B.Tech. CIVIL ENGINEERING (BTCLEVI)

Term-End Examination

□□5?2   **December, 2017**

BICEE-004 : STRUCTURAL OPTIMIZATION

Time : 3 hours   *Maximum Marks : 70*

Note : *Answer any **seven** questions. All questions carry equal marks. Use of scientific calculator is permitted.*

1. A firm plans to purchase at least 200 quintals of scrap containing high quality metal X and low quality metal Y. Scrap can be purchased from two suppliers, A and B. Scrap must contain 100 quintals of metal X and no more than 35 quintals of metal Y. The percentage of X and Y in metals in terms of weight in the scrap supplied by A and B is given as follows :

Metal	Supplier A	Supplier B
X	25%	75%
Y	10%	20%

The price of A's scrap is ₹ 2,000 per quintal and that of B's is ₹ 4,000 per quintal. Formulate the L.P.P. to determine the quantity to be purchased from each supplier so that the cost is minimum. *10*

2. Shivkumar Food Corporation plans to dispatch a truck with food items to another city. There are five items the corporation plans to dispatch with the restriction that the weight to the items on the truck must not exceed 115 units. The details of the food items are as follows :

Item No.	Weight	Value	Value per unit weight
1	80	40	1/2
2	20	50	5/2
3	30	60	2
4	55	55	1
5	40	60	3/2

What should be the loading pattern so that the value of the truck is maximum ? Divisibility of the food items is not permissible. *10*

3. Test the definiteness of the function *10*

$$f(x) = -3x_1^2 + 2x_2^2 - 3x_3^2 - 10x_1x_2 +$$

$$4x_2x_3 + 6x_1x_3.$$

4. Show that a convex function is unimodal. *10*

5. Find the maximum of $f(x) = x(1.5 - x^2)$ in the interval [0, 1], using dichotomous search method, to within 10% of the exact value. Take $\delta = 0.001$. *10*

6. Using dynamic programming, find three non-negative real numbers such that the sum of the squares of these is minimum with the restriction that their sum is not less than 45. **10**

7. We have to load a truck with three different items. The maximum allowable weight is 6. The weight and values per unit are given in the following table :

Item	Weight per unit	Value per unit
1	1	15
2	3	70
3	2	35

Find the loading pattern which maximizes the value of the truck under the weight constraint by using dynamic programming. **10**

8. A circular cylindrical log of radius R and length L is available. It is required to cut the stiffest rectangular beam from this log. The stiffness of a rectangular beam is proportional to the product of its width and the cube of its depth. Find the dimensions of the stiffest beam. **10**

9. Minimize the following functions : **10**

$$f = x_1 + 4x_2 + 2x_1^{-1} ; x_1, x_2 > 0$$

10. Consider the following non-linear programming problem :

Minimize

$$z = 2x_1^2 - 24x_1 + 2x_2^2 - 8x_2 + 2x_3^2 - 12x_3 + 200$$

by separating this function into three one-variable functions. Show that the function is convex. Solve the problem by solving each one-variable function. *10*