SuccessClap

Online Coaching for UPSC MATHEMATICS

QUESTION BANK SERIES

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SuccessClap : Question Bank for Practice

LPP

L1. A manufacturer produces two types of models M_1 & M_2. Each model of type M_1 requires 4 hr of grinding and 2 hr of polishing. Whereas model M_2 requires 2 hr of grinding and 5 hr of polishing. The manufacturer has 2 grinders and 3 polishers. Each grinder works 60 hr a week and each polisher works 50 hr a week. Profit on model M_1 is Rs. 4.00 and on model M_2 is Rs. 5.00. How should the manufacturer allocate his production capacity to the two types of models, so that he may make the maximum profit in a week? Formulate the linear programming problem.

L2. A paper mill produces two grades of paper X and Y. Because of raw material restrictions it cannot produce more than 500 tons of grade X and 400 tons of grade Y in a week. There are 175 production hr in a week. It requires 0.2 and 0.4 hr to produce one ton of product X and Y respectively with corresponding profit of Rs. 4.00 and 5.00 per ton. Formulate the above as L.P.P to maximize the profit.

L3. A person requires 10, 12 and 12 unit chemicals P,Q,R respectively for his garden. A liquid product contains 5,2 and 1 units of P,Q and R respectively per jar. A dry product contains 1,2 and 4 units of P,Q and R per carton of the liquid product sales Rs. 5.00 per jar and dry product sales Rs. 3.00 per carton, how many of each should be purchased in order to minimize the cost. Formulate it as L.P.P.

L4. A manufacturer produces there models I, II and III of a certain product. He uses two types of raw material (A and B) of which 5000 and 8000 units respectively are available. Raw material of type A requires 3,4 and 6 units of each model. Whereas type B requires 6,4 and 8 of model I, II and III respectively. The labour time of each unit of model I is twice that of model II and three times of model III. The entire labour force of the factory can produce equivalent of 3000 units of model I. A market survey indicates that the minimum demand of three models is 600, 400 and 350 units repectively. However, the ratios of number of units produced must be equal to 3:2:5. Assume that the profit per unit of models I, II and III are Rs. 80,50 and 120 respectively. Formulate this problem a linear programming model to determine the number of units of each product which will maximize the profit.

L5. A research laboratory has two melts A and B of copper (Cu), Nickel (Ni) and Zinc (Zn) alloy to make up a new alley. The composition of metals are as follows:

Melt	Composition (Parts)		
	Cu	Ni	Za
A	3	2	1
B	2	2	1

To make up a new alloy at least 15 kg of copper, 10 kg of nickel, and 6 kg of zinc are needed. Melt A cost Rs. 45 per kg and melt B cost Rs. 50 per kg. Formulate the L.P.P for the quantities of each melt to be used to minimized cost.

L6. The objective of a diet problem is to ascertain the quantities of a certain foods that should be eaten to meet certain nutritional requirement at a minimum cost. The consideration is limited to milk, beef and eggs and two vitamins A,B and C. The number of milligrams of each of these vitamins contained with a unit of each food is given below:

Vitamin	Gallon of milk	Pound of beef	Dozen of eggs	Minimum daily requirement
A	1	1	10	1 mg
B	100	10	10	50 mg
C	10	100	10	10 mg
Cost	Rs 1.00	Rs. 1.10	Rs 0.50	-

What is the L.P.P for this problem?

L7. A firm can produce three types of cloth A, B and C. Three kinds of wool is required for it, say red, green and blue wools. One unit length of type A cloth needs 2 yards of red wool, 5 yards of blue wools, one unit length of type B cloth needs 3 yards of red wool, 4 yards of green wool, and 2 yards of blue wool, and one unit length of type C cloth needs 6 yards of green and 5 yards of blue wools. The firm has only a stock of 10 yards of red wool, 12 yards of green wool and 17 yards of blue wool. It is assumed that the income obtained from one unit length of type A, B and C are Rs 4.00, 5.00 and 6.00 respectively. Determine how the firm should use the available material, so as to maximize the income from the finished cloths.

L8. An oil refinery uses blending process to produce gasoline in a typical manufacturing process. Crude A and B are mixed to produce gasoline G_1 and G_2. The input and output of the process are as follows:

Process	Input		Output	
	Crude A	Crude B	G_1	G_2
1	1	2	6	8
2	6	8	5	7

Availability of crude A is only 200 tonnes and B is 500 tonnes. Market demand of G_1 is 150 tonnes and G_2 is 200 tonnes. Profit on process 1 and process 2 is Rs 300 and 500 per tonne. What is the optimal mixture of two blending processes so that refinery can maximize its profit?

