МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ

федеральное государственное бюджетное образовательное учреждение

высшего образования

**«УЛЬЯНОВСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

Кафедра «Вычислительная техника»

Дисциплина «Теория принятия решения»

**Лабораторная работа №2.**

**Решение задачи линейного программирования симплекс-методом**

Выполнил:

студент группы ИВТАПбд-21

Кондратьев П. С.

Проверил:

Фролов В. А.

Ульяновск, 2018

**Симплекс-метод** алгоритм решения [оптимизационной](https://ru.wikipedia.org/wiki/%D0%9E%D0%BF%D1%82%D0%B8%D0%BC%D0%B8%D0%B7%D0%B0%D1%86%D0%B8%D1%8F_(%D0%BC%D0%B0%D1%82%D0%B5%D0%BC%D0%B0%D1%82%D0%B8%D0%BA%D0%B0)) задачи [линейного программирования](https://ru.wikipedia.org/wiki/%D0%9B%D0%B8%D0%BD%D0%B5%D0%B9%D0%BD%D0%BE%D0%B5_%D0%BF%D1%80%D0%BE%D0%B3%D1%80%D0%B0%D0%BC%D0%BC%D0%B8%D1%80%D0%BE%D0%B2%D0%B0%D0%BD%D0%B8%D0%B5) путём перебора вершин выпуклого многогранника в многомерном пространстве.

Сущность метода: построение базисных решений, на которых монотонно убывает линейный функционал, до ситуации, когда выполняются необходимые условия локальной оптимальности.

Нахождение оптимального плана задачи линейного программирования симплекс методом:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| |  | | --- | | *x*1, *x*2, *x*3, *x*4 ≥ 0 | |

Преобразуем неравенства в равенства добавлением неотрицательных переменных:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  | | --- | --- | --- | | |  | | --- | | 2 | | ·*x*1 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −3 | | ·*x*2 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 6 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*5 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*6 | | → | *max* | | |  |  |  | | --- | --- | --- | | |  | | --- | | 2 | | ·*x