PROBLEM 1

MAX Z = 4x1 + 6x2+x3

x1 <= 5

x2 <= 7

4x1 + 3x2+X3 <= 19

x1,x2,X3 >= 0

$$
\begin{aligned}
&Z - 4x1 - 6x2 - x3 = 0\\
&x1 + S1 = 5\\
&x2 + S2 = 7\\
&4x1 + 3x2 + x3 + S3 = 19\\
&x1, x2, S1, S2, S3 \geq 0
\end{aligned}
$$

$$
\begin{bmatrix}
1 & -4 & -6 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 & 1 & 0 \\
0 & 4 & 3 & 0 & 0 & 1
\end{bmatrix}
\begin{matrix}
Z \\ X1 \\ X2 \\ X3 \\ S1 \\ S2 \\ S3
\end{matrix}
\quad = \quad
\begin{matrix}
\\ 0 \\ 5 \\ 7 \\ 9
\end{matrix}
$$

B1= 1 0 0 0
0 1 0 0
0 0 1 0
0 0 0 1

B= 1 0 0
0 1 0
0 0 1
0 0 0

CB=(0 0 0)

B	***XB***	***β0*** ***Z***	***β1*** ***S1***	***β2*** ***S2***	***β3*** ***S3***	***x1***	***x2***
Z	0	1	0	0	0	-4	-6
*S*1	5	0	1	0	0	1	0
*S*2	7	0	0	1	0	0	1
*S*3	19	0	0	0	1	4	3

MAX (1 0 0 0) -4 -6
1 0
0 1
4 3

MAX (4 6 1)

=6

B1-1.a2= -6
0
1
3

Xb= 0
5
7
19

Min(7,19/3)

=6.333

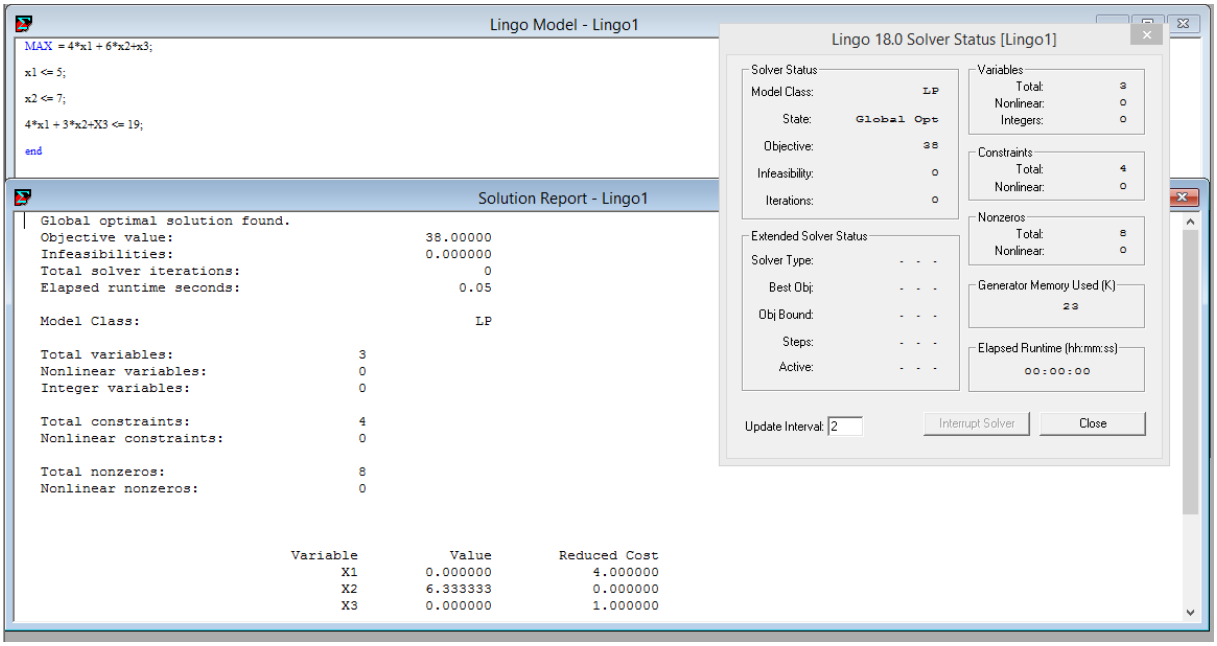
B	***XB***	***β0*** ***Z***	***β1*** ***S1***	***β2*** ***S2***	***β3*** ***S3***	***y2*** ***Ck-Zk***	ORAN	***x1***	***x2***
Z	0	1	0	0	0	-6	---	-4	-6
*S*1	5	0	1	0	0	0	---	1	0
*S*2	7	0	0	1	0	1	7	0	1
*S*3	19	0	0	0	1	3	6.3333	4	3

