Time: 3Hrs **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.

Marks

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

a) List any five engineering applications of optimization. **(5)**

b) Show the formulation of a generalized transportation problem. **(5)**

c) Explain the branch and bound technique. In this technique when is the node said to be fathomed? **(5)**

d) What do you understand by full factorial and fractional factorial design? **(5)**

e) Explain the concept of Taguchi loss function with an example. **(5)**

Q. 2 a) Solve the following Simplex problem **(10)**

Maximize $Z = 2x_1 + 5x_2$

S.T. $x_1 + 4x_2 \leq 24$

$3x_1 + x_2 \leq 21$

$x_1 + x_2 \leq 9$

$x_1, x_2 \geq 0$

b) Determine maximum and minimum values of the function **(10)**

$f(x) = 3x^4 - 4x^3 - 24x^2 + 48x + 15$

Q. 3 a) Solve using the Lagrange's multiplier method the following NLPP **(10)**

Optimize $Z = 6{x_1}^2 + 5{x_2}^2$

S. T. $x_1 + 5x_2 = 7$

$x_1, x_2 \geq 0$

b) List the non-traditional optimization techniques and explain any one in detail. **(10)**

Q. 4 a) A person has to select a house from given 3 alternatives he has with the details as given in the table. He considers 3 attributes of price, near to market and near to school with weights as 0.625, 0.125 and 0.25 respectively. Select the best alternative of house by SAW method. **(10)**

Alternative/criteria	Price (Rs lakhs)	Near Market (Km)	Near School (Km)
House 1	100	1.5	2.75
House 2	140	1.0	3.5
House 3	80	1.7	3.0

b) A sample of 100 arrivals of a customer at a retail sales depot is according to the following distribution. **(10)**

Time between arrival (mins.)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Frequency	2	6	10	25	20	14	10	7	4	2

A study of the time required to service customer by adding up the bills, receiving payments and placing packages yields the following distribution.

Service time (mins.)	0.5	1.0	1.5	2.0	2.5	3.0
Frequency	12	21	36	19	7	5

Estimate the average of customer waiting time and average of idle time of the server by simulation for the next 10 arrivals.
Use random number for arrivals: 93, 22, 53, 64, 39, 07, 10, 63, 76, 35
Use random number for service: 78, 76, 58, 54, 74, 92, 38, 70, 96, 92

Q. 5 a) Apply dynamic programming method and solve **(10)**

Maximize $Z = y_1y_2y_3$

S.T. $y_1 + y_2 + y_3 = 5$

$y_1, y_2, y_3 \geq 0$

b) Describe the procedure of AHP method step wise in detail. **(10)**

Q. 6 a) Write the dual of the following primal problem **(5)**

Maximize $Z = x_1 - x_2 + 3x_3$

S.T. $x_1 + x_2 + x_3 \leq 10$

$2x_1 - x_2 - x_3 \leq 2$

$2x_1 - 2x_2 - 3x_3 \leq 6$

$x_1, x_2, x_3 \geq 0$

b) 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. The profit per unit for product 1, 2 and 3 is Rupees 4, 3 and 6 respectively. Formulate the mathematical linear programming model that will maximize the daily profit. **(5)**

Machine	Time per unit (Minutes)			Machine Capacity (Minutes / Day)
	Product 1	Product 2	Product 3	
M1	2	3	2	440
M2	4	-	3	470
M3	2	5	-	430

c) Write a note on Design of Experiment. **(5)**

d) Determine the quadratic form of matrix $A = \begin{bmatrix} 4 & -5 & 7 \\ -5 & -6 & 8 \\ 7 & 8 & -9 \end{bmatrix}$ **(5)**

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