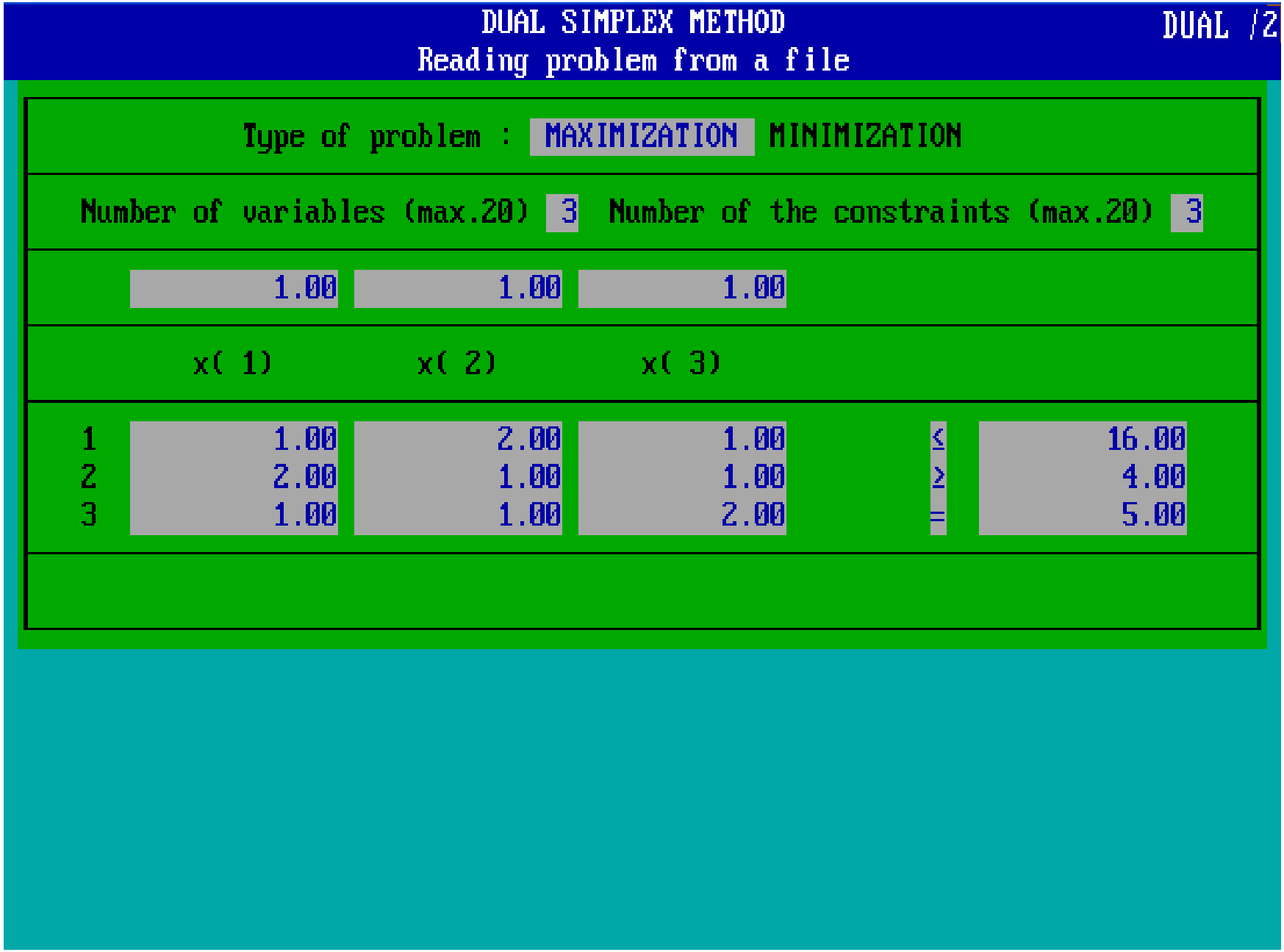
# Программа DUAL.EXE

**Исследование операций**

**с применением компьютера**

**Версия 2.00a (2007)**


DUAL SIMPLEX METHOD
DUAL /2
Reading problem from a file
Type of problem : MAXIMIZATION MINIMIZATION
Number of variables (max.20) 3 Number of the constraints (max.20) 3
1.00 1.00 1.00
x( 1) x( 2) x( 3)
1 1.00 2.00 1.00 ≤ 16.00
2 2.00 1.00 1.00 ≥ 4.00
3 1.00 1.00 2.00 = 5.00