XB	*β*1	*β*2	*β*3	*y*2	
*R*1	0	0	0	0	-6
*R*2	5	1	0	0	0
*R*3	7	0	1	0	1
*R*4	19	0	0	1	3

B	***XB***	***β0*** ***Z***	***β1*** ***S1***	***β2*** ***S2***	***β3*** ***x2***	***y2*** ***Ck-Zk***	**ORAN**	***x1***	***S3***
Z	38	1	0	0	2		---	-4	0
*S*1	5	0	1	0	0		---	1	0
*S*2	0.6667	0	0	1	-0.3333		---	0	0
*x*2	6.3333	0	0	0	0.3333		---	4	1

*x*1=0,*x*2=6.3333,x3=0

Max *Z*=38



PROBLEM 2

MAX Z = x1 + 2x2 + 4x3

x1 + x2 <= 6
x2 + x3 <= 4
x1 + x2 + x3 <= 13
x1,x2,x3 >= 0

$$Z - x1 - 2x2 - 4x3 = 0$$
$$x1 + x2 + S1 = 6$$
$$x2 + x3 + S2 = 4$$
$$x1 + x2 + x3 + S3 = 13$$
$$,x1,x2,x3,S1,S2,S3 \geq 0$$

$$\begin{bmatrix} 1 & -1 & -2 & -4 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 \end{bmatrix} \begin{matrix} Z \\ X1 \\ X2 \\ X3 \\ S1 \\ S2 \\ S3 \end{matrix} = \begin{matrix} 0 \\ 6 \\ 4 \\ 13 \end{matrix}$$

B	***XB***	***β0*** ***Z***	***β1*** ***S1***	***β2*** ***S2***	***β3*** ***S3***	***y1*** ***Ck-Zk***	**ORAN**	***x1***	***x2***	***x3***
Z	0	1	0	0	0		---	-1	-2	-4
S1	6	0	1	0	0		---	1	1	0
S2	4	0	0	1	0		---	0	1	1
S3	13	0	0	0	1		---	1	1	1

MAX=(1 2 4)

=4

Y3=$B^{-1}a3$= -4, 0, 1, 1

Xb= 0, 6, 4, 13

Min=(4 13)

=4

B	***XB***	***β*0 *Z***	***β*1 *S*1**	***β*2 *S*2**	***β*3 *S*3**	***y*3 *Ck-Zk***	**ORAN**	***x*1**	***x*2**	***x*3**
Z	0	1	0	0	0	-4	---	-1	-2	-4
*S*1	6	0	1	0	0	0	---	1	1	0
*S*2	4	0	0	1	0	1	4	0	1	1
*S*3	13	0	0	0	1	1	13	1	1	1

XB	*β*1	*β*2	*β*3	*y*3	
*R*1	0	0	0	0	-4
*R*2	6	1	0	0	0
*R*3	4	0	1	0	1
*R*4	13	0	0	1	1

