(Time : 3 Hours) **(Total Marks: 80)**

Note :

- **Question No.1 is compulsory.**
- **Solve ANY THREE questions from the remaining five questions.**
- **Figure to the right indicates full marks.**
- **Assume suitable data wherever required, but justify the same.**

Q. 1 Solve **ANY FOUR** from the following.

a) What is an infeasible solution, and how does it occur? How is this condition recognized in the graphical method? **(05)**

b) Explain the terms Local optimum, global optimum and saddle point. **(05)**

c) Explain Taguchi's loss function **(05)**

d) What is duality? What is the significance of dual variables in an LP model? **(05)**

e) Explain concept of Dynamic programming **(05)**

Q. 2 a) Solve the following problem by simplex method **(10)**

Maximize $Z = 6x_1 + 4x_2$

Subject to $x_1 + x_2 <= 8$

$x_1 - x_2 <= 4$

$x_1, x_2 >= 0$

b) Minimize $f(x) = 8x_1 + 4x_2 + x_1x_2 - x_1^2 - x_2^2$ **(05)**

subject to $2x_1 + 3x_2 \leq 24$

$-5x_1 + 12x_2 \leq 24$

$x2 \leq 5$

State the Kuhn–Tucker conditions for above.

c What is integer linear programming? How does the optimal solution of an integer programming problem compare with that of the linear programming problem? **(05)**

Q. 3 a) Following table shows the various alternatives of Material (M1, M2,..) for piston cyinder, and corresponding attributes as Cost (A1), tensile strength (A2), thermal conductivity (A3), and machinability index (A4) Suggest suitable material using SAW method. Assume equal weight of 0.25 for the all attributes, A1 as non-beneficial and rest all as beneficial attributes for the following case. **(10)**

No	Alternative	M1(Rs/kg)	A2 (MPa)	A3 (W/m-K)	A4
1	M1	300	110	142	100
2	M2	350	100	125	110
3	M3	375	120	100	105
4	M4	400	130	120	120
5	M5	315	125	135	115

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b Determine the stationary points, minima or maxima of the following function $f(x) = 2x^6 - 6x^4 + 6x^2 + 10$ **(05)**

c Write a note on design of experiments **(05)**

Q. 4 **a)** A confectioner sells confectionery items. Past data of demand per week (in hundred kilograms), with probabilities, is given below: **(10)**

Demand/week :	05	10	15	20	25
Probabilities	0.36	0.31	0.19	0.09	0.05

Using the following sequence of random numbers, generate the demand for the next 10 weeks. Also find the average demand per week:
52, 90, 13, 23, 73, 34, 57, 35, 83, 94

b) A factory can manufacture 2 products A & B. The profit on one unit of A is Rs. 80 and one unit of B is Rs. 40. The maximum demand of A is 6 units per week and of B it is 8 units per week. The manufacturer has set up a goal of achieving a profit of exactly Rs. 640 per week. Show only the formulation of the problem as goal programming. **(05)**

c) Describe briefly geometric programming **(05)**

Q. 5 **a)** What are the various non-traditional optimization techniques? Explain any one with illustration **(10)**

b) Explain multi attribute decision making with suitable illustration. **(10)**

Q. 6 **a)** Write plan of experiments having 3 factors each at three levels. **(05)**

b) A company produces three types of bearings, B1, B2, and B3, on two machines, A1 and A2. The processing times of the bearings on the two machines are indicated in the following table: **(05)**

	Processing time (min) for bearing:		
Machine	B1	B2	B3
A1	10	6	12
A2	8	4	4

The times available on machines A1 and A2 per day are 1200 and 1000 minutes, respectively. The profits per unit of B1, B2, and B3 are Rs 4, Rs 2, and Rs 3, respectively. The maximum number of units the company can sell are 500, 400, and 600 for B1, B2, and B3, respectively. Formulate the problem for maximizing the profit.

c) Explain concept of robust design **(05)**

d) Discuss in brief some applications of Optimization in Engineering **(05)**

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