SOLVE BY GRAPHICAL METHOD

G1. Solve the following L.P.P by graphical method

Min $Z = 20x_1 + 10x_2$

Subject to $x_1 + 2x_2 \leq 40$

$3x_1 + x_2 \geq 30$

$4x_1 + 3x_2 \geq 60$

$x_1 . x_2 \geq 0$

G2. Solve the following L.P.P using graphical methods

Max $Z = 6x_1 + 8x_2$

Subject to $5x_1 + 10x_2 \leq 60$

$4x_1 + 4x_2 \leq 40$

$x_1 . x_2 \geq 0$

G3. Use graphical method to solve the L.P.P

Min $Z = 3x_1 + 2x_2$

S.T $5x_1 + x_2 \geq 10$

$x_1 + x_2 \geq 6$

$x_1 + 4x_2 \geq 12$

$x_1 . x_2 \geq 0$

G4. Solve the following L.P.P by graphical method

Max $Z = 3x_1 + 2x_2$

S. T $x_1 - x_2 \geq 1$

$x_1 + x_2 \geq 3$

$x_1 . x_2 \geq 0$

G5. By graphical method solve the following

Max $Z = 3x_1 + 4x_2$

S.T $5x_1 + 4x_2 \leq 200$

$3x_1 + 5x_2 \leq 150$

$5x_1 + 4x_2 \geq 100$

$8x_1 + 4x_2 \geq 80$

$x_1 . x_2 \geq 0$

SOLVE BY SIMPLEX METHOD

S1. Using simplex method to solve the L.P.P

Max $Z = 3x_1 + 2x_2$

S.T $x_1 + x_2 \leq 4$

$x_1 - x_2 \leq 2$

$x_1 . x_2 \geq 0$

S2. Solve the L.P.P by simplex method

$$\text{Max } Z = 10x_1 + 6x_2$$
$$\text{S.T} \quad x_1 + x_2 \leq 2$$
$$2x_1 + x_2 \leq 4$$
$$3x_1 + 8x_2 \leq 12$$
$$x_1 . x_2 \geq 0$$

S3. Solve the following L.P.P by simplex method

$$\text{Max } Z = x_1 + x_2 + 3x_3$$
$$3x_1 + 2x_2 + x_3 \leq 2$$
$$2x_1 + x_2 + 2x_3 \leq 2$$
$$x_1 , x_2 , x_3 \geq 0$$

S4. Use simplex method to solve the L.P.P

$$\text{Min } Z = x_1 - 3x_2 + 2x_3$$
$$\text{S.T} \quad 3x_1 - x_2 + 2x_3 \leq 7$$
$$-2x_1 + 4x_2 \leq 12$$
$$-4x_1 + 3x_2 + 8x_3 \leq 10$$
$$x_1, x_2, x_3 \geq 0$$

S5. Solve the L.P.P by simplex method

$$\text{Max } Z = 3x_1 + 2x_2 + 5x_3$$
$$\text{S.T} \quad x_1 + 2x_2 + x_3 \leq 430$$
$$3x_1 + 0x_2 + 2x_3 \leq 460$$
$$x_1 + 4x_2 + 0x_3 \leq 420$$
$$x_1, x_2, x_3 \geq 0$$

S6. Use Big. M Method to solve the following L.P.P

$$\text{Max } Z = 3x_1 + 2x_2$$
$$\text{S.T} \quad 2x_1 + x_2 \geq 2$$
$$3x_1 + 4x_2 \geq 12$$
$$x_1 , x_2 \geq 0$$

S7. Solve the following L.P.P using Big M. method

$$\text{Max } Z = x_1 + 2x_2 + 3x_2 - x_4$$
$$\text{S.T} \quad x_1 + 2x_2 + 3x_3 = 15$$
$$2x_1 + x_2 + 5x_3 = 20$$
$$x_1 + 2x_2 + x_3 + x_4 = 10$$

