

**AG. ECON. 7123 - - - OPERATION RESEARCH METHODS IN AG. ECON.
CHAPTER 4 -- THE SIMPLEX METHOD**

Initial Tableau

Basis		Z	x ₁	x ₂	x ₃	x ₄	x ₅	RHS
Z	(0)	1	-3	-2	0	0	0	0
x ₃	(1)	0	1	0	1	0	0	4
x ₄	(2)	0	1	3	0	1	0	15
x ₅	(3)	0	2	1	0	0	1	10
Z=0		Nonbasic variables p x ₁ , x ₂ = 0, 0			Basic variables p x ₃ , x ₄ , x ₅ = 4, 15, 10			

Max Z = 3x₁ + 2x₂

s.t.

$$\begin{aligned} x_1 &\leq 4 & [x_1 + x_3 &= 4] \\ x_1 + 3x_2 &\leq 15 & [x_1 + 3x_2 + x_4 &= 15] \\ 2x_1 + x_2 &\leq 10 & [2x_1 + x_2 + x_5 &= 10] \end{aligned}$$

Pivot column = x₁

Pivot row = (1)

Pivot number = 1

Iteration 1

Basis		Z	x ₁	x ₂	x ₃	x ₄	x ₅	RHS
Z	(0)	1	0	-2	3	0	0	12
x ₁	(1)	0	1	0	1	0	0	4
x ₄	(2)	0	0	3	-1	1	0	11
x ₅	(3)	0	0	1	-2	0	1	2
Z=12		Nonbasic variables p x ₂ , x ₃ = 0, 0			Basic variables p x ₁ , x ₄ , x ₅ = 4, 11, 2			

Steps in Iteration 1:

(1) Divide row (1) by 1.

p [puts new basic variable x₁ in equation (1) with a coefficient of 1.]

(2) Multiply new row (1) by -3 and subtract from row (0).

p [takes basic variable x₁ out of equation (0).]

(3) Multiply new row (1) by 1 and subtract from row (2).

p [takes basic variable x₁ out of equation (2).]

(4) Multiply new row (1) by 2 and subtract from row (3).

p [takes basic variable x₁ out of equation (3).]

Iteration 2

Basis		Z	x ₁	x ₂	x ₃	x ₄	x ₅	RHS
Z	(0)	1	0	0	-1	0	2	16
x ₁	(1)	0	1	0	1	0	0	4
x ₄	(2)	0	0	0	5	1	-3	5
x ₂	(3)	0	0	1	-2	0	1	2
Z=16		Nonbasic variables p x ₃ , x ₅ = 0, 0			Basic variables p x ₁ , x ₂ , x ₄ = 4, 2, 5			

Steps in Iteration 2:

(1) Divide row (3) by 1.

p [puts new basic variable x₂ in equation (3) with a coefficient of 1.]

(2) Multiply new row (3) by -2 and subtract from row (0).

p [takes basic variable x₂ out of equation (0).]

(3) Multiply new row (3) by 0 and subtract from row (1).

p [no transformation needed for row (1)]

(4) Multiply new row (3) by 3 and subtract from row (2).

p [takes basic variable x₂ out of equation (2).]

Iteration 3

Basis		Z	x ₁	x ₂	x ₃	x ₄	x ₅	RHS
Z	(0)	1	0	0	0	0.2	1.4	17
x ₁	(1)	0	1	0	0	-0.2	0.6	3
x ₃	(2)	0	0	0	1	0.2	-0.6	1
x ₂	(3)	0	0	1	0	0.4	-0.2	4
Z=17		Nonbasic variables p x ₄ , x ₅ = 0, 0			Basic variables p x ₁ , x ₂ , x ₃ = 3, 4, 1			

Steps in Iteration 3:

(1) Divide row (2) by 5.

p [puts new basic variable x₃ in equation (2) with a coefficient of 1.]

(2) Multiply new row (2) by -1 and subtract from row (0).

p [takes basic variable x₃ out of equation (0).]

(3) Multiply new row (2) by 1 and subtract from row (1).

p [takes basic variable x₃ out of equation (1).]

