Question Bank

OPERATIONAL RESEARCH LAB

P58

A firm produces three products. These products are processed on three different machines. The time required to manufacture one unit of each of the three products and the daily capacity of the three machines are given in the table below.

Machine	Time per unit (minutes)			Machine capacity (minutes/day)
	Product 1	Product 2	Product 3	
M_1	2	3	2	440
M_2	4	—	3	470
M_3	2	5	—	430

It is required to determine the daily number of units to be manufactured for each product. The profit per unit for product 1, 2 and 3 is ₹ 4, ₹ 3 and ₹ 6 respectively. It is assumed that all the amounts produced are consumed in the market. Formulate the mathematical (L.P.) model that will maximize the daily profit.

P59

A person wants to decide the constituents of a diet which will fulfil his daily requirements of proteins, fats and carbohydrates at the minimum cost. The choice is to be made from four different types of foods. The yields per unit of these foods are given in table

Food type	Yield per unit			Cost per unit (₹)
	Proteins	Fats	Carbohydrates	
1	3	2	6	45
2	4	2	4	40
3	8	7	7	85
4	6	5	4	65
Minimum requirement	800	200	700	

Formulate linear programming model for the problem.

P60

A firm produces an alloy having the following specifications:

(i) specific gravity ≤ 0.98,

(ii) chromium ≥ 8%,

(iii) melting point ≥ 450°C.

Raw materials A, B and C having the properties shown in the table can be used to make the alloy.

Property	Properties of raw material		
	A	B	C
Specific gravity	0.92	0.97	1.04
Chromium	7%	13%	16%
Melting point	440°C	490°C	480°C

Costs of the various raw materials per ton are: ₹ 90 for A, ₹ 280 for B and ₹ 40 for C. Formulate the L.P. model to find the proportions in which A, B and C be used to obtain an alloy of desired properties while the cost of raw materials is minimum.

P132

Maximize the following problem graphically

$$\begin{aligned} \textit{Maximize } Z &= 2x_1 + x_2, \\ \textit{subject to } x_1 &+ 2x_2 \le 10, \\ x_1 &+ x_2 \le 6, \\ x_1 &- x_2 \le 2, \\ x_1 &- 2x_2 \le 1, \\ x_1, x_2 &\ge 0. \end{aligned}$$

P136

Minimize the following problem graphically

$$\begin{aligned} &\textit{Find the minimum value of} \\ &Z = -x_1 + 2x_2, \\ \textit{subject to } &-x_1 + 3x_2 \le 10, \\ &x_1 + x_2 \le 6, \\ &x_1 - x_2 \le 2, \\ &x_1, x_2 \ge 0. \end{aligned}$$

P142

Maximize the following problem graphically

$$\text{maximize } Z = 40x_1 + 100x_2,$$

where $x_1, x_2 \ge 0$.

Constraints are on the time available on each machine.

$$\left.\begin{array}{ll} \text{for lathes,} & 12x_1 + 6x_2 \le 3{,}000, \\ \text{for milling machines,} & 4x_1 + 10x_2 \le 2{,}000, \\ \text{and for grinding machines,} & 2x_1 + 3x_2 \le 900. \end{array}\right]$$

P144

Maximize the following problem graphically

$$\begin{aligned} \textit{Maximize } Z &= -4x_1 + 3x_2, \\ \textit{subject to } x_1 &- x_2 \le 0, \\ x_1 &\le 4, \\ x_1, x_2 &\ge 0. \end{aligned}$$

P146

Maximize the following problem graphically

$$\begin{aligned} \textit{Maximize } Z &= 3x + 2y, \\ \textit{subject to } -2x &+ 3y \le 9, \\ 3x &- 2y \le -20, \\ x, y &\ge 0. \end{aligned}$$

P185

Use simplex method to solve the following problem :

$$\text{Maximize } Z = 2x_1 + 5x_2,$$
$$\text{subject to} \quad x_1 + 4x_2 \le 24,$$
$$3x_1 + x_2 \le 21,$$
$$x_1 + x_2 \le 9,$$
$$x_1, x_2 \ge 0.$$

P198

Use simplex method to solve the following problem by using Big M method.

$$\text{Maximize } Z = 3x_1 - x_2,$$
$$\text{subject to} \quad 2x_1 + x_2 \le 2,$$
$$x_1 + 3x_2 \ge 3,$$
$$x_2 \le 4,$$
$$x_1, x_2 \ge 0.$$

P206

Use the two-phase simplex method to

maximize $Z = 5x_1 + 3x_2,$

subject to the constraints $2x_1 + x_2 \le 1,$

$x_1 + 4x_2 \ge 6,$

$x_1, x_2, \ge 0.$

P238

Consider the problem

$$\text{minimize } Z = x_2 - 3x_3 + 2x_5,$$
$$\text{subject to} \quad x_1 + 3x_2 - x_3 + 2x_5 = 7,$$
$$-2x_2 + 4x_3 + x_4 = 12,$$
$$-4x_2 + 3x_3 + 8x_5 + x_6 = 10,$$
$$x_1, x_2, \ldots, x_6 \ge 0.$$

Convert it into a maximization problem and solve by the simplex method.

P265

A dairy firm has three plants located in a state. Daily milk production at each plant is as follows:

Plant 1 ... 6 million litres,
plant 2 ... 1 million litres, and
plant 3 ... 10 million litres.

Each day the firm must fulfil the needs of its four distribution centres. Milk requirement at each centre is as follows:

Distribution centre 1 ... 7 million litres,
distribution centre 2 ... 5 million litres,
distribution centre 3 ... 3 million litres, and
distribution centre 4 ... 2 million litres.

