Example5_1Case3

```
load simplex.sage
```

```
simplex functions loaded.
```

```
# Example 5.1
A=matrix(QQ,[[0,-5,-1,12,0],[10,3,2,1,0],[16,5,3,0,1]]);
B=[3,4]; A
```

```
[ 0 -5 -1 12  0]
[10  3  2  1  0]
[16  5  3  0  1]
```

```
# Solve this LP using the primal simplex algorithm.
prepare_tableau(A,B)
result=simplex(A,B)
A
```

```
We have an optimal solution with cost= -12
[12  0  0  2  7]
[ 2  0  1  5 -3]
[ 2  1  0 -3  2]
```

```
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We add the constraint $x_1+x_2=5$ to the LP.  This constraint is not
satisfied by the previous optimal solution, so we add this constraint
with a slack variable $x_{n+1}=x_5$ that is nonnegative.
```

We add the constraint $x_1+x_2=5$ to the LP. This constraint is not satis

```
R.<M>=PolynomialRing(QQ)
A=matrix(R,A).stack(matrix(R,1,5,[5,1,1,0,0])).augment(matrix(R,4,1,[M,0,0,
B.append(5); A
```

```
[12  0  0  2  7  M]
[ 2  0  1  5 -3  0]
[ 2  1  0 -3  2  0]
[ 5  1  1  0  0  1]
```

```
# We prepare the initial tableau.
pivot(A,B,1,2)
pivot(A,B,2,1)
pivot(A,B,5,3)
```

```
Pivoting tableau on col= 1 row= 2
[12  0  0  2  7  M]
[ 2  0  1  5 -3  0]
[ 2  1  0 -3  2  0]
[ 3  0  1  3 -2  1]
Pivoting tableau on col= 2 row= 1
[12  0  0  2  7  M]
[ 2  0  1  5 -3  0]
[ 2  1  0 -3  2  0]
[ 1  0  0 -2  1  1]
```

```
Pivoting tableau on col= 5 row= 3
[-M + 12       0       0 2*M + 2  -M + 7       0]
[      2       0       1       5      -3       0]
[      2       1       0      -3       2       0]
[      1       0       0      -2       1       1]
```

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Remember that $M$ is extremely large; hence, $7-M$ is negative.
```

Remember that M is extremely large; hence, $7-M$ is negative.

```
pivot(A,B,4,3)
```

```
Pivoting tableau on col= 4 row= 3
[    5     0     0    16     0 M - 7]
[    5     0     1    -1     0     3]
[    0     1     0     1     0    -2]
[    1     0     0    -2     1     1]
```

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Note that $M-7$ is positive; hence we have an optimal solution.
```

Note that $M-7$ is positive; hence we have an optimal solution.

```
print cost(A),basic_solution(A,B)
```

```
-5 (0, 5, 0, 1, 0)
```

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Since $x_{n+1}=x_5=0$, we have an optimal solution to the new LP with
the additional equality constraint.
```

Since $x_{n+1} = x_5 = 0$, we have an optimal solution to the new LP with the add