

### 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

$$X1=2, X2=0, X3=2 \text{ MAX } Z=-16$$

### Problem 1 Lingo Çözümü

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

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

$$6 \cdot x_1 + 20 \cdot x_2 + 4 \cdot x_3 = 20;$$

$$@GIN(X1);$$

$$@GIN(X2);$$

$$@GIN(X3);$$

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 ↑	---	

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

$$\text{max} = 8 * x_1 + 5 * x_2 ;$$

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

$$x_1 + x_2 \leq 6 ;$$

$$@gin(x_1) ;$$

```
@gin(x2);
end
```

Global optimal solution found.

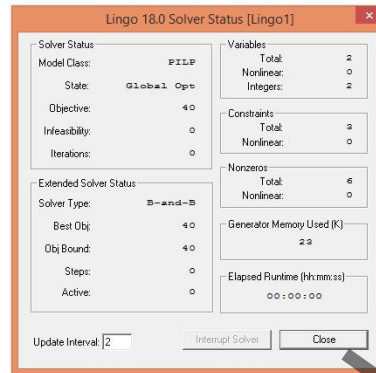
Objective value:	40.00000
Objective bound:	40.00000
Infeasibilities:	0.000000
Extended solver steps:	0
Total solver iterations:	0
Elapsed runtime seconds:	0.07

Model Class:                      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	5.000000	-5.000000
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

$$\text{MAX } z = 2x_1 + x_2$$

$$5x_1 + 2x_2 \leq 8$$

$$x_1 + x_2 \leq 3$$

$x_1, x_2 \geq 0$ ;  $x_1$  tamsayı optimal tablosu verilmiş olan problemi kesme düzlemi algoritmasıyla çözünüz.

	$x_1$	$x_2$	$S_1$	$S_2$	
<b>Z</b>	<b>2</b>	<b>1</b>	<b>0.3333</b>	<b>0.3333</b>	<b>3.6667</b>
$x_1$	1	0	0.3333	-0.6667	0.6667
$x_2$	0	1	-0.3333	1.6667	2.3333

$$0.6667 = x_1 + 0.3333s_1 - 0.6667s_2$$

$$0.6667 = x_1 + 0.3333s_1 + (-1 + 0.3333)s_2$$

$$-0.6667 = s_3 - 0.3333s_1 - 0.3333s_2 \text{ (cut 1)}$$

	$x_1$	$x_2$	$S_1$	$S_2$	$S_3$	
$z$	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

$$x_1=0, x_2=3 \text{ max } z=3$$

### PROBLEM 3 LINGO ÇÖZÜMÜ

MAX = 2 \*x1+ x2;

5 \*x1 + 2 \*x2 <= 8;

x1+ x2<= 3 ;

@gin(x1);

@gin(x2);

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]

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

Update Interval: 2    Interrupt Solver    Close