

**PROBLEM 1**

$$\max Z = 2x_1 + 20x_2 - 10x_3$$

$$2x_1 + 20x_2 + 4x_3 \leq 15$$

$$6x_1 + 20x_2 + 4x_3 = 20$$

$x_1, x_2, x_3 \geq 0$  ve tamsayı olduğuna göre optimal tablosu verilmiş olan problemi kesme düzlemi algoritmasıyla çözünüz.

Z	X1	X2	X3	S1	A1	
	0	0	14	1	M	15
X2	0	1	0.2	0.075	-0.025	0.625
X1	1	0	0	-0.25	0.25	1.25

$$0.625 = X_2 + 0.2X_3 + 0.075S_1$$

$$-0.625 = S_4 - 0.2X_3 - 0.075S_1 \text{ (CUT 1)}$$

Z	X1	X2	X3	S1	S4	
	0	0	14	1	0	15
X2	0	1	0.2	0.075	0	0.625
X1	1	0	0	-0.25	0	1.25
S4	0	0	-0.2	-0.075	1	-0.625

Z	X1	X2	X3	S1	S4	
	0	0	11.3	0	13.3	6.67
X2	0	1	0	0	-3.33	0
X1	1	0	0.67	1	-13.3	3.3
S1	0	0	2.67	0	13.3	8.3

$$-0.33 = S_5 - 0.67X_3 - 0.67S_3 \text{ (CUT 2)}$$

Z	X1	X2	X3	S1	S3	S4	
	0	0	0	0	2	17	1
X2	0	1	0	0	1	0	0
X1	1	0	0	0	-4	1	3
S1	0	0	0	1	-16	4	7
X3	0	0	1	0	1	-1.5	0.5

$$-0.5=S5-0.5S4(\text{CUT } 3)$$

Z	X1	X2	X3	S1	S3	S4	S5	-16
	0	0	0	0	2	0	34	0
X2	0	1	0	0	-4	0	0	2
X1	1	0	0	0	-16	0	2	3
S1	0	0	0	1	1	0	8	2
X3	0	0	1	0	0	1	-3	1

$X1=2, X2=0, X3=2$  MAX  $Z=-16$

### Problem 1 Lingo Çözümü

$$\max = 2 \cdot x1 + 20 \cdot x2 - 10 \cdot x3;$$

$$2 \cdot x1 + 20 \cdot x2 + 4 \cdot x3 \leq 15;$$

$$6 \cdot x1 + 20 \cdot x2 + 4 \cdot x3 = 20;$$

@GIN(X1);

@GIN(X2);

@GIN(X3);

END

Global optimal solution found.

Objective value: -16.00000  
 Objective bound: -16.00000  
 Infeasibilities: 0.000000  
 Extended solver steps: 0  
 Total solver iterations: 0  
 Elapsed runtime seconds: 0.10

Model Class: MILP

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

Total constraints: 3  
 Nonlinear constraints: 0

Total nonzeros: 9  
 Nonlinear nonzeros: 0

Variable	Value	Reduced Cost
X1	2.000000	-2.000000
X2	0.000000	-20.00000
X3	2.000000	10.00000

Row	Slack or Surplus	Dual Price
1	-16.00000	1.000000
2	3.000000	0.000000
3	0.000000	0.000000

**Lingo 18.0 Solver Status [Lingo2]**

**Solver Status**

Model Class: MILP

State: Global Opt

Objective: -16

Infeasibility: 0

Iterations: 0

**Extended Solver Status**

Solver Type: B-and-B

Best Obj: -16

Obj Bound: -16

Steps: 0

Active: 0

**Variables**

Total: 3

Nonlinear: 0

Integers: 3

**Constraints**

Total: 3

Nonlinear: 0

**Nonzeros**

Total: 9

Nonlinear: 0

**Generator Memory Used (K)**

23

**Elapsed Runtime (hh:mm:ss)**

00:00:00

Update Interval: 2    Interrupt Solver    Close

## PROBLEM 2

$$\text{Enb } z=8x_1+5x_2$$

$$9x_1+5x_2 \leq 45$$

$$x_1+x_2 \leq 6$$

$x_1, x_2 \geq 0$  ve tamsayı optimal çözüm tablosu verilmiş olan problemi kesme düzlemi yöntemiyle çözünüz.