$x_1 . x_2 . x_3 . x_4 \geq 0$

S8. Solve the following L.P.P using Big M. method

Min $z = x_1 + x_2$

S.T $2x_1 + x_2 \geq 4$

$x_1 + 7x_2 \geq 7$

$x_1, x_2 \geq 0$

S9. Use two – phase simplex method to solve

Max $Z = 5x_1 + 3x_2$

S.T $2x_1 + x_2 \leq 1$

$x_1 + 4x_2 \geq 6$

$x_1, x_2 \geq 0$

S10. Solve the following L.P.P by two – phase simplex method

Max $Z = 5x_1 - 4x_2 + 3x_3$

S.T $2x_1 + x_2 - 6x_3 = 20$

$6x_1 + 5x_2 + 10x_3 \leq 76$

$8x_1 - 3x_2 + 6x_3 \leq 50$

$x_1, x_2, x_3 \geq 0$

S11. Write the dual of the problem

Min $Z = 3x_1 + x_2$

S.T $2x_1 + 3x_2 \geq 2$

$x_1 + x_2 \geq 1$

$x_1 . x_2 \geq 0$

S12. Find the dual of the following L.P.P

Max $Z = 3x_1 - x_2 + x_3$

S.T $4x_1 - x_2 \leq 8$

$8x_1 + x_2 + 3x_3 \geq 12$

$5x_1 - 6x_3 \leq 13$

$x_1, x_2, x_3 \geq 0$

S13. Find the dual of the following

Min $Z = x_1 + 3x_3$

S.T $2x_1 + x_3 \leq 3$

$x_1 + 2x_2 + 6xy \geq 5$

$-x_1 + x_2 + 2x_3 = 2$

$x_1, x_2, x_3 \geq 0$

S14. Find the dual of the following L.P.P

$$\text{Min } Z = x_2 + 3x_3$$
$$\text{S.T} \quad 2x_1 + x_2 \leq 2$$
$$X_1 + 2x_2 + 6x_3 \geq 5$$
$$-x_1 + x_2 + 2x_3 = 2$$
$$x_1, x_2, x_3 \geq 0$$

S15. Find the dual of the following L.P.P and solve it

$$\text{Max } Z = 4x_1 + 2x_2$$
$$\text{S.T} \quad x_1 + x_2 \geq 3$$
$$x_1 - x_2 \geq 2$$
$$x_1, x_2 \geq 0$$

S16. Solve the following L.P.P by converting it into its dual

$$\text{Min } Z = 20x_1 + 10x_2$$
$$\text{S.T} \quad x_1 + x_2 \geq 10$$
$$3x_1 + 2x_2 \geq 24$$
$$x_1, x_2 \geq 0$$

S17. Use dual simplex method to solve the L.P.P

$$\text{Max } Z = -3x_1 + x_2$$
$$\text{S.T} \quad -x_1 - x_2 \geq 1$$
$$2x_1 - 3x_2 \geq 2$$
$$x_1, x_2 \geq 0$$

S18. Use dual simplex method to solve the following L.P.P

$$\text{Max } Z = -2x_1 - 3x_2$$
$$\text{S.T} \quad x_1 + x_2 \geq 2$$
$$2x_1 + x_2 \leq 10$$
$$x_1 + x_2 \leq 8$$
$$x_1, x_2 \geq 0$$

S19. Use dual simplex method to solve the L.P.P

$$\text{Max } Z = -2x_1 - x_3$$
$$\text{S.T} \quad x_1 + x_2 - x_3 \geq 5$$
$$x_1 - 2x_2 + 4x_3 \geq 8$$
$$x_1, x_2, x_3 \geq 0$$

T1. Determine an initial basic feasible solution to the following transportation problem using north – west corner rule.

	To					Supply
Demand	40	6	8	18	6	
	3	4	6	8	9	20
	2	10	1	5	8	30
	7	11	20	40	3	15
	2	1	9	14	16	13

T2. Find the initial BFS of the following T – problem their cell contains unit transportation cost by NWC method.

Warehouse→ Factory ↓	W_1	W_2	W_3	W_4	Factory capacity
F_1	19	30	50	10	7
F_2	70	30	40	60	9
F_3	40	8	70	20	18
Warehouse requirement	5	8	7	14	34

T3. Solve the following T – problem by lowest cost entry method.

	To W_1	W_2	W_3	W_4	W_5	Supply
F_1	3	4	6	8	9	20
F_2	2	10	1	5	8	30
F_3	7	11	20	40	3	15
F_4	2	1	9	14	16	13
Demand →	40	6	8	18	6	78 / 78

T4. Solve the following transportation problem by Vogel's approximation method.

