Time: 3 Hours **Total Marks: 100**

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

Q.1 (a) Choose correct Answer for the following (ANY FIVE) **(10)**

i. The objective function is always of maximization type in …….. **(2)**
a) general form of LPP b) canonical form of LPP
c) standard form of LPP d) none of the above

ii. Let x_1 be the expressed as $x_1^{'} - x_1^{''}$ in the canonical form of L.P.P. then x_1 is **(2)**
a) unrestricted b) non-negative
c) positive d) non-positive

iii. Feasible solution satisfies **(2)**
a) only constraints b) only non-negative restrictions
c) (a) and (b) both d) (a), (b) and optimum solution

iv. The transportation problem in which ……. Then it is called as balanced transportation problem **(2)**
a) Total Supply ≠ Total Demand b) Total Supply < Total Demand
c) Total Supply > Total Demand d) Total Supply = Total Demand

v. The number of basic decision variables of the general transportation problem at any stage of feasible solution must be **(2)**
a) $m + n - 1$ b) $m - n - 1$
c) $m + n + 1$ d) $m - n + 1$

vi. The solution to assignment problem can be obtained by using **(2)**
a) Complete enumeration method (if n no. of worker and jobs is small) b) Hungarian method
c) Sequencing algorithm d) (a) and (b) both

vii. A sequencing problem involving six jobs and three machines requires evaluation of: **(2)**
a) $(6! + 6! + 6!)$ sequences b) $(6!)^3$ sequences
c) $(6 \times 6 \times 6)$ sequences d) $(6 + 6 + 6)$ sequences

Q.1 (b) Answer the following in one/ two sentences (ANY FIVE) **(10)**

i. Explain the concept of linearity in LPP **(2)**

ii. What are the different types of constraints in LPP? **(2)**

iii. What is Iso-profit line in graphical solution to LPP? **(2)**

iv. What is meant by unbalanced transportation problem? **(2)**

v. Mention the necessary and sufficient condition for the solution of transportation problem to be feasible. **(2)**

vi. What is meant by sequencing problem? **(2)**

vii. What is no passing rule? **(2)**

Q2 Attempt Any Two sub-questions: **(20)**

(a) **(i)** An investor wants to invest in two securities A and B. The risk and return associated with these securities is different. Security A gives a return of 9% and has risk factor of 5 on a scale of zero to 10. Security B gives return of 15% but has risk factor of 8. Total amount to be invested is Rs. 5,00,000. Total minimum returns on the investment should be 12%. Maximum combined risk should not be more than 6. Formulate the LPP. **(03)**

(ii) A company manufacturers two products A and B. both products are processed on two machines P and Q. **(07)**

	P	Q
A	6 Hrs. /unit	2 Hrs. /unit
B	4 Hrs. /unit	4 Hrs. /unit
Availability	7200 Hrs./month	4000 Hrs./month

Profit per unit for A is Rs. 100 and for B is Rs. 80. Find out monthly production of A and B to maximize profit by graphical method. Also find and plot iso-profit line.

(b) Minimize $Z = 4x + 3y$ **(10)**

subject to constraints:

$$200x + 100y \geq 4000,$$
$$x + 2y \geq 50,$$
$$40x + 40y \geq 1400,$$
$$x, y \geq 0.$$

Find optimal solution using simplex method.

(c) **(i)** Find dual of the following LPP: **(05)**

Minimize $Z = 25x_1 + 30x_2$

subject to constraints:

$$4x_1 + 3x_2 \geq 30,$$
$$2x_1 + 3x_2 \geq 36,$$
$$x_1 \geq 0, x_2 \geq 0.$$

(ii) Write down the canonical form of general LPP and its characteristic. **(05)**

Q3 Attempt Any Two sub-questions: **(20)**

(a) A company has three factories A, B, C with production capacities of 11, 13, 19 units (in thousands). It has four warehouses P, Q, R and S with demands 6, 10, 12, 15 units (in thousands). Unit cost of transportation is given from each factory to each warehouse. **(10)**

From ↓ To →	P	Q	R	S
A	42	32	50	26
B	34	36	28	46
C	64	54	36	82

Based on above information, Find initial basic solution using (i)North-West Corner Rule Method and (ii) Least cost method. Also compare the solution obtained by both the methods and comment on it.

(b) **(i)** Consider following profit Table: **(05)**

Sources	X	Y	Z	Supply
A	25	22	23	2000
B	15	20	18	1500
C	18	17	16	1000
Demand	1200	1800	1000	

Find initial basic feasible solution using VAM to maximize total profit.

(ii) Define transportation problem. Also discuss the structure of transportation problem. **(05)**

(c) (i) Explain North-West Corner Method to solve transportation problem for an initial solution. **(05)**

(ii) How to solve unbalanced transportation problem of maximization type? **(05)**

Q4 **Attempt Any Two sub-questions:** **(20)**

(a) In a factory, 5 employees and 5 jobs are to be done on one-to-one basis. The required time (in Minutes) for each employee to do each job is given below. Find the optimal combination of employees and jobs to minimize total time. **(10)**

Jobs →	Time (in Minutes)				
Employees ↓	A	B	C	D	E
I	160	130	175	190	200
II	135	120	130	160	175
III	140	110	155	170	185
IV	50	50	80	80	110
V	55	35	70	80	105

(b) What is travelling salesman problem? Explain how it is solved. Also solve the following problem to find which route should be selected by the Van so that the total distance travelled by it is minimized using following data? **(10)**

From \ To	Bakery	Outlet A	Outlet B	Outlet C
Bakery	∞	4	7	3
Outlet A	4	∞	6	3
Outlet B	7	6	∞	7
Outlet C	3	3	7	∞

(c) Define assignment problem. Also suggest optimum sequence of processing the jobs if Seven jobs are to be processed on two machines A and B in the order AB. Each machine can process only one job at a time. The processing times in hours are as follows: **(10)**

Job	1	2	3	4	5	6	7
Machine A	10	12	13	7	14	5	16
Machine B	15	11	8	9	6	7	16

Also calculate the total elapsed time.

Q5 Attempt Any Two sub-questions: **(20)**

(a) A company produces two products P and Q. profit per unit for P and Q is Rs. 400 and Rs. 300 respectively. Both the products are processed on a machine having maximum capacity of 30,000 machine hours. Maximum demand for P and Q is estimated at 80 and 120 units respectively. For one unit of P, 300 machine hours are required. For one unit of Q, 100 machine hours are required. Formulate the LPP to maximize the profit and solve graphically. **(10)**

(b) (i) Explain Vogel's Approximation Method to solve transportation problem for an initial solution. **(05)**

(ii) Explain the procedure of selecting outgoing and incoming cell in context of transportation problem **(05)**

(c) (i) Define the following terms: (i) Number of machines, (ii) Processing order, (iii) Processing time, (iv) Total elapsed time, (v) Idle time on a machine. **(05)**

(ii) Six jobs are to be processed on two machines M_1 and M_2 in the order $M_1 \rightarrow M_2$. Each machine can process only one job at a time. The processing times in hours are as follows: **(05)**

Job	A	B	C	D	E	F
Machine M_1	3	12	18	9	15	6
Machine M_2	9	18	24	24	3	15

Suggest optimum sequence of processing the jobs and the total elapsed time.

****