Converting problem to basic form

| | | | | |
|---|---|---|---|---|
| Max | + | + | + | |
| x | 1 | 2 | 3 | |
| | 1 | + 1 | ≤ | + |
| | + | 1 1 | ≥ | + |
| | 1 | 1 | + = | + |

Is the problem in basic form ? Yes No

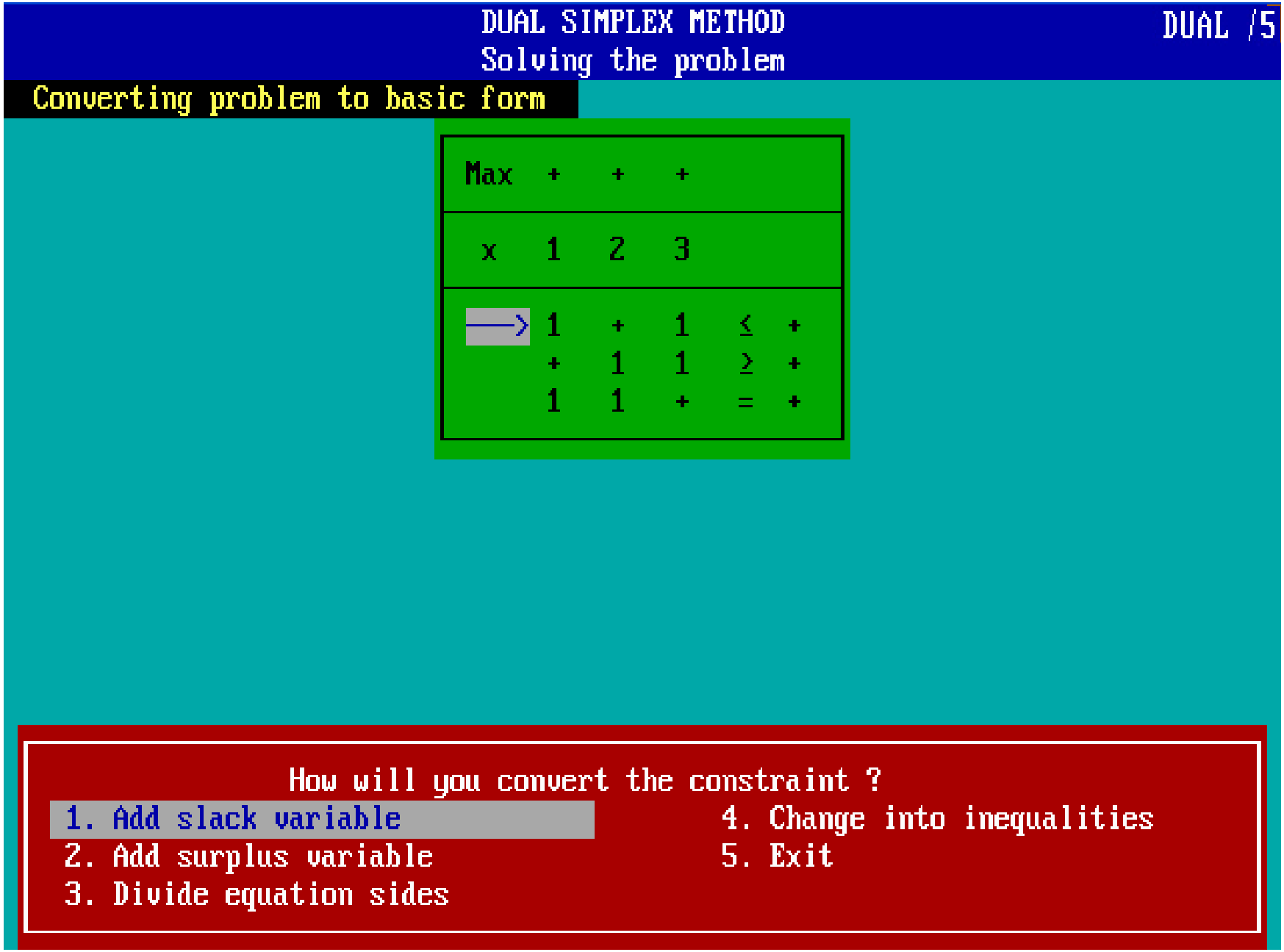
DUAL SIMPLEX METHOD
Solving the problem

DUAL /4

Converting problem to basic form

| | | | | | |
|---|---|---|---|---|---|
| Max | + | + | + | | |
| x | 1 | 2 | 3 | | |
| → | 1 | + | 1 | ≤ | + |
| → | + | 1 | 1 | ≥ | + |
| → | 1 | 1 | + | = | + |

Select the constraint


DUAL SIMPLEX METHOD
Solving the problem
DUAL /5
Converting problem to basic form
Max + + +
x 1 2 3
—> 1 + 1 ≤ +
+ 1 1 ≥ +
1 1 + = +
How will you convert the constraint ?
1. Add slack variable
2. Add surplus variable
3. Divide equation sides
4. Change into inequalities
5. Exit

DUAL SIMPLEX METHOD DUAL /6

Solving the problem

Converting problem to optimal basic form

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Max | + | + | + | 0 | 0 | 0 | 0 | | |
| x | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
| x( 4) | 1 | + | 1 | 1 | 0 | 0 | 0 | = | + |
| x( 5) | - | - | - | 0 | 1 | 0 | 0 | = | - |
| x( 6) | 1 | 1 | + | 0 | 0 | 1 | 0 | = | + |
| x( 7) | - | - | - | 0 | 0 | 0 | 1 | = | - |
| d | + | + | + | 0 | 0 | 0 | 0 | | |

Is it necessary to add an artificial constraint ? Yes No

DUAL SIMPLEX METHOD
Solving the problem



Converting problem to optimal basic form

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Max | + | + | + | 0 | 0 | 0 | 0 | 0 | | |
