1711E1292

Candidate's Seat No :________

M.Sc. Sem.-3 Examination

504

Mathematics (EA)

(M.P.)

November-2025

Time : 2-30 Hours] **[Max. Marks : 70**

Instructions: All questions are compulsory. Use of non-programmable scientific calculator is allowed.

Q.1 **(a)** Solve the given LPP by using Simplex Method: **(07)**

$Max\ Z = 5x_1 + 4x_2$

Subject to constraints: $4x_1 + 5x_2 \leq 10$

$3x_1 + 2x_2 \leq 9$

$8x_1 + 3x_2 \leq 12; \quad x_1, x_2 \geq 0$

(b) Find the optimum integer solution of LPP: **(07)**

$Max\ Z = 4x_1 + 3x_2$

Subject to constraints: $x_1 + 2x_2 \leq 4$

$2x_1 + x_2 \leq 6; \quad x_1, x_2 \geq 0$

OR

Q.1 **(a)** Solve the given LPP by using dual simplex method. **(07)**

Minimize $Z = x_1 + x_2$

Subject to constraints: $2x_1 + x_2 \geq 2$

$-x_1 - x_2 \geq 1; \quad x_1, x_2 \geq 0$

(b) Solve the given LPP by using Big-M Method: **(07)**

Maximize $z = 3x_1 + 2x_2$

Subject to constraints: $2x_1 + x_2 \leq 2$

$3x_1 + 4x_2 \leq 12; \quad x_1, x_2 \geq 0$

Q.2 **(a)** The manager of the Swimming Club is planning the club's swimming team program. The first team practice is scheduled for May 1. The activities, their immediate predecessors, and the activity time estimates (in weeks) are as follows: **(07)**

			Time (weeks)		
Activity	**Description**	**Immediate Predecessor**	**Optimistic**	**Most Probable**	**Pessimistic**
A	Meet with board	-	1	1	2
B	Hire coaches	A	4	6	8
C	Reserve pool	A	2	4	6
D	Announce program	B, C	1	2	3
E	Meet with coaches	B	2	3	4
F	Order team suits	A	1	2	3
G	Register swimmers	D	1	2	3
H	Collect fees	G	1	2	3
I	Plan first practice	E, H, F	1	1	1

P.T.O

E1292-2

a. Draw a project network.
b. Develop an activity schedule.
c. If the club manager plans to start the project on February 1, what is the probability the swimming program will be ready by the scheduled May 1 date (13 weeks)? Should the manager begin planning the swimming program before February 1?

Z	0.5	0.67	1.00	1.34	2.00
$P(0 < x < Z)$	0.1915	0.2486	0.3413	0.4099	0.4772

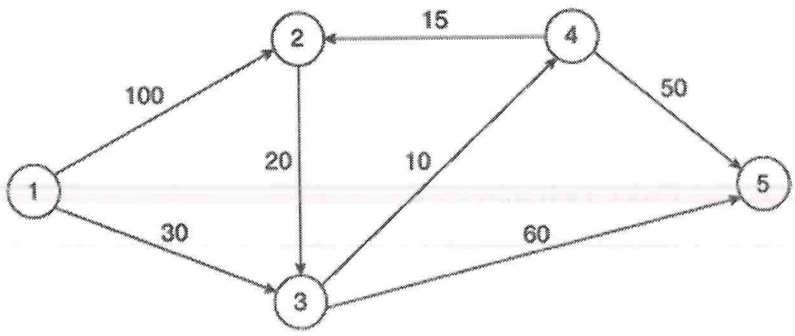
(b) County Parks is planning to develop a new park and recreational area on a recently purchased 100-acre tract. Project development activities include clearing playground and picnic areas, constructing roads, constructing a shelter house, purchasing picnic equipment, and so on. The following activities and their estimated times (in weeks) are being used in the planning, scheduling, and controlling of this project: **(07)**

Activity	Immediate Predecessor	Time (weeks)
A	-	9
B	-	6
C	A	6
D	A	3
E	B, C	0
F	B, C	3
G	F	2
H	D, E	6
I	G, H	3

a. Draw a project network. Draw a project network.
b. What is the critical path for this network?
c. Show the activity schedule for this project.
d. The park commissioner would like to open the park to the public within six months from the time the work on the project starts. Does this opening date appear to be feasible? Explain.

OR

Q.2 (a) Using Dijkstra's algorithm, find the shortest path from source 1 to destination 5, through the network given below. **(07)**



(b) Consider the following activity information for the project and activity times (in days): **(07)**

		Time (days)		Cost ($)	
Activity	**Immediate Predecessor**	**Normal**	**Crash**	**Normal**	**Crash**
A	-	3	2	800	1400
B	-	2	1	1200	1900
C	A	5	3	2000	2800
D	B	5	3	1500	2300
E	C, D	6	4	1800	2800
F	C, D	2	1	600	1000
G	F	2	1	500	1000

a. Draw a project network.
b. Find the critical path and the expected project completion time.
c. What is the total project cost using the normal times?
d. Assume that management desires a 12-day project completion time. Formulate a linear programming model that can be used to assist with the crashing decisions.