	$x_1$	$x_2$	$S_1$	$S_2$	
	0	0	0.75	1.25	41.25
$x_1$	1	0	0.25	-1.25	3.75
$x_2$	0	1	-0.25	2.25	2.25

$$-0.75 = s_3 - 0.25s_1 - 0.75s_2$$

Iteration-1						
$B$	$x_1$	$x_2$	$S_1$	$S_2$	$S_3$	$Z=41.25$
$Z$	0	0	0.75	1.25	0	
$x_1$	1	0	0.25	-1.25	0	3.75
$x_2$	0	1	-0.25	2.25	0	2.25
$S_3$	0	0	-0.25	$(-0.75)$	1	-0.75
	---	---	-3	$-1.6667 \uparrow$	---	

Iteration-2						
	$x_1$	$x_2$	$S_1$	$S_2$	$S_3$	
$Z$	8	5	0.3333	0	1.6667	40
$x_1$	1	0	0.6667	0	-1.6667	8
$x_2$	0	1	-1	0	3	5
$S_2$	0	0	0.3333	1	-1.3333	0

$$x_1=5 \quad x_2=0 \quad \text{Max } z=40$$

## Problem 2 Lingo Çözümü

$\max=8*x1+5*x2$  ;

$9*x1+5*x2 \leq 45$ ;

$x1+x2 \leq 6$ ;

@gin (x1) ;

@gin (x2) ;

end

```
Global optimal solution found.
Objective value:           40.00000
Objective bound:           40.00000
Infeasibilities:            0.000000
Extended solver steps:      0
Total solver iterations:    0
Elapsed runtime seconds:    0.07

Model Class:
                    PILP

Total variables:         2
Nonlinear variables:      0
Integer variables:       2

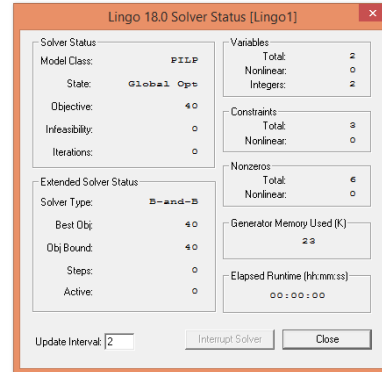
Total constraints:        3
Nonlinear constraints:    0

Total nonzeros:          6
Nonlinear nonzeros:      0
```

Variable	Value	Reduced Cost
X1	5.000000	-8.000000
X2	0.000000	-5.000000

Row	Slack or Surplus	Dual Price
1	40.00000	1.000000
2	0.000000	0.000000
3	1.000000	0.000000



## PROBLEM 3

$\text{MAX } z = 2 x1 + x2$

$5 x1 + 2 x2 \leq 8$

$x1 + x2 \leq 3$

$x1, x2 \geq 0$ ;  $x1$  tamsayı optimal tablosu verilmiş olan problemi kesme düzlemi algoritmasıyla çözünüz.

	$x1$	$x2$	$S1$	$S2$	
$Z$	2	1	0.3333	0.3333	3.6667
$x1$	1	0	0.3333	-0.6667	0.6667
$x2$	0	1	-0.3333	1.6667	2.3333

$$0.6667 = x1 + 0.3333s1 - 0.6667s2$$

$$0.6667 = x1 + 0.3333s1 + (-1 + 0.3333)$$

$$-0.6667 = s3 - 0.3333s1 - 0.3333s2 \text{ (cut 1)}$$

	$x_1$	$x_2$	$S_1$	$S_2$	$S_3$	
$z$	0	0	0	0	1	<b>3</b>
$x_1$	1	0	0	-1	1	2
$x_2$	0	1	0	2	-1	1
$S_1$	0	0	1	1	-3	0

$x_1=0, x_2=3 \max z=3$

### PROBLEM 3 LINGO ÇÖZÜMÜ

**MAX** = 2 \* $x_1$ +  $x_2$ ;

5 \* $x_1$  + 2 \* $x_2$  <= 8;

$x_1$ +  $x_2$ <= 3 ;

@gin( $x_1$ ) ;

@gin( $x_2$ ) ;

end

```
Global optimal solution found.
Objective value:                3.000000
Objective bound:                3.000000
Infeasibilities:                0.000000
Extended solver steps:          0
Total solver iterations:        0
Elapsed runtime seconds:        0.04

Model Class:                    MILP

Total variables:                2
Nonlinear variables:            0
Integer variables:              2

Total constraints:              3
Nonlinear constraints:          0

Total nonzeros:                6
Nonlinear nonzeros:            0

Variable      Value      Reduced Cost
X1            1.000000      -2.000000
X2            1.000000      -1.000000

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

Lingo 18.0 Solver Status [Lingo1]

<b>Solver Status</b> Model Class: <b>MILP</b> State: <b>Global Opt</b> Objective: <b>3</b> Infeasibility: <b>0</b> Iterations: <b>0</b>		<b>Variables</b> Total: <b>2</b> Nonlinear: <b>0</b> Integers: <b>2</b>
<b>Extended Solver Status</b> Solver Type: <b>B-and-B</b> Best Obj: <b>3</b> Obj Bound: <b>3</b> Steps: <b>0</b> Active: <b>0</b>		<b>Constraints</b> Total: <b>3</b> Nonlinear: <b>0</b>
Update Interval: <b>2</b>		<b>Nonzeros</b> Total: <b>6</b> Nonlinear: <b>0</b>
Interrupt Solver         Close		<b>Generator Memory Used (K)</b> <b>23</b>
<b>Elapsed Runtime (hh:mm:ss)</b> <b>00:00:00</b>		