		To				
	W_1	W_2	W_3	W_4	W_5	Supply↓
From F_1	3	4	6	8	9	20
F_2	2	10	1	5	8	30
F_3	7	11	20	40	3	15
F_4	2	1	9	14	16	13
Demand→	40	6	8	18	6	

T5. Determine the initial basic feasible solution of the following transportation problem by using VAM method.

	Destination				
	D_1	D_2	D_3	D_4	Supply↓
A	11	13	17	14	250
B	16	18	14	10	300
C	21	24	13	10	400
Demand →	200	225	275	250	950

T6. Solve the following transportation problem using VAM.

	D_1	D_2	D_3	D_4	Supply
S_1	19	30	50	10	7
S_2	70	30	40	60	9
S_3	40	8	70	20	18
Demand	5	8	7	14	

T7. Using Vogel's approximation method solve the following transportation problem.

	D_1	D_2	D_3	D_4	D_5	Available
0_1	21	16	25	13		11
0_2	17	18	14	23		13
0_3	32	27	18	41		19
Requirement	6	10	12	15		

T8. Solve the following T – problem

	D_1	D_2	D_3	D_4	Supply↓
S_1	5	2	4	3	60
S_2	6	4	9	5	60
S_3	2	3	8	1	90
Demand→	50	65	65	30	210

T9. Solve the following transportation problem using Vogel's approximation method. Verify its optimality test.

Destination

	1	2	3	4	Capacity
1	20	22	17	4	120
2	24	37	9	7	70
3	32	37	20	15	150
Demand	60	40	30	110	

T10. A product is produced by 4 factories A, B, C and D. The unit production costs in them Rs 2, Rs. 3, Re. 1 and Rs. 5 respectively. There production capacity are factory A 50 unit, B 70 units, C 30 units and D 50 units.
These factories supply the product to 4 stores demand of which are 25, 35, 105 and 20 units respectively. Unit transportation cost in Rs. from each factory to store is given by

Store

	1	2	3	4
A	2	4	6	11
B	10	8	7	5
C	13	3	9	12
D	4	6	8	3

Determine the extent of deliveries from each of the factories to the store so that the total production and cost is minimum.

T11. Solve the following T – problem to determine total minimum cost.

Destination

		1	2	3	Supply
Origin	1	25	17	25	350
	2	15	10	18	350
Demand		300	350	550	

T12. A company has plants in four places, which supply to market A , B,C, D and E. Monthly plant capacities are 200, 175, 150 and 325 units respectively. Monthly market requirements are 110,90, 120, 230 and 160 units respectively. Unit – shipping costs are given by

To / From	A	B	C	D	E	Supply
1	13	-	31	8	20	200
2	14	9	17	6	10	175
3	25	11	12	17	15	150
4	10	21	13	-	17	325
Demand	110	90	120	230	160	

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

T13. An oil refinery has two plants located at Alwar and Bikaner with capacity of 300 units and 200 units per week respectively. The industries supplies oil to its four subdivisions situated at Jaipur, Kota, Jodhpur and Jaisalmer which have maximum demand of 90, 150, 150 and 50

T14. There are three fertilizers factories X, Y and Z located at different parts of the country produce 0,4 and 5 lakh tonnes of urea respectively. Under the directive of the central govt. they are to be distributed to 3 states A, B and C as 5,3 and 7 lakh tonnes respectively.
The selling price per tonne (in Rs.) and shipping cost (in Rs) are given by Tables (i) and (ii)

Table (i)

	A	B	C
X	21	37	31
Y	23	34	34
Z	24	39	32

Table (ii)

	A	B	C
X	11	17	16
Y	15	12	14
Z	20	12	15

Determine suitable transportation problem pattern so as to maximize the profit by using VAM method.

T15. Food packets have to be air lifted by three aircraft from an airport and air dropped to five villages. The quantities in one trip by these aircraft to the village are given below. The total number of trips per day that an aircraft can make to the village are also given. Find the number of trips each aircraft should make to each village so that the total quantity of food transported is maximum.

