Time 3 hours **Total Marks : 100**

Note:

1. **All questions are compulsory.**
2. **Figures to the right indicate full marks.**
3. **Use of non-programmable scientific calculator is allowed.**
4. **Graph papers will be supplied on request.**

Q.1 A. Answer whether following statements are True or False. 8

i) Replacement theory is concerned with the optimal replacement period of equipment such that the total cost of replacement and maintenance is the least.

ii) With the passage of years, the running and operating costs of items subject to normal wear and tear increases.

iii) The graphical method of solving linear programming problem is useful because of its applicability to the problems with more than two variables.

iv) All constraints in a linear programming problem are nonlinear inequalities in decision variables.

v) Properly defining the decision variables is an important step in model formulation.

vi) The initial solution to any transportation problem is found using North-West Corner Rule or least cost method or Vogel's Approximation Method.

vii) The basic requirement for using the transportation technique is that the transportation model has to be balanced.

viii) If a constant value is added to every cost element C_{ij} in the transportation tableau, the optimum values of the variables X_{ij} will change.

B. Select the most appropriate choice for the following: 7

i) When time value of money is considered _____.

a) timing of incurrence of costs is important. b) costs need to be discounted.
c) the present value factors serve as the weights. d) all of these

ii) The problem of replacement is not concerned with _____

a) items that deteriorate gradually.
b) items that fail suddenly
c) determination of optimum replacement interval.
d) maintenance of items to workout profitability.

iii) For the items that deteriorate gradually _____.

a) operating and maintenance costs increase with passage of time
b) optimum replacement interval is the minimum time elapsing between the successive replacements.
c) the annual maintenance cost and annual depreciation tend to decrease.
d) maintenance of items to workout profitability.

iv) The transportation problem deals with the transportation of

a) a single product from several sources to a single destination.
b) a single product from several sources to a several destinations.
c) multiple products from several sources to a several destination.
d) none of these.

v) Modified distribution method isused to find _____ .

a) an optimum solution.
b) an initial solution.
c) initial allotments depending on the minimum cost of the cells.
d) all of these.

vi) For maximization linear programming problem, the coefficient of an artificial variable in the objective function is _____ .

a) +M b) -M

c) zero d) none of these

vii) If two constraints do not intersect in the positive quadrant of the graph then _____ .

a) one of the constraint is redundant. b) the solution is infeasible.

c) the solution is unbounded. d) none of these.

C. Answer briefly in one or two sentences: 5

i) What is a feasible region with reference to L.P.P.?

ii) Define slack variable in L.P.P.

iii) What is meant by balanced transportation problem?

iv) What is meant by gradual failure?

v) What is meant by the multiple optimum solution to a transportation problem?

Q.2 A. A company is currently spending Rs. 1500 on transportation of its product from three plants to four distribution centers. The transportation cost per unit is given below: 20

Plants	Distribution centers				Availability
	C_1	C_2	C_3	C_4	
P_1	19	30	50	12	17
P_2	70	30	40	60	20
P_3	40	10	30	20	18
Requirements	15	8	8	15	

Determine optimum distribution plan. Also state the maximum amount saved by the company by implementing optimum distribution plan.

OR

B. Solve the following transportation problem for maximum profit. 20

Ware houses	Profit in Rs. Per unit				Availability
	Markets				
	I	II	III	IV	
A	40	25	22	33	65
B	44	35	30	30	30
Z	38	38	28	30	55
Demand	40	20	60	30	

Q.3 A. A company produces three products A,B and C. The profits per unit of these products are Rs.3, 4 and 6 respectively. The products are processed in three departments P, Q and R. The time in hours required for each product in these departments and available time in hours is as follows : 20

	Departments		
Product	P	Q	R
A	4	5	1
B	1	3	2
C	6	1	3
Available time	960	640	320

Formulate the above problem as linear programming problem and solve it by simplex method.

OR

B. i) A small scale manufacturing unit produces two products A and B using three operations: grinding, assembly and testing. Product A requires 30, 20, and 10 minutes to grinding, assembly and testing respectively, whereas product B requires 15, 40, and 10 minutes to grinding, assembly and testing respectively. At least 900 minutes of grinding, 1200 minutes of assembly and 500 minutes of testing should be used. Each product A costs Rs. 60 and each product B costs Rs. 90 to manufacture. Formulate the above problem as linear programming problem and solve it by graphical method. 15

ii) Write the dual of the following linear programming problem: 5

Maximize $Z=60X_1 +30X_2 +20X_3$

subject to $X_1 - 5X_2 + 3X_3 = 18$,

$5X_1 + 4X_2 -2X_3 \leq 14$,

$2X_1 +5X_2 +X_3 \geq 11$,

$X_1 \geq 0, X_2 \geq 0, X_3 \geq 0$

Q.4 Attempt **ANY TWO** of the following:

A A factory has 5000 bulbs. The failure rate of the bulbs is given below: 10

Year	1	2	3	4	5
Probability of failure:	0.15	0.25	0.3	0.2	0.1

If all the bulbs are to be replaced together irrespective of their failure, then the cost per bulb is Rs. 5 . The cost of replacement of each bulb individually is Rs. 20 per bulb. Find the optimum replacement policy for the bulbs.

B The initial cost of the machine is Rs. 100000 and running cost increase with the age of the machine is given below: 10

Year	1	2	3	4	5	6	7
Running cost(Rs.)	10000	15000	20000	25000	30000	40000	50000

It is given that money is worth 10% per year and the scrap value is nil. Find the optimum period of replacement for the machine.

C For the following data find the optimum period of replacement: 10

Initial cost of the machine 100000

Year	1	2	3	4	5	6	7	8
Labour cost:	4000	5000	6000	7000	8000	9000	10000	12000
Spare part cost:	1000	1200	1600	2000	2400	2800	3200	3600
Scrap value:	60000	50000	40000	30000	25000	20000	10000	10000

Q.5 Attempt **ANY FOUR** of the following

A Describe briefly the different phases of Operations Research. 5

B Explain briefly any five advantages of Operations Research. 5

C Discuss the special cases of infeasible solution and unbounded solution with reference to linear programming problems. 5

D Write the Linear Programming Problem corresponding to initial simplex table for a minimization problem given below: 5

Basis		C_j	50	30	0	0	M	M
		Solution	X_1	X_2	S_1	S_2	A_1	A_2
C_i	X_i	b_I						
0	S_1	15	3	5	1	0	0	0
M	A_1	20	4	4	0	0	1	0
M	A_2	30	5	3	0	-1	0	1

E What is meant by degenerate solution of a transportation problem? How to overcome the degeneracy of the solution of a transportation problem. 5

F The table below has been taken from the solution procedure of a transportation problem. 5

	D_1	D_2	D_3	D_4	Supply
S_1	10	8	7	12	500
S_2	12	13	6	10	600
S_3	8	10	12	14	900
Demand	700	550	450	400	

The allocations are $S_1 \rightarrow D_2 = 350$, $S_1 \rightarrow D_4 = 150$, $S_2 \rightarrow D_3 = 450$, $S_2 \rightarrow D_4 = 150$, $S_3 \rightarrow D_1 = 700$, $S_3 \rightarrow D_2 = 200$.

Answer the following questions with reasons:

i) Is the above problem balanced?

ii) Is the above solution is optimum? If not then find the optimum solution.

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