School of Mathematics, Thapar University
Operations Research (UMA-019)
Tutorial Sheet 3

1. Find an optimal solution to the following linear program using (a) simplex algorithm (b) algebraic method.
   Min $z = x_1 + 2x_2 + 3x_3$, s/t $x_1 + 3x_2 + 6x_3 = 6$, $x_1\ x_2, x_3 \geq 0$.

2. Use the Simplex method to solve
   Max $z = 5x_1 + 4x_2$, s/t $6x_1 + 4x_2 \leq 24$, $x_1 + 2x_2 \leq 6$, $-x_1 + x_2 \leq 1$, $x_2 \leq 6$, $x_1, x_2 \geq 0$,

3. Consider the following Linear programming problem
   Max $z = x_1 + x_2$, s/t $x_1 + 2x_2 \leq 3$, $2x_1 + x_2 \leq 3$, $x_1, x_2 \geq 0$,
   Answer the following questions:

   1. Convert the problem into standard form and find all Basic solutions and identify Basic feasible solution.
   2. Plot the feasible region.
   3. Identify relation between BFS and corner points of the feasible region of above LPP.
   4. Construct the simplex table corresponding to the corner point (3/2,0) of the feasible region.
   5. Using the simplex table obtained in Part-4 above, find optimal Basic feasible solution of LPP.
   6. Identify all the simplex tables obtained in Part 5 above on the graph of the feasible region.
   7. What happens if a non basic variable with most positive z_j - c_j enters into the basis for the given the problem.

4. Use the simplex method to solve
   Min $z = -x_1 - x_2$, s/t $x_1 + 2x_2 \leq 3$, $x_1 + x_2 \leq 2$, $3x_1 + 2x_2 \leq 6$, $x_1, x_2 \geq 0$.
   Find an alternate optimal solution if one exists.

5. Formulate the LPP from the following Optimal table;

C_B	B.V.	x_1	x_2	x_3	s_1	s_2	Sol.
	Z	0	0	17/7	6/7	4/7	2
4	x_2	0	1	1/7	2/7	-1/7	0
2	x_1	1	0	17/7	-1/7	4/7	1

6.
7.

6. Without using Simplex / Two-phase / Big-M, Solve the following problem ,
   $Min\ z = x_1 - 2x_2 + 3x_3$, $s/t\, 2x_1 + 2x_2 + 2x_3 + 2x_4 = 6$, $4x_1 + 5x_2 + 2x_3 + 2x_4 = 12$, $x_1, x_2, x_3, x_4 \geq 0$

7. Two consecutive simplex tableaus of a LPP are

B.V.	x_1	x_2	x_3	x_4	x_5	Soln.(X_B)
	A	-1	3	0	0	
x_4	B	C	D	I	0	6
x_5	-1	2	E	0	1	1

B.V.	x_1	x_2	x_3	x_4	x_5	Soln.(X_B)
	0	-4	J	K	0	

x_1	G	2/3	2/3	1/3	0	F
x_5	H	8/3	-1/3	1/3	1	3

Find the values of "A to K".

8. Use the Simplex method to show that the following problem has unbounded solution:
Max $z = x_1 + x_2$, s/t $3x_1 - 4x_2 \geq -3$, $x_1 - x_2 - x_3 = 0$, $x_1, x_2, x_3 \geq 0$.

9. Solve the following systems of equations using Simplex method:
(a) $2x_1 + x_2 - x_3 = 1$, $-2x_1 + 2x_2 - x_3 = -2$, $x_1 + x_3 = 3$, $x_1, x_2, x_3 \geq 0$.
(b) $x_1 - x_2 + x_3 = 1$, $x_1 + x_3 = 2$, $2x_1 + x_2 + 2x_3 = 3$.

10. Solve by the Simplex method (without using artificial variables)
(a) Min $z = -5x_1 - 3x_2$ s/t
$x_1 + x_2 + x_3 = 2$, $5x_1 + 2x_2 + x_4 = 10$
$3x_1 + 8x_2 + x_5 = 12$, $x_1, x_2, x_3, x_4, x_5 \geq 0$
Verify your result graphically.
(b) Max $z = 3x_1 + x_2 + 2x_3$
$12x_1 + 3x_2 + 6x_3 + 3x_4 = 9$, $8x_1 + x_2 - 4x_3 + 2x_5 = 10$
$3x_1 - x_6 = 0$, $x_1, \ldots, x_6 \geq 0$.

11. Describe the big M and the two phase methods. Which should be preferred and why? Solve the following problems by both these methods:
(a) Min $z = 3x_1 + 5x_2$, s/t $x_1 + 3x_2 \geq 3$, $x_1 + x_2 \geq 2$, $x_1, x_2 \geq 0$.
(b) Max $z = 4x_2 - 3x_1$, s/t $x_1 - x_2 \geq 0$, $2x_1 - x_2 \geq 2$, $x_1, x_2 \geq 0$.
(c) Max $z = 3x_1 + 2x_2$, s/t $2x_1 + x_2 \leq 2$, $3x_1 + 4x_2 \geq 12$, $x_1, x_2 \geq 0$.