**CE 213 Systems Techniques in Water Resources Engg**

**Assignment - 2**

1. Solving the following linear programming problems by Graphical Method and identify in-active constraints, if any. Also show the feasible region and optimal point on the plot.

(a)

$$Maximize\ Z = 5a + 8b$$
$$subject\ to$$
$$40a + 30b \le 480$$
$$24a + 32b \le 480$$
$$20a + 24b \le 480$$
$$a \ge 0; b \ge 0$$

(b)

$$Minimize\ Z = x + 1.5y$$
$$subject\ to$$
$$0.15x + 0.60y \ge 3000$$
$$0.25x + 0.30y \ge 2500$$
$$0.60x + 0.10y \ge 2000$$
$$x \ge 0; y \ge 0$$

(c)

$$Maximize\ Z = x_1 + 2x_2$$
$$subject\ to$$
$$2x_1 + 3x_2 \le 12$$
$$5x_1 + 2x_2 \le 15$$
$$x_1 \ge 0; x_2 \ge 0$$

(d)

$$Minimize\ Z = 4x + 6y$$
$$subject\ to$$
$$2x + 5y \ge 10$$
$$3x + 2y \ge 6$$
$$x \ge 0; y \ge 0$$

(e) In problem 1(d), if the objective function is changed to $Z=x+8y$, will there be a different optimal solution ?

2. Solve problems 1(b) and 1(c) by Simplex method.

3. Solve the following optimization problem by Simplex method.

Maximize 20 X1 + 10 X2 + 5 X3
Subject to 5 X1 + 3 X2 + X3 $\le$ 1050
4 X1 + 3 X2 + 2 X3 $\le$ 1000
X1 + 2 X2 + 2 X3 $\le$ 400
X1, X2 and X3 $\ge$ 0

4. Consider a system composed of a manufacturing factory and a waste treatment plant owned by the manufacturer. The manufacturing plant produces finished goods that sell for a unit price of Rs 10,000. However, the finished goods cost Rs 3,000 per unit to produce. In the manufacturing process two units of waste are generated for each unit of finished goods produced. In addition to deciding how many units of goods to produce, the plant manager must also decide how much waste will be discharged into a river without treatment so that the total net benefit to the company can be maximised and the water quality requirement of the water course is met. The treatment plant has a maximum capacity of treating ten units of waste with 80% waste removal efficiency at a treatment cost of Rs 600 per unit of waste. There is also an effluent tax imposed on the waste discharged to the receiving

water body (Rs 2,000 for each unit of waste discharged). The water pollution control authority has set an upper limit of four units on the amount of waste the company may discharge. Formulate an LP model clearly specifying the decision variables, Objective function and constraints and solve it is using both graphical method as well as simplex method.

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$$\textit{Maximize } Z = 5x_1 - x_2$$

*subject to*

$$2x_1 - x_2 \leq 10$$

$$0.4x_1 + 0.8x_2 \leq 4$$

$$2x_1 - x_2 \geq 0$$

$$x_1 \geq 0; x_2 \geq 0$$