	V_1	V_2	V_3	V_4	V_5	Trips/day by aircraft
A_1	10	8	6	9	12	50
A_2	5	3	8	4	10	90
A_3	7	9	6	10	4	60
Trips/day to village	100	80	70	40	20	

A1. Solve the following assignment problem

Jobs (hr)

Workers↓	L_1	L_2	L_3	L_4	L_5
W_1	2	9	2	7	1
W_2	6	8	7	6	1
W_3	4	6	5	3	1
W_4	4	2	7	3	1
W_5	5	3	9	5	1

A2. On the basis of research work, HRD department selects five researchers to perform five projects. The time (in hr) each researcher will take to perform each project is given by the effectiveness matrix.

Researcher

Project↓	R_1	R_2	R_3	R_4	R_5
P_1	15	10	25	25	10
P_2	1	8	10	20	2
P_3	8	9	17	20	10
P_4	14	10	25	27	15
P_5	10	8	25	27	12

How should the project be allocated one per researcher, so as to minimize the total time?

A3. Solve the following assignment problem

Jobs↓	I	II	III	IV	V	(Machines)
1	20	23	18	10	16	20
2	50	20	17	16	15	11
3	60	30	40	55	8	7
4	6	7	10	20	25	9
5	18	19	28	17	60	70
6	9	10	20	30	40	55

A4. A national truck service has a surplus of one truck in each of the cities 1,2,3,4,5 and 6 and a deficit of one truck in each of the cities 7,8,9,10,11 and 12. The distances (in km) between the cities with a surplus and cities with deficit are displayed in the table

	To					
From↓	7	8	9	10	11	12
1	31	62	29	42	15	41
2	12	19	39	55	71	40
3	17	29	50	41	22	22
4	35	40	38	42	27	33
5	19	30	29	16	20	23
6	72	30	30	50	41	20

How should the trucks be displayed so as to minimize the total distance travelled?

A5. Find an optimal solution to an assignment with the following cost matrix.

	J_1	J_2	J_3	J_4
M_1	10	9	7	8
M_2	5	8	7	7
M_3	5	4	6	5
M_4	2	3	4	5

A6. For a product of the following data are given:

Territory	Annual sales (Rs)
I	Rs. 60,000/-
II	Rs. 50,000/-
III	Rs. 40,000/-
IV	Rs. 30,000/-

Working under same condition. The yearly sales of salesman are in the following proportion:

Salesman : A B C D

Proportion: 7 5 5 4

How the territories should be assigned to salesman so that the sale is maximized?

A7. A company has a team of four salesman and there are four districts where the company wants to start its business. After taking into account the capabilities of salesman and the nature of districts, the company estimates that the profit per day in rupees for each salesman in each district is as below:

	District			
Salesman↓	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 salesman to various districts which yield maximum profit.

A8. The processing time in (minutes) taken 5 operators to make 5 different products are given below. The effective working hours in day are 6. Profits per product are Rs 4,2,3,3 and 4 respectively for products 1,2,3,4 and 5 respectively. Find the allocation of operators to products so as to maximize total profit. The effective matrix as follows.

	Products				
Operators	1	2	3	4	5
A	10	12	18	15	9
B	12	10	20	18	10
C	8	9	15	10	8
D	9	8	24	12	12
E	10	15	18	12	10

A9. A finding agency "DST" has five projects to be done. The following matrix shows the return in rupees of assigning ith.

Institute (i = 1,2,...5) to the jth project (j = 1,2,...5)

	Project				
Institute↓	P_1	P_2	P_3	P_4	P_5

1	5	11	10	12	4
2	2	4	6	3	5
3	3	12	5	14	6
4	6	14	4	11	7
5	7	9	8	12	5

Assign five projects to the five institutes so as to maximize the total expected profit.

A10. Solve the following assignment problem for minimum optimal cost.

To city

From City↓	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

A11. A methods of engineer want to assign four new methods to three work centres. The assignment of the new methods will increase production and they are given below. If only one method can be assigned to a work centre, determine optimum assignment.

Work Centre

Method↓	A	B	C
1	10	7	8
2	8	9	7
3	7	12	6
4	10	10	8

A12. A fast – food chain wants to build four stores. In the past, the chain has used six different construction companies and having been satisfied with each, has invited each to bid on each job. The final bids (in lakhs of rupees) are shown in the table.

Construction Companies

	1	2	3	4	5	6
Store 1	85.3	88.0	87.5	82.4	89.1	86.7
Store 2	78.9	77.4	77.4	76.5	79.3	78.3

Store 3	82.0	81.3	82.4	80.6	83.5	81.7
Store 4	84.3	84.2	86.2	83.3	84.4	85.5

What assignment results in minimum total cost of the fast – food chain?

