Time: 3 Hrs **Marks : 80**

1) **Question No. 1 is compulsory.**
2) **Answer any three out of the remaining five questions.**
3) **Figures to the right indicate full marks.**
4) **Illustrate answers with neat sketches wherever required.**

Q. 1 Explain briefly any four **20**

a Robust design

b Engineering applications of optimization

c Integer Programming

d Genetic Algorithm

e Analytic Hierarchy Process (AHP) Method

Q2 a Explain design of experiments. Explain its application and state its importance. **10**

b A firm manufacture product P & Q which pass through machining and finishing departments. Machining has 90 hours available; finishing can handle up to 72 hours of work. Manufacturing one product P requires 6 hours in machining and 3 hours in finishing. Each product Q requires 3 hours in machining and 6 hours in finishing. If profit is Rs. 120/- per product P and Rs. 90/- per product Q. Formulate as goal programming problem to determine combination of product P & Q to realise profit of exactly Rs. 2100 **10**

Q3 a Find the maximum and minimum value of $y = 3x^5 - 5x^3$. **10**

b Solve LPP by simplex method **10**

Maximize: $Z = 40x_1 + 35x_2$ subjected to,

$$2x_1 + 3x_2 \leq 60$$
$$4x_1 + 3x_2 \leq 96$$
$$x_1, x_2 \geq 0$$

Q4 a Solve following problem by big M method **10**
Minimize $Z = 600x_1 + 500x_2$ subjected to,

$2x_1 + x_2 \geq 80$

$x_1 + 2x_2 \geq 60$, where $x_1, x_2 \geq 0$.

b Write the dual of the following primal LP problems **5**
Max $Z = 2x_1 + 5x_2 + 6x_3$
subject to (i) $5x_1 + 6x_2 - x_3 \leq 3$ (ii) $-2x_1 + 3x_2 + 4x_3 \leq 4$ (iii) x1 – 5x2 + 3x3 ≤ 1 (iv) $-3x_1 - 3x_2 + 7x_3 \leq 6$ and $x_1, x_2, x_3 \geq 0$

c State methods of normalization and explain any one. **5**

Q5 a Solve the following NLPP: Maximum $Z = 4x_1 + 6x_2 - 2x_1x_2 - 2x^2_2$ **10**
subjected to $x_1 + 2x_2 = 2$, $x_1, x_2 \geq 0$.

b Explain concept of dynamic programming and bellman's principle of optimality **10**

Q6 a Explain multi attribute decision making with suitable illustration **10**

b Explain briefly taguchi's loss function **5**

c A production process makes batteries for 9 +/- 0.25 volts applications at a cost of $ 0.75 each. Determine: **5**

a. Complete expression for loss function

b. Loss when a part is made at 9.10 V

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