| x | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| x( 4) | 1 | + | 1 | 1 | 0 | 0 | 0 | 0 | = | + |
| x( 5) | - | - | - | 0 | 1 | 0 | 0 | 0 | = | - |
| x( 6) | 1 | 1 | + | 0 | 0 | 1 | 0 | 0 | = | + |
| x( 7) | - | - | - | 0 | 0 | 0 | 1 | 0 | = | - |
| x( 8) | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | = | M |

Enter coefficients of artificial constraint

DUAL SIMPLEX METHOD DUAL /8

Solving the problem

Converting problem to optimal basic form

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Max | + | + | + | 0 | 0 | 0 | 0 | 0 | | |
| x | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| x( 4) | 1 | + | 1 | 1 | 0 | 0 | 0 | 0 | = | + |
| x( 5) | - | - | - | 0 | 1 | 0 | 0 | 0 | = | - |
| x( 6) | 1 | 1 | + | 0 | 0 | 1 | 0 | 0 | = | + |
| x( 7) | - | - | - | 0 | 0 | 0 | 1 | 0 | = | - |
| x( 8) | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | = | M |

Do you want to enter value of M ? Yes No

DUAL SIMPLEX METHOD DUAL /9

Solving the problem

Generating the first optimal basic solution

| cx ——> max | | 1.00 | 1.00 | 1.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 1) | x( 2) | x( 3) | |
| x( 4) | 0.00 | 1.00 | 2.00 | 1.00 | 16.00 |
| x( 5) | 0.00 | -2.00 | -1.00 | -1.00 | -4.00 |
| x( 6) | 0.00 | 1.00 | 1.00 | 2.00 | 5.00 |
| x( 7) | 0.00 | -1.00 | -1.00 | -2.00 | -5.00 |
| x( 8) | 0.00 | 1.00 | 1.00 | 1.00 | 1600.00 |
| c(i)-z(i) | | 1.00 | 1.00 | 1.00 | |

