(N.B. Attempt any five questions.)

M.E.(M) sem II PTDC M/c Design optimization 24/6/08.

1. (a) State the various methods available for solving a multivariable optimization problem with equality constraints. 8

(b) A uniform column of rectangular cross section is to be constructed for supporting a water tank of mass M. 12

It is required (i) to minimize the mass of the column for economy and (ii) to maximize the natural frequency of transverse vibration of the system for avoiding possible resonance due to wind. Formulate the problem of designing the column to avoide failure due to direct compression and buckling.

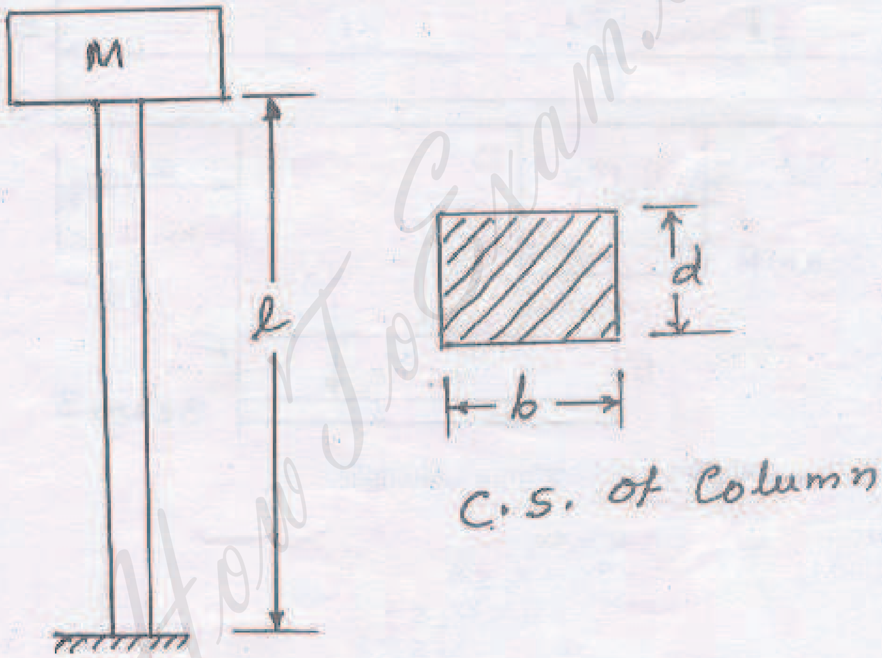
Assume the permissible compresive stress to be σ_{max}.

[**Hint** : The natural frequency of transverse vibration of water tank (ω) by treating it as a cantilever beam with a tip mass M is given by]

$$\omega = \left[\frac{3EI}{\left(M + \frac{33}{140} m \right) l^3} \right]^{1/2}$$

and buckling stress for a fixed-free column (σ_b) is given by

$$\sigma_b = \left(\frac{\pi^2 EI}{4l^2} \right) \frac{1}{bd} \Big\}$$



Water Tank on a Column

2. (a) A firm manufactures two items. It purchases castings which are then machined, bored and polished. Castings for items A and B cost Rs. 2 and Rs. 3 respectively and are sold at Rs. 5 and Rs. 6 each respectively. Running cost of the three machines are Rs. 20, Rs. 14 and Rs. 17.50 per hour respectively. 12

Capacities of the machines are :

	Part A	Part B
Machining Capacity	25/hr	40/hr
Boring Capacity	28/hr	35/hr
Polishing Capacity	35/hr	25/hr

Formulate the L.P. model to determine the product mix that maximizes the profit.

(b) Explain the following terms : 8

(i) Global Maxima
(ii) Relative Maxima
(iii) Global Minima
(iv) Relative Minima
(v) Feasible Region
(vi) Non Feasible Region
(vii) Saddle Point
(viii) Constraints.

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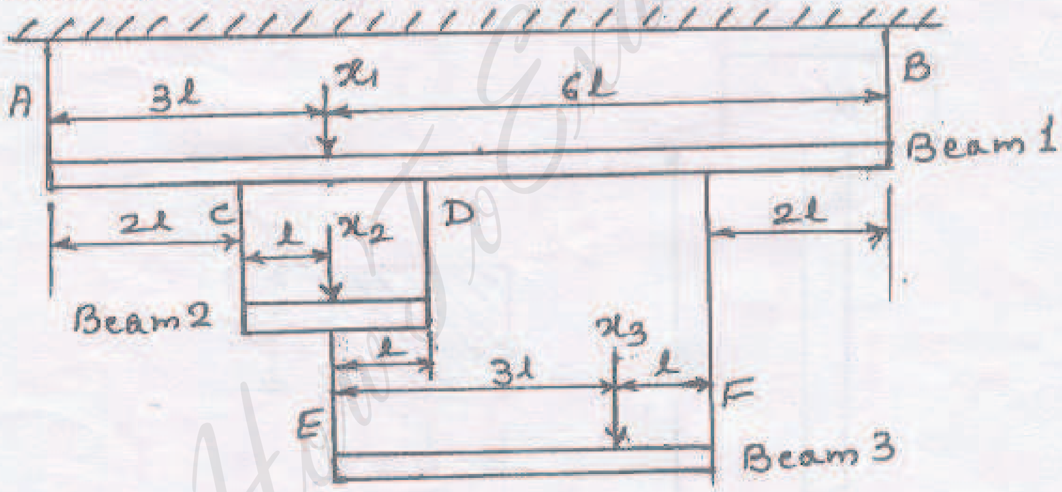
3\. (a) The manager of an oil refinery has to decide upon the optimal mix of two possible blending processes of which the inputs and outputs per production run are as follows : 15

Process	Input		Output	
	Crude A	Crude B	Gasoline X	Gasoline Y
1	5	3	5	8
2	4	5	4	5

The maximum amount available of crude A and B is 200 units and 150 units respectively. Market requirements show that at least 100 units of gasoline X and 80 units of gasoline Y must be produced. The profits per production run from process 1 and process 2 are Rs. 3 and Rs. 4 respectively. Formulate the problem as a linear programming problem. Solve the problem by the graphical method.

(b) State the necessary and sufficient condition for maximization of multivariable function f(x). 5

4\. (a) A scaffolding system consists of three beams and six ropes as shown in **figure**. Each of the top ropes A and B can carry a load of W_1, each of the middle ropes C and D can carry a load of W_2, and each of the bottom ropes E and F can carry load of W_3. If the loads acting on beams 1, 2 and 3 are x_1, x_2, and x_3 respectively, as shown in **figure** formulate the problem of finding the maximum load ($x_1 + x_2 + x_3$) that can be supported by the system. Assume that the weights of beam 1, 2 and 3 are w_1, w_2 and w_3 respectively and the weights of the ropes are negligible. 15



(b) Explain the significance of Lagrange's Multiplier. 5

5\. (a) Minimize $Z = x_1 - 4x_2$ 10

Subjected to

$$-3x_1 + x_2 \le 6$$
$$x_1 + 2x_2 \le 4$$
$$x_2 \le -3$$

(b) Explain the general linear programming problem. 10

6\. (a) Find all the basic feasible solution of the equations : 10

$$2x_1 + 6x_2 + 2x_3 + x_4 = 3$$
$$6x_1 + 4x_2 + 4x_3 + 6x_4 = 2$$

(b) Explain Canonical and Standard Forms of linear programming problem. 10

7\. Write short notes on the following :— 20

(a) Dynamic Programming
(b) Computer implementation of genetic algorithm
(c) The Simplex Method
(d) Lagrange multiplier method.