A13. Solve the following assignment problem.

To

From↓	A_1	B_1	C_1	D_1	E_1
A	-	7	6	8	4
B	7	-	8	5	6
C	6	8	-	9	7
D	8	5	9	-	8
E	4	6	7	8	-

A14. Five mechanics are available to work on five machines and the respective cost in rupees for each mechanics machine combination is given in the matrix. A sixth machine is available to replace one of the existing machines and associated cost is given in the matrix. Find

$\leftarrow Machine$

Mechanic↓	1	2	3	4	5	6
A	19	15	-	16	13	22
B	13		15		21	14
C	15	17	19	20	12	18
D	20	22	16	18	17	-
E	-	16	14	19	18	15
F	0	0	0	0	0	0

Whether the new machines are accepted.
The optimal assignment and the associated cost.

A15. A salesman has to visit five cities A,B,C,D and E. the distance (in hundred) km between the five cities are as follows.

$\leftarrow To\ city$

From city↓	A	B	C	D	E
A		17	16	18	14
B	17		18	15	16
C	16	18	-	19	17
D	16	15	19		17

E	14	16	17	18	

If the salesman start from city and has to come back to city A. which route should he select so that the total distance travelled by him is minimized?

T16. Find the least route for the travelling salesman problem shown below.

To city

From city↓	1	2	3	4	5	6	7
1	∞	8	14	8	6	10	3
2	8	∞	12	7	6	5	5
3	10	9	∞	13	5	13	10
4	7	6	13	∞	7	10	8
5	7	4	9	10	∞	6	9
6	8	5	13	7	6	∞	4
7	4	5	11	9	6	5	∞

A17. For a travelling salesman problem following information as given

$C_{12} = 20$, $C_{13} = 4$, $C_{14} = 10$, $C_{23} = 5$, $C_{24} = 6$, $C_{25} = 10$,

$C_{35} = 6$, $C_{45} = 20$

where $C_{ij} = C_{ji}$ and there is no route between cities i to j if the value for C_{ij} is not shown.

A18. Solve the following maxi. profit (Rs) assignment problem and comment which job should be declined?

Jobs

Machinists↓	J_1	J_2	J_3	J_4	J_5
1	6.10	7.50	4.00	8.10	7.20
2	7.20	8.20	5.60	3.50	4.90
3	8.70	9.40	12.20	10.10	7.10
4	4.80	6.20	6.00	9.50	10.0

A19. In RTO office employs typists on hourly price – rate basis for their work. There are four typists and their charges and speeds are different. According to an earlier understanding only one job is given to one typist at a time and the typist is paid for full one hour even if he works for a fraction of an hour. Find the least cost given the following information.

Typists	Rate/hr (Rs.)	No. of page typed/hr
M_1	6	10

M_2	9	12
M_3	5	9
M_4	4	15

Job	No. of pages
J_1	125
J_2	130
J_3	140
J_4	160

A20. Research and Development Centre of Rajasthan Technical University, Kota produces four new types of equipment. There are four researchers who are capable of producing any of these four new types of equipments. The processing time is different for each researcher. The working time of the researcher in laboratory is 5 hours a day and no time for lunch permitted. The processing time in minutes and profit for each of the equipment are given by matrix below.

New type of equipment

Researcher	NE_1	NE_2	NE_3	NE_4
R_1	5	10	15	20
R_2	30	60	20	6
R_3	50	100	150	10
R_4	15	30	6	5
Profit (Rs.)/unit	10	8	6	4

Determine: The optimal assignment of new type of equipment to researcher so as to maximize the profit.

A21. A medicine company has five scientists to manufacture five different types of new medicine. All the scientists are capable of manufacturing all type of new medicines. The output per day per scientist and profit (Rs.) for each type of medicine are given below.

New Medicine

Scientists↓	NM_1	NM_2	NM_3	NM_4	NM_5
S_1	3	10	3	1	8
S_2	7	9	8	1	7
S_3	5	7	6	1	4
S_4	5	3	8	1	4

S_5	6	4	10	1	6
Profit(Rs.)	5	6	4	9	10

Per medicine

Determine:

Optimal assignment for medicine so as to maximize the profit.

If the scientist S_4 is absent for a specified period and no other substituition of scientist is available, what should be the optimal assignment?