Value of the objective function = 0.0000000000

Select the variable leaving the basis

DUAL SIMPLEX METHOD DUAL/10

Solving the problem

Generating the first optimal basic solution

| cx ——> max | | 1.00 | 1.00 | 1.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 1) | x( 2) | x( 3) | |
| x( 4) | 0.00 | 1.00 | 2.00 | 1.00 | 16.00 |
| x( 5) | 0.00 | -2.00 | -1.00 | -1.00 | -4.00 |
| x( 6) | 0.00 | 1.00 | 1.00 | 2.00 | 5.00 |
| x( 7) | 0.00 | -1.00 | -1.00 | -2.00 | -5.00 |
| x( 8) | 0.00 | 1.00 | 1.00 | 1.00 | 1600.00 |
| c(i)-z(i) | | 1.00 | 1.00 | 1.00 | |

Value of the optimality coefficient = 1.0000000000

Value of the objective function = 0.0000000000

Select the variable entering the basis

DUAL SIMPLEX METHOD
Solving the problem

DUAL/11

Iteration 1

| cx ——> max | | 1.00 | 1.00 | 0.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 2) | x( 3) | x( 8) | |
| x( 4) | 0.00 | 1.00 | 0.00 | -1.00 | -1584.00 |
| x( 5) | 0.00 | 1.00 | 1.00 | 2.00 | 3196.00 |
| x( 6) | 0.00 | 0.00 | 1.00 | -1.00 | -1595.00 |
| x( 7) | 0.00 | 0.00 | -1.00 | 1.00 | 1595.00 |
| x( 1) | 1.00 | 1.00 | 1.00 | 1.00 | 1600.00 |
| c(i)-z(i) | | 0.00 | 0.00 | -1.00 | |

Value of the objective function = 1600.0000000000

Is the solution feasible ? Yes No

DUAL SIMPLEX METHOD DUAL/12

Solving the problem

Iteration 1

| cx ——> max | | 1.00 | 1.00 | 0.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 2) | x( 3) | x( 8) | |
| x( 4) | 0.00 | 1.00 | 0.00 | -1.00 | -1584.00 |
| x( 5) | 0.00 | 1.00 | 1.00 | 2.00 | 3196.00 |
| x( 6) | 0.00 | 0.00 | 1.00 | -1.00 | -1595.00 |
| x( 7) | 0.00 | 0.00 | -1.00 | 1.00 | 1595.00 |
| x( 1) | 1.00 | 1.00 | 1.00 | 1.00 | 1600.00 |
| c(i)-z(i) | | 0.00 | 0.00 | -1.00 | |

Right-hand side value = -1595.0000000000

Value of the objective function = 1600.0000000000

Select the variable leaving the basis

DUAL SIMPLEX METHOD
Solving the problem



Iteration 1

| cx ——> max | | 1.00 | 1.00 | 0.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 2) | x( 3) | x( 8) | |
| x( 4) | 0.00 | 1.00 | 0.00 | -1.00 | -1584.00 |
| x( 5) | 0.00 | 1.00 | 1.00 | 2.00 | 3196.00 |
| x( 6) | 0.00 | 0.00 | 1.00 | -1.00 | -1595.00 |
| x( 7) | 0.00 | 0.00 | -1.00 | 1.00 | 1595.00 |
| x( 1) | 1.00 | 1.00 | 1.00 | 1.00 | 1600.00 |
| c(i)-z(i) | | 0.00 | 0.00 | -1.00 | |

Value of the objective function = 1600.0000000000

Does the selected variable indicate problem infeasiblity ? Yes No

DUAL SIMPLEX METHOD
Solving the problem

DUAL/14

Iteration 1

| Variables | Vector of optimality coefficients | Row of coefficients for row 3 | Vector of ratios |
|---|---|---|---|
| x( 2) | 0.0000 | 0.0000 | undefined |
| x( 3) | 0.0000 | 1.0000 | 0.00000000 |
| x( 8) | -1.0000 | -1.0000 | 1.00000000 |

