Lab-10:

Exercise 1:

1.

Let x_i denote the no. of aircrafts bought of the i th kind.

Maximize: 2*x1+x2+2*x3+x4+x5

Subject to the constraints:

3*x1+3*x2+2*x3+2*x4+3*x5<=13

2*x1+x2+3*x3+x4+2*x5<=11

xi>=0 ,i=1(1)5

The variables x_i's must be integers.

3.
Refer: ex1a.mod

Optimal value=9

Optimal Solution:

```
x[i] [*] :=
1  3
2  0
3  1
4  1
5  0
```

4.

Refer: ex1d.mod

Optimal value=9.6

Optimal Solution:

```
x[i] [*] :=
1  3.4
2  0
3  1.4
4  0
5  0
```

5. The solution of MILP cannot be obtained by rounding off the solution of LP because by restricting our variables to integer type, we are drastically cutting down on our feasible region. Hence, the point which was a maxima for the LP may no longer remain inside our feasible region and the rounded off quantity might not necessarily be the optima. For eg. Consider the optimal solution above in subpart 3 and 4

Objective value in LP: 9.6

Objective value in MILP: 9

The objective value can be rounded off to 10, which is not the optimal value.

6.

Refer: ex1f_LP.mod; ex1f_MILP.mod

Objective value in LP: 14.4

Objective value in MILP: 14

7.

Scaling factor=2

Objective value in LP: 19.2

Objective value in MILP: 19

Scaling factor=3

Objective value in LP: 28.4

Objective value in MILP: 28

Scaling factor=4

Objective value in LP: 38.4

Objective value in MILP: 38

Scaling factor=2.5

Objective value in LP: 24

Objective value in MILP: 23

The objective value in both cases(LP as well as MILP) are directly proportional to the Scaling factor.

Exercise-2:

2.

Refer: ex2b.mod, lp_ip.dat

The optimal solution value is: 295828

3.

Time required to solve the MILP= 36sec

No. of simplex iterations= 349309

4.

Refer: ex2d.mod, lp_ip.dat

The optimal solution value is: 295896.377

5.

Time required to solve the MILP= <1 sec

No. of simplex iterations= 18

<u>Exercise 3:</u>

1.

Let x_i denote the quantity of steel produced in the i th month. i=1(1)n

Let $VCOST_i$ denote the variable cost for the i th month. i=1(1)n

Let D_i denote the demand for the i th week. i=1(1)n

And let h be the holding cost per unit steel wire for each month.

minimize cost: $\sum_1^n$ (x[i]*VCOST[i]+(12-i)*h*(x[i]-D[i]))

s.t. $\sum_1^i$ (x[j]-D[j])>=0 for all i=1(1)n
s.t. $\sum_1^n$ (x[i]-D[i])=0
s.t. x[i]>=0,<=10000, integer for all i=1(1)n

2.
Refer: ex3a.mod, ex3.txt

The objective value is 9585000.

The production quantity for each month are given as:

```
x[i] [*] :=
 1  10000
 2   5000
 3      0
 4      0
 5      0
 6  10000
 7      0
 8      0
 9  10000
10   1500
11      0
12   3000
```

3.

We have to define the variables Y_i such that:

Y_i= 1, if X_i>0
Y_i= 0, if X_i=0

Now,
This relation can also be implied by:

(X/M)<=Y<=MX for any no. M>10000

Here, X can take any integer value between 0 and 10000. So, clearly the LHS of the above inequality is >=0.
Also Y will be taking the value 0, if X=0. Since from the inequality (0/M)<=Y and Y<=(M*0).
And if X>0, then the LHS would be >0 but <1, since M is selected to be a no.>10000. Moreover Y is a binary variable assuming values only 0 and 1. So, it will be taking the value 1 in case X>0.

The following linear inequalities will imply the constraint:

Y<=1
Y>=0
0<=X
X<=10000
X/10001<=Y
Y<=10001*X

4.
Let x_i denote the quantity of steel produced in the i th month. i=1(1)n

Let $VCOST_i$ denote the variable cost for the i th month. i=1(1)n

Let D_i denote the demand for the i th week. i=1(1)n

And let h be the holding cost per unit steel wire for each month.

minimize cost: $\sum_1^n$ (x[i]*VCOST[i]+(12-i)*h*(x[i]-D[i]))

s.t. $\sum_1^i$ (x[j]-D[j])>=0 for all i=1(1)n
s.t. $\sum_1^n$ (x[i]-D[i])=0
s.t. y[i]<=10001*x[i] for all i=1(1)n
s.t. x[i]<=10001*y[i] for all i=1(1)n
s.t. x[i]>=0, <=10000, integer for all i=1(1)n
s.t. y[i]>=0,<=1, integer for all i=1(1)n

5.
Refer ex3c.mod, ex3.txt

The optimal solution is: 10785000

The production quantity for each month are given as:

```
x[i] [*] :=
 1  10000
 2   5000
 3      0
 4      0
 5      0
 6  10000
 7      0
 8      0
 9  10000
10   1500
11      0
12   3000
```

There has been no production in 6 months.

6.
Refer: ex3e.mod, ex3.txt

The optimal solution is 11985000

The production quantity for each month are given as:

```
x[i] [*] :=
 1  10000
 2   5000
 3      0
 4      0
 5      0
 6  10000
 7      0
 8      0
 9  10000
10   1500
11      0
12   3000
```

The 1^{st},2^{nd},6^{th},9^{th},10^{th} and 12^{th} months will see production.