Q.3 **(a)** Use Wolfe's method to solve the following QPP: **(07)**

$$\text{Max}\, z = 2x_1 + x_2 - x_1^2$$
$$s.to.c: 2x_1 + 3x_2 \leq 6$$
$$2x_1 + x_2 \leq 4$$
$$x_1, x_2 \geq 0$$

(b) Find the optimal solution using Lagrange's multiplier method **(07)**

$$\text{Min}\, z = 4x_1^2 + 2x_2^2 + x_3^2 - 4x_1x_2$$
$$s.to.c: x_1 + x_2 + x_3 = 15$$
$$2x_1 - x_2 + 2x_3 = 20$$

OR

Q.3 **(a)** Find the optimal solution using Kuhn – Tucker condition **(07)**

$$\text{Max}\, z = x_1 - x_2$$
$$s.to.c: x_1^2 + x_2^2 \leq 1$$

(b) XYZ Manufacturing has two production facilities that manufacture baseball gloves. Production costs at the two facilities differ because of varying labor rates, local property taxes, type of equipment, capacity, and so on. The City A plant has weekly costs that can be expressed as a function of the number of gloves produced: **(07)**

$$TCA(X) = X^2 - X + 5$$

where X is the weekly production volume in thousands of units and $TCA(X)$ is the cost in thousands of dollars. The City B plant's weekly production costs are given by

$$TCB(Y) = Y^2 + 2Y + 3$$

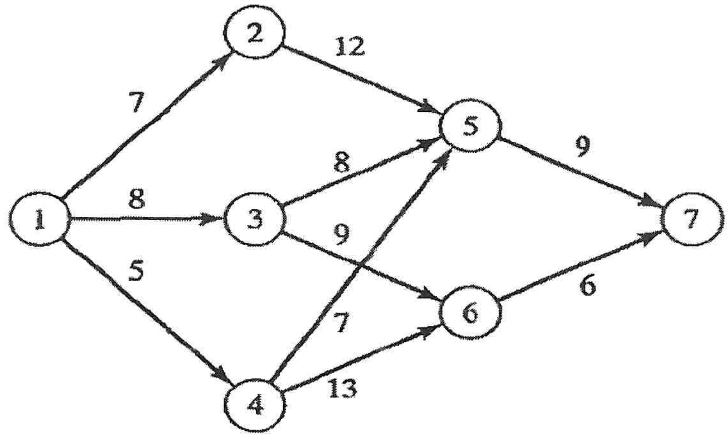
where Y is the weekly production volume in thousands of units and $TCB(Y)$ is the cost in thousands of dollars. XYZ Manufacturing would like to produce 8000 gloves per

P.T.O

E1292-4

week at the lowest possible cost. Formulate a mathematical model that can be used to determine the optimal number of gloves to produce each week at each facility and find the solution to your mathematical model to determine the optimal number of gloves to produce at each facility by Lagrange's multiplier method.

Q.4 **(a)** Find the shortest path of the following network: **(07)**



(b) A vessel is to be loaded with stocks of three items. Each unit of item i has a weight w_i and value r_i. The maximum cargo weight the vessel can take is 5 and the details of the three items are as follows: **(07)**

Item i	w_i	r_i
1	1	30
2	3	80
3	2	65

Develop the recursive equation for the above case and find the most valuable cargo load without exceeding the maximum cargo weight by using dynamic programming.

OR

Q.4 **(a)** Solve the following problem using dynamic programming. **(07)**

Minimize $Z = y_1^3 + y_2^3 + y_3^3$

Subject to constraint: $y_1 \cdot y_2 \cdot y_3 = 8$ and $y_1, y_2, y_3 \geq 0$ are positive integers.

(b) Solve the LPP by dynamic programming. **(07)**

Max $Z = 3x_1 + 9x_2$

Subject to constraints, $x_1 + 4x_2 \leq 8$, $x_1 + 2x_2 \leq 4$ and $x_1, x_2 \geq 0$.

Q.5 Attempt any **SEVEN** out of **TWELVE:** **(14)**

(1) Write the dual of the following LPP:

Minimize $Z = 4x_1 + 6x_2 + 18x_3$

Subject to constraints: $x_1 + 3x_2 \geq 3$

$x_2 + 2x_3 \geq 5$; $x_1, x_2, x_3 \geq 0$

(2) Explain unbounded solution for linear programming problems.

E1295-5

(3) A farmer has 1000 acres of land on which he can grow corn, wheat or soyabeans. Each acre of corn costs Rs.100 for preparation, requires 7 man-days of work and yields a profit of Rs.30. An acre of wheat costs Rs. 120 to prepare, requires 10 man-days of work and yields a profit of Rs. 40. An acre of soyabeans costs Rs. 70 to prepare, requires 8 man-days of work and yields a profit of Rs. 20. If the farmer has Rs. 1,00,000 for preparation and can count on 8000 man-days of work, how many should be allocated to each crop to maximize profits? Only formulate the problem as a linear programming problem.

(4) Write down the difference between CPM and PERT.

(5) Explain free float and total float.

(6) What is cost slope?

(7) Explain convex and concave function.

(8) What is Nonlinear programming?

(9) The cost per day of running a hospital is $200{,}000 + 0.002x^2$ dollars, where $x =$ patients served per day. What size hospital minimizes the per-patient cost of running the hospital?

(10) Define states and stages in dynamic programming.

(11) What is Linear Fractional Programming?

(12) Transform the given LFPP into LPP using Charnes-Cooper transformation.

Maximize $Z = \frac{6x_1+3x_2+6}{5x_1+2x_2+5}$

Subject to constraints, $4x_1 - 2x_2 \leq 20$

$3x_1 + 5x_2 \leq 25$

and $x_1, x_2 \geq 0$.

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