Coefficient = 1.0000000000

Select the variable entering the basis

Feasible solution

| cx ——> max | | 1.00 | 1.00 | 0.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 2) | x( 3) | x( 6) | |
| x( 4) | 0.00 | 1.00 | -1.00 | -1.00 | 11.00 |
| x( 5) | 0.00 | 1.00 | 3.00 | 2.00 | 6.00 |
| x( 8) | 0.00 | 0.00 | -1.00 | -1.00 | 1595.00 |
| x( 7) | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| x( 1) | 1.00 | 1.00 | 2.00 | 1.00 | 5.00 |
| c(i)-z(i) | | 0.00 | -1.00 | -1.00 | |

Value of the objective function = 5.0000000000

Is the objective function unbounded ? Yes No

Feasible solution

| cx ——> max | | 1.00 | 1.00 | 0.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 2) | x( 3) | x( 6) | |
| x( 4) | 0.00 | 1.00 | -1.00 | -1.00 | 11.00 |
| x( 5) | 0.00 | 1.00 | 3.00 | 2.00 | 6.00 |
| x( 8) | 0.00 | 0.00 | -1.00 | -1.00 | 1595.00 |
| x( 7) | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| x( 1) | 1.00 | 1.00 | 2.00 | 1.00 | 5.00 |
| c(i)-z(i) | | 0.00 | -1.00 | -1.00 | |

Value of the objective function = 5.0000000000

1. Alternative solution
2. Exact solution
3. Sensitivity analysis
4. Exit

## Optimal solution

| Variable | Value | Optimality coefficient | Decision variable | Basic variable |
|---|---|---|---|---|
| x( 1) | 5.00 | 0.00 | Yes | Yes |
| x( 2) | 0.00 | 0.00 | Yes | No |
| x( 3) | 0.00 | -1.00 | Yes | No |
| x( 4) | 11.00 | 0.00 | No | Yes |
| x( 5) | 6.00 | 0.00 | No | Yes |
| x( 6) | 0.00 | -1.00 | No | No |
| x( 7) | 0.00 | 0.00 | No | Yes |
| x( 8) | 1595.00 | 0.00 | No | Yes |

Value of the objective function = 5.00

Generating alternative solution

| cx ——> max | | 1.00 | 1.00 | 0.00 | Vector of const. |
|---|---|---|---|---|---|
| Basis | c(B) | x( 2) | x( 3) | x( 6) | |
| x( 4) | 0.00 | 1.00 | -1.00 | -1.00 | 11.00 |
| x( 5) | 0.00 | 1.00 | 3.00 | 2.00 | 6.00 |
| x( 8) | 0.00 | 0.00 | -1.00 | -1.00 | 1595.00 |
| x( 7) | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| x( 1) | 1.00 | 1.00 | 2.00 | 1.00 | 5.00 |
| c(i)-z(i) | | 0.00 | -1.00 | -1.00 | |

Value of the optimality coefficient = 0.0000000000
Value of the objective function = 5.0000000000

Select the variable entering the basis

Generating alternative solution

| Basis | Vector of const. | Coefficients for variable x( 2) | Vector of ratios |
|---|---|---|---|
| x( 4) | 11.0000 | 1.0000 | 11.00000000 |
| x( 5) | 6.0000 | 1.0000 | 6.00000000 |
| x( 8) | 1595.0000 | 0.0000 | undefined |
| x( 7) | 0.0000 | 0.0000 | undefined |
| x( 1) | 5.0000 | 1.0000 | 5.00000000 |

Coefficient = 5.0000000000

Select the variable leaving the basis

## Sensitivity analysis

| Coef-ficient | Lower bound | Value in problem | Upper bound |
|---|---|---|---|
| c( 1) | none | 1.00000 | 1.00000 |
| c( 2) | 1.00000 | 1.00000 | none |
| c( 3) | none | 1.00000 | 2.00000 |