Cost of shipping one million litres of milk from each plant to each distribution centre is given in the following table in hundreds of rupees:

		Distribution centres			
		1	2	3	4
Plants	1	2	3	11	7
	2	1	0	6	1
	3	5	8	15	9

Determine the optimal transportation policy.

P283

Minimize the following transportation problem

		Stores					
		1	2	3	4	5	6
Warehouses	1	9	12	9	6	9	10
	2	7	3	7	7	5	5
	3	6	5	9	11	3	11
	4	6	8	11	2	2	10

P305

A company has 3 factories manufacturing the same product and 5 sale agencies in different parts of the country. Production costs differ from factory to factory and the sales prices from agency to agency. The shipping cost per unit product from each factory to each agency is known. Given the following data, find the production and distribution schedules most profitable to the company.

Factory i	Production cost/unit (Rs.)	Max. capacity (No. of units)
1	18	140
2	20	190
3	16	115

Factory i	1	2	2	6	10	5
	2	10	8	9	4	7
	3	5	6	4	3	8
Ajency j		1	2	3	4	5
Demand		74	94	69	39	119
Sales price (Rs.)		35	37	36	39	34

Shipping cost (Rs.)

P314

A company has factories at four different places, which supply warehouses A, B, C, D and E. Monthly factory capacities are 200, 175, 150 and 325 units respectively. Monthly warehouse requirements are 110, 90, 120, 230 and 160 units respectively. Unit shipping costs are given in table 3.157. The costs are in rupees.

To / From	A	B	C	D	E
1	13	--	31	8	20
2	14	9	17	6	10
3	25	11	12	17	15
4	10	21	13	--	17

Shipment from 1 to B and from 4 to D is not possible. Determine the optimum distribution to minimize shipping costs.

P376

A machine tool company decides to make four subassemblies through four contractors. Each contractor is to receive only one subassembly. The cost of each subassembly is determined by the bids submitted by each contractor and is shown in table 4.7 in hundreds of rupees.

Subassemblies \ Contractors	1	2	3	4
1	15	13	14	17
2	11	12	15	13
3	13	12	10	11
4	15	17	14	16

Assign the different subassemblies to contractors so as to minimize the total cost.

P388

A company has one surplus truck in each of the cities A, B, C, D and E and one deficit truck in each of the cities 1, 2, 3, 4, 5 and 6. The distance between the cities in kilometres is shown in the matrix below . Find the assignment of trucks from cities in surplus to cities in deficit so that the total distance covered by vehicles is minimum.

	1	2	3	4	5	6
A	12	10	15	22	18	8
B	10	18	25	15	16	12
C	11	10	3	8	5	9
D	6	14	10	13	13	12
E	8	12	11	7	13	10

P394

A company has a team of four salesmen and there are four districts where the company wants to start its business. After taking into account the capabilities of salesmen and the natrue of districts, the company estimates that the profit per day in rupees for each salesman in each district is as below.

Salesman	District 1	2	3	4
A	16	10	14	11
B	14	11	15	15
C	15	15	13	12
D	13	12	14	15

Find the assignment of salesmen to various districts which will yield maximum profit.

P524

Solve the following l.p.p. by using its dual:

$$\text{Maximize} \quad Z = 5x_1 - 2x_2 + 3x_3,$$
$$\text{subject to} \quad 2x_1 + 2x_2 - x_3 \geq 2,$$
$$3x_1 - 4x_2 \leq 3,$$
$$x_2 + 3x_3 \leq 5,$$
$$x_1, x_2, x_3 \geq 0.$$

P986

On an average, 6 customers reach a telephone booth every hour to make calls. Determine the probability that exactly 4 customers will reach in 30-minute period, assuming that arrivals follow Poisson distribution.

P995

A self-service store employs one cashier at its counter. Nine customers arrive on an average every 5 minutes while the cashier can serve 10 customers in 5 minutes. Assuming Poisson distribution for arrival rate and exponential distribution for service time, find

1. *Average number of customers in the system.*
2. *Average number of customers in the queue or average queue length.*
3. *Average time a customer spends in the system.*
4. *Average time a customer waits before being served.*

P1120

A stockist has to supply 12,000 units of a product per year to his customer. The demand is fixed and known and the shortage cost is assumed is to be infinite. The inventory holding cost is ₹ 0.20 per unit per month and the ordering cost per order is ₹ 350. Determine

(i) The optimum lot size q_0
(ii) optimum scheduling period t_0,
(iii) minimum total variable yearly cost.

P1167

Find the optimal order quantity for a product for which the price breaks are as follows:

Quantity	Unit cost
$0 < q < 500$	₹ 10,
$500 \leq q < 750$	₹ 9.25,
$750 \leq q$	₹ 8.75.

The monthly demand for the product is 200 units, storage cost is 2% of the unit cost and cost of ordering is ₹ 100.

P Task 14 Class work ABC Analysis

A company produces a mix of high technology products for use in hospitals. The annual sales data are as follows: Categorize into ABC

Product Type	Number of Units	Unit Price (Rs)
1	1000	2.5
2	250	0.55
3	150	6.5
4	300	1
5	100	1.5
6	700	1.43
7	500	7
8	15	4.98
9	1000	0.75
10	600	1.62

P Class problem: Random Number generation

Historical daily demand for radial tires at Harry's auto tire and probability distribution is as follows;

Demand for tires:	0	10	2	3	4	5
Frequency (Days):	10	20	40	60	40	30

Assume the random number generation for ten days as 52,37,82,69,98,96,33,50,88,90. Find the expected average daily demand and compare with simulation of demand for radial tires.