Module 3:

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)
$$\begin{aligned}&\textit{Maximize } Z = 5a + 3b\\ &\textit{subject to}\\ &40a + 30b \le 480\\ &24a + 32b \le 480\\ &20a + 24b \le 480\\ &a \ge 0; b \ge 0\end{aligned}$$

(b)
$$\begin{aligned}&\textit{Minimize } Z = x + .5y\\ &\textit{subject to}\\ &0.15x + 0.60y \ge 3000\\ &0.25x + 0.30y \ge 2500\\ &0.60x + 0.10y \ge 2000\\ &x \ge 0; y \ge 0\end{aligned}$$

(c)
$$\begin{aligned}&\textit{Maximize } Z = x_1 + 2x_2\\ &\textit{subject to}\\ &2x_1 + 5x_2 \le 2\\ &5x_1 + 2x_2 \le 5\\ &x_1 \ge 0; x_2 \ge 0\end{aligned}$$

(d)
$$\begin{aligned}&\textit{Minimize } Z = 4x + 5y\\ &\textit{subject to}\\ &2x + 5y \ge 0\\ &3x + 2y \ge 5\\ &x \ge 0; y \ge 0\end{aligned}$$

(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(a), 1(b) and 1(c) by Simplex method.

3. 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 using both graphical method as well as simplex method.

4. A reservoir is to be constructed to supply water at a maximum constant rate per season for a city. The inflows in the six seasons of the year are 3, 12, 7, 3, 2 and 3 respectively. Determine the minimum required reservoir capacity using (i) Mass diagram method and (ii) Sequent Peak Method neglecting all losses.
5. Solve the following problem by using (i) Mass diagram method (ii) Sequent Peak Method and (iii) Linear Programming to estimate the reservoir capacity. (Neglect evaporation losses).

Period, t	1	2	3	4	5	6
Inflow, Qt	4	8	7	3	2	0
Demand, Dt (=Rt)	5	0	5	6	2	6

6. Solve the following problem by using Linear Programming to estimate the reservoir capacity. Monthly Inflows and demands are in Mm^3 and e_t in mm.
Area at dead storage level, $A_0 = 38.52$ Mm^2. Slope, $a = 0.127$.

	June	July	Aug	Sept	Oct	Nov
Q_t	86.52	425.75	360.60	159.39	122.85	56.08
D_t	55.69	139.68	138.76	71.26	39.59	220.15
e_t	230.53	151.60	150.52	154.45	120.56	119.28
	Dec	Jan	Feb	Mar	Apr	May
Q_t	22.65	17.38	12.99	9.58	10.81	21.22
D_t	220.15	191.30	90.19	0	0	0
e_t	96.69	95.45	100.59	150.89	225.42	245.92