D. J. SANGHVI COLLEGE OF ENGINEERING

OPERATIONS RESEARCH

TUTORIAL-I

1. Solve the following LP by graphical means:

$$\begin{aligned} Max \quad z =& x_1 + 0.5x_2 \\ s.t. \quad 2x_1 + 3x_2 \leq& 12 \\ 2x_1 + x_2 \leq& 8 \\ x_1,\ x_2 \geq& 0 \end{aligned}$$

2. Solve the following LP by graphical means:

$$\begin{aligned} Max \quad z =& x_1 - 2x_2 \\ s.t. \quad 2x_1 - x_2 \geq& 0 \\ -2x_1 + 3x_2 \leq& 6 \\ x_1,\ x_2 \geq& 0 \end{aligned}$$

3. Solve the following LP by graphical means:

$$\begin{aligned} Max.\ z =& -0.05x_1 + x_2 \\ s.t. \quad x_1 2x_2 \leq& 10 \\ 4x_1 + x_2 \leq& 3 \\ -x_1 - 2x_2 \geq& -6 \\ x_1,\ x_2 \geq& 0 \end{aligned}$$

4. Consider the following LP:

$$\begin{aligned} Max. \quad z =& 16x_1 + 15x_2 \\ s.t. \quad 40x_1 + 31x_2 \leq& 124 \\ -x_1 + x_2 \leq& 1 \\ x_1 \leq& 3 \\ x_1,\ x_2 \geq& 0 \end{aligned}$$

   - Solve the problem by the Simplex Method where the entering variable is the non-basic variable with the most negative ofc(objective function coeff.)
   - Resolve the problem by the Simplex Method, always ensuring that the entering variable is the non-basic variable with the least negative ofc.
   - What are the inferences from the solutions above?

5. Solve the following LP by Simplex Method:

$$\begin{aligned} Max \quad z =& 2x_1 + 3x_2 - 5x_3 \\ s.t. \quad x_1 + x_2 + x_3 =& 7 \\ 2x_1 - 5x_2 + x_3 \geq& 10 \\ x_1,\ x_2,\ x_3 \geq& 0 \end{aligned}$$

6. Solve the following LPP by Simplex:

$$\begin{aligned} Min.\ \ z = & -3x_1 + x_2 + x_3 \\ s.t.\ \ x_1 - 2x_2 + x_3 \leq & \ 11 \\ -4x_1 + x_2 + 2x_3 \geq & \ 3 \\ 2x_1 - x_3 = & -1 \\ x_1,\ x_2,\ x_3 \geq & \ 0 \end{aligned}$$

7. Solve the following LP by the two-phase method:

$$\begin{aligned} Min.\ \ z = & \ x_1 + 2x_2 \\ s.t.\ \ 2x_1 + 3x_2 \geq & \ 12 \\ 3x_1 + 2x_2 \geq & \ 12 \\ 2x_1 + x_2 \geq & \ 8 \\ x_1,\ x_2 \geq & \ 0 \end{aligned}$$

8. A trucking company has borrowed \$600,000 for new equipment and is contemplating three kinds of trucks. Truck A costs \$10,000, truck B \$20,000, and truck C \$23,000. How many trucks of each kind should be ordered to obtain the greatest capacity in ton-miles per day based on the following data? Truck A requires one driver per day and produces 2100 ton-miles per day. Truck B requires two drivers per day and produces 3600 ton-miles per day. Truck C requires two drivers per day and produces 3780 ton-miles per day. There is a limit of 30 trucks and 145 drivers. Formulate a complete mathematical statement of the problem, and label each individual part, identifying the objective function and constraints. List the variables with appropriate units.

9. Design a diet of bread and milk to get at least five units of vitamin A and six units of vitamin B each day. The amounts of vitamins A and B in one kilogram of each food and their costs are given below:

Vitamin	*Bread*	*Milk*
A	1.0	2.0
B	3.5	2.0
Cost \$/*kg*	3.0	2.0

10. Hi-V produces three types of canned juice drinks, A, B, and C, using fresh strawberries, grapes, and apples. The daily supply is limited to 200 tons of strawberries, 100 tons of grapes, and 150 tons of apples. The cost per ton of strawberries, grapes, and apples is \$200, \$100, *and* \$90 respectively. Each ton makes 750 *kg* of strawberry juice, 600 *kg* of grape juice, and 500 *kg* of apple juice. Drink A is a 1 : 1 mix of strawberry and apple juice. Drink B is a 1 : 1 : 2 mix straberry, grape, and apple juice. Drink C is a 2 : 3 mix of grape and apple juice. All drinks are canned in 0.5 *kg* cans. The price per can is \$1.15, \$1.25, *and* \$1.20 for drinks A, B, and C respectively. Determine the optimal product mix of the three drinks.

11. An assembly line consisting of three consecutive stations produces two FM radio models $HiFi-1$ and $HiFi-2$. The following table provides the assembly times for the three work stations:

	Minutes per unit	
Workstation	$HiFi-1$	$HiFi-2$
1	6	4
2	5	5
3	4	6

The daily maintenance for stations $1,\ 2, and\ 3$ consume $10\%,\ 14\%,\ and\ 12\%$, respectively of the maximum 480 *min* available for each station each day. Determine the optimal product mix that minimizes the total idle time in the three work stations.

12. A company operates ten hours a day, and produces three products on three sequential processes. The following table provides the time, in minutes, taken by each product on each process:

Product	*Process* 1	*Process* 2	*Process* 3	*Unit Price*
A	10	6	8	\$4.50
B	5	8	10	\$5.00
C	6	9	12	\$4.00

Determine the optimal product mix. How long does process 2 remain idle?

13. A gentleman farmer wishes to optimize his crop of tomatoes, cabbage and lettuce. He can sell tomatoes at 20 cents a kg, cabbage at 25 cents a head, and lettuce at 18 cents a head. The average yield per acre is 1500 kg of tomatoes, 1500 heads of cabbage, and 2500 heads of lettuce. Labor required per acre during the growing season is five man days for tomatoes and six man days for both cabbage and lettuce. Within the cooperative 400 man days of labor are available and each laborer is paid \$30 per man day. Fertilizer costs 15 cents per kg; fertilizer requirements are 125 kg per acre of tomatoes and 50 kg per acre of cabbage and lettuce. Formulate the problem as an LP for maximum profit, if the farmer has a total of 100 acres of land at his disposal.

14. A 12 kilo ton vessel is to be loaded with one or more of three items. The following table gives the unit weight w_i in tons, and the unit revenue r_i in thousands of dollars, for each item i.

Item	w_i	r_i
1	2.0	31
2	3.0	47
3	1.0	14

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