(4) Multiply new row (2) by -2 and subtract from row (3).

p [takes basic variable x₃ out of equation (3).]

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*****
*   HILLIER & LIEBERMAN, P. 173 PROBLEM 4.1-6   *
*****;
DATA NEW;
INPUT _TYPE_ $ _ROW_ $ _COL_ $ _COEF_;
CARDS;
MAX          OBJFNC          .          .
.            OBJFNC          X1          3.0
.            OBJFNC          X2          2.0
LE           X3SL            X1          1.0
.            X3SL            _RHS_       4.0
LE           X4SL            X1          1.0
.            X4SL            X2          3.0
.            X4SL            _RHS_       15.0
LE           X5SL            X1          2.0
.            X5SL            X2          1.0
.            X5SL            _RHS_       10.0
;
PROC LP SPARSEDATA FLOW TABLEAUPRINT;
      TITLE1 'HILLIER & LIEBERMAN, CHAP. 4';
      TITLE2 'PROBLEM 4.1-6 (P. 173)';
RUN;

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HILLIER & LIEBERMAN, CHAP. 4
 PROBLEM 4.1-6 (p. 173)
 The LP Procedure

[Problem Summary]

Objective Function	Max OBJFNC
Rhs Variable	_RHS_
Type Variable	_TYPE_
Problem Density (%)	53.33
Variables	Number
Non-negative	2
Slack	3
Total	5
Constraints	Number
LE	3
Objective	1
Total	4

HILLIER & LIEBERMAN, CHAP. 4
 PROBLEM 4.1-6 (p. 173)

The LP Procedure
[Iteration Log]

Phase		Iteration	Entering Variable	Leaving Variable	Reduced Cost	Objective Value
2	1	X1	X3SL	X3SL	3.000000	12
2	2	X2	X5SL	X5SL	2.000000	16
2	3	X3SL	X4SL	X4SL	0.500000	17

HILLIER & LIEBERMAN, CHAP. 4
 PROBLEM 4.1-6 (p. 173)

The LP Procedure
[Solution Summary]
 Terminated Successfully

Objective Value	17
Phase 1 Iterations	0
Phase 2 Iterations	3
Phase 3 Iterations	0
Integer Iterations	0
Integer Solutions	0
Initial Basic Feasible Variables	5
Time Used (seconds)	0
Number of Inversions	2
Epsilon	1E-8
Infinity	1.797693E308
Maximum Phase 1 Iterations	100
Maximum Phase 2 Iterations	100
Maximum Phase 3 Iterations	99999999
Maximum Integer Iterations	100
Time Limit (seconds)	120

HILLIER & LIEBERMAN, CHAP. 4
 PROBLEM 4.1-6 (p. 173)

The LP Procedure
[Variable Summary]

Variable		Price	Activity	Reduced Cost
Col Name	Status Type			
1 X1	BASIC NON-NEG	3	3	0
2 X2	BASIC NON-NEG	2	4	0
3 X3SL	BASIC SLACK	0	1	0
4 X4SL	SLACK	0	0	-0.2
5 X5SL	SLACK	0	0	-1.4

HILLIER & LIEBERMAN, CHAP. 4
 PROBLEM 4.1-6 (p. 173)

The LP Procedure
[Constraint Summary]

Constraint		S/S	Dual
Row Name	Type	Col Rhs Activity	Activity
1 OBJFNC	OBJECTIVE	. 0 17	.
2 X3SL	LE	3 4 3	0
3 X4SL	LE	4 15 15	0.2
4 X5SL	LE	5 10 10	1.4

HILLIER & LIEBERMAN, CHAP. 4
 PROBLEM 4.1-6 (p. 173)

The LP Procedure
[Current Tableau]

INV(B)*R		X5SL	X4SL
R_COSTS	.	-1.4	-0.2
X1	3	0.6	-0.2
X3SL	1	-0.6	0.2
X2	4	-0.2	0.4
PHASE_1_	0	0	0
OBJFNC	17	1.4	0.2