$

Unit – IV

5. Solve the QPP by Wolfe's method:

Max. $z = 2x_1 + x_2 - x_2^2$

Subject to $2x_1 + 3x_2 \leq 6$

$2x_1 + x_2 \leq 4$

and $x_1, x_2 \geq 0$

OR

Use separable programming algorithm to find an approximate optimal solution to the NLPP.

Max. $z = x_1 + x_2^4$

Subject to $3x_1 + 2x_2^2 \leq 9$

and $x_1 \geq 0,\ x_2 \geq 0$

Unit- V

6. Solve the following queuing model:

(M/M/1) : (N/FIFO)

OR

On a telephone booth, arrivals of customers follow the Poisson process with an average time of 10 minutes between one arrival and next arrival. The length of a phone call is assumed to be distributed exponentially with mean 3 minutes.

(a) Find the average number of persons waiting in the system.
(b) What is probability that a customer spends more than 10 minutes in the booth.
(c) What is the probability that a person arriving at the booth will have to wait.
(d) Find the fraction of a day when the phone will be used.