B	***XB***	***β*0 *Z***	***β*1 *S*1**	***β*2 *x*3**	***β*3 *S*3**	***y*3 *Ck-Zk***	**ORAN**	***x*1**	***x*2**	***S*2**
Z	16	1	0	4	0		---	-1	-2	0
*S*1	6	0	1	0	0		---	1	1	0
*x*3	4	0	0	1	0		---	0	1	1
*S*3	9	0	0	-1	1		---	1	1	0

MAX=(1 -2 4)

MAX=1

B	***XB***	***β0*** ***Z***	***β1*** ***S1***	***β2*** ***x3***	***β3*** ***S3***	***y1*** ***Ck-Zk***	**ORAN**	***x1***	***x2***	***S2***
Z	16	1	0	4	0	-1	---	-1	-2	0
*S*1	6	0	1	0	0	1	6	1	1	0
*x*3	4	0	0	1	0	0	---	0	1	1
*S*3	9	0	0	-1	1	1	9	1	1	0

XB	*β*1	*β*2	*β*3	*y*1	
*R*1	16	0	4	0	-1
*R*2	6	1	0	0	1
*R*3	4	0	1	0	0
*R*4	9	0	-1	1	1

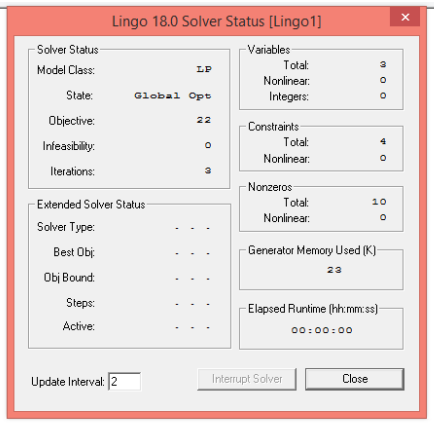
B	***XB***	***β0*** ***Z***	***β1*** ***x1***	***β2*** ***x3***	***β3*** ***S3***	***y1*** ***Ck-Zk***	**ORAN**	***S1***	***x2***	***S2***
Z	22	1	1	4	0		---	0	-2	0
*x*1	6	0	1	0	0		---	1	1	0
*x*3	4	0	0	1	0		---	0	1	1
*S*3	3	0	-1	-1	1		---	0	1	0

MAX=(-1 -3 -4)

X1=6,X2=0,X3=4

MAXZ=22

```
 Global optimal solution found.
 Objective value:                              22.00000
 Infeasibilities:                              0.000000
 Total solver iterations:                             3
 Elapsed runtime seconds:                          0.03

 Model Class:                                        LP

 Total variables:                     3
 Nonlinear variables:                 0
 Integer variables:                   0

 Total constraints:                   4
 Nonlinear constraints:               0

 Total nonzeros:                     10
 Nonlinear nonzeros:                  0


                        Variable           Value        Reduced Cost
                              X1        6.000000            0.000000
                              X2        0.000000            3.000000
                              X3        4.000000            0.000000

                             Row    Slack or Surplus      Dual Price
                               1        22.00000            1.000000
                               2        0.000000            1.000000
                               3        0.000000            4.000000
                               4        3.000000            0.000000
```



PROBLEM 3

MAX Z = 3x1 + 4x2 + 5x3

x1 + 2x2 <= 12

4x2 + 3x3 <= 32

x1 + x2 + 2x3 <= 10

x1,x2,x3 >= 0

$$Z - 3x1 - 4x2 - 5x3 = 0$$
$$x1 + 2x2 + S1 = 12$$
$$4x2 + 3x3 + S2 = 32$$
$$x1 + x2 + 2x3 + S3 = 10$$
$$x1,x2,x3,S1,S2,S3 \geq 0$$

$$\begin{bmatrix} 1 & -3 & -4 & -5 & 0 & 0 & 0 \\ 0 & 1 & 2 & 0 & 1 & 0 & 0 \\ 0 & 0 & 4 & 3 & 0 & 1 & 0 \\ 0 & 1 & 1 & 2 & 0 & 0 & 1 \end{bmatrix} \begin{matrix} Z \\ X1 \\ X2 \\ X3 \\ S1 \\ S2 \\ S3 \end{matrix} \begin{matrix} \\ = \\ \\ \\ \\ \\ \end{matrix} \begin{matrix} \\ 0 \\ 12 \\ 32 \\ 10 \\ \\ \end{matrix}$$

B	***XB***	***β*0** ***Z***	***β*1** ***S*1**	***β*2** ***S*2**	***β*3** ***S*3**	***y*1** ***Ck-Zk***	**ORAN**	***x*1**	***x*2**	***x*3**
Z	0	1	0	0	0		---	-3	-4	-5
*S*1	12	0	1	0	0		---	1	2	0
*S*2	32	0	0	1	0		---	0	4	3
*S*3	10	0	0	0	1		---	1	1	2

MAX=(3 4 5)

=5

MİN(32/3,10/2)

=5

B	***XB***	***β*0** ***Z***	***β*1** ***S*1**	***β*2** ***S*2**	***β*3** ***S*3**	***y*3** ***Ck-Zk***	**ORAN**	***x*1**	***x*2**	***x*3**
Z	0	1	0	0	0	-5	---	-3	-4	-5
*S*1	12	0	1	0	0	0	---	1	2	0
*S*2	32	0	0	1	0	3	10.6667	0	4	3
*S*3	10	0	0	0	1	2	5	1	1	2

XB	*β*1	*β*2	*β*3	*y*3	
*R*1	0	0	0	0	-5
*R*2	12	1	0	0	0
*R*3	32	0	1	0	3
*R*4	10	0	0	1	2

B	***XB***	***β*0** ***Z***	***β*1** ***S*1**	***β*2** ***S*2**	***β*3** ***x*3**	***y*3** ***Ck-Zk***	**ORAN**	***x*1**	***x*2**	***S*3**
Z	25	1	0	0	2.5		---	-3	-4	0
*S*1	12	0	1	0	0		---	1	2	0
*S*2	17	0	0	1	-1.5		---	0	4	0
*x*3	5	0	0	0	0.5		---	1	1	1

MAX=(1/2 3/2 5 /2)

=1.5

MİN=(6,6.8,10)

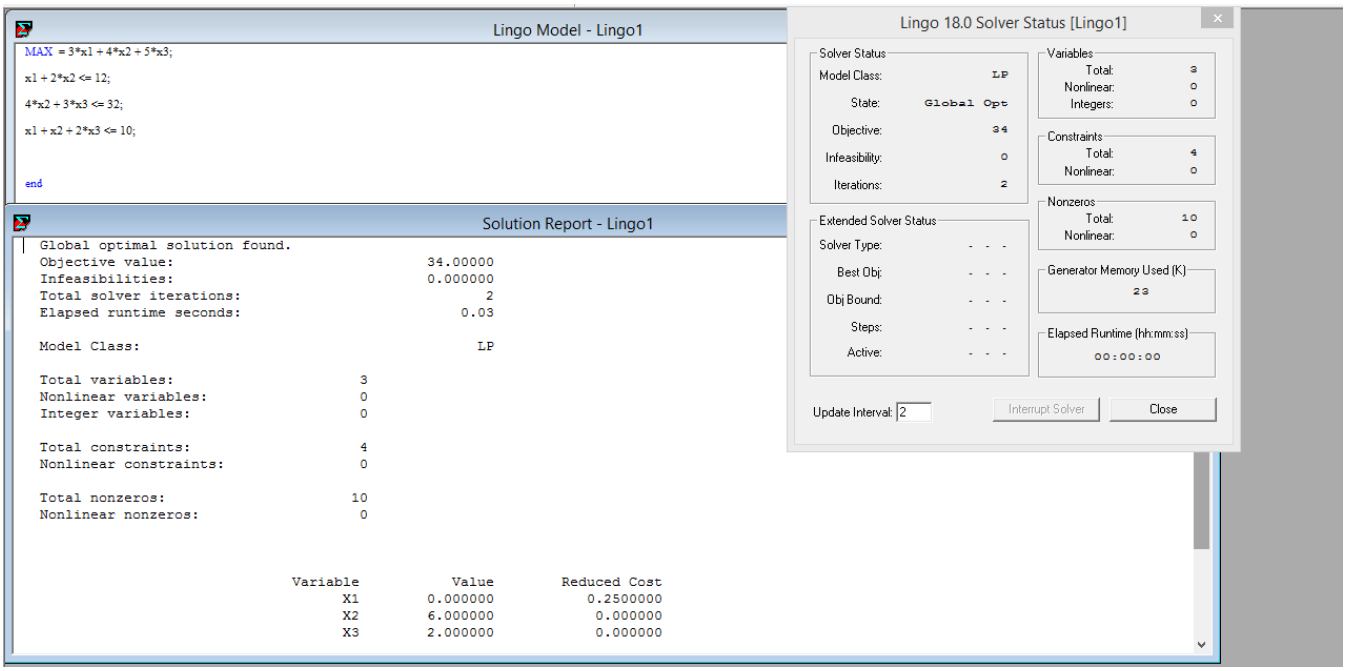
=6

B	***XB***	***β*0** ***Z***	***β*1** ***S*1**	***β*2** ***S*2**	***β*3** ***x*3**	***y*2** ***Ck-Zk***	**ORAN**	***x*1**	***x*2**	***S*3**
Z	25	1	0	0	2.5	-1.5	---	-3	-4	0
*S*1	12	0	1	0	0	2	6	1	2	0
*S*2	17	0	0	1	-1.5	2.5	6.8	0	4	0
*x*3	5	0	0	0	0.5	0.5	10	1	1	1

XB	*β*1	*β*2	*β*3	*y*2	
*R*1	25	0	0	2.5	-1.5
*R*2	12	1	0	0	2
*R*3	17	0	1	-1.5	2.5
*R*4	5	0	0	0.5	0.5

B	***XB***	***β*0** ***Z***	***β*1** ***x*2**	***β*2** ***S*2**	***β*3** ***x*3**	***y*2** ***Ck-Zk***	**ORAN**	***x*1**	***S*1**	***S*3**
Z	34	1	0.75	0	2.5		---	-3	0	0
*x*2	6	0	0.5	0	0		---	1	1	0
*S*2	2	0	-1.25	1	-1.5		---	0	0	0
*x*3	2	0	-0.25	0	0.5		---	1	0	1

X1=0,X2=6, X3=2 MAXZ=34


Lingo Model - Lingo1
MAX = 3*x1 + 4*x2 + 5*x3;
x1 + 2*x2 <= 12;
4*x2 + 3*x3 <= 32;
x1 + x2 + 2*x3 <= 10;
end
Solution Report - Lingo1
Global optimal solution found.
Objective value: 34.00000
Infeasibilities: 0.000000
Total solver iterations: 2
Elapsed runtime seconds: 0.03
Model Class: LP
Total variables: 3
Nonlinear variables: 0
Integer variables: 0
Total constraints: 4
Nonlinear constraints: 0
Total nonzeros: 10
Nonlinear nonzeros: 0
Variable Value Reduced Cost
X1 0.000000 0.2500000
X2 6.000000 0.000000
X3 2.000000 0.000000
Lingo 18.0 Solver Status [Lingo1]
Solver Status
Model Class: LP
State: Global Opt
Objective: 34
Infeasibility: 0
Iterations: 2
Extended Solver Status
Solver Type: - - -
Best Obj: - - -
Obj Bound: - - -
Steps: - - -
Active: - - -
Variables
Total: 3
Nonlinear: 0
Integers: 0
Constraints
Total: 4
Nonlinear: 0
Nonzeros
Total: 10
Nonlinear: 0
Generator Memory Used (K)
23
Elapsed Runtime (hh:mm:ss)
00:00:00
Update Interval: 2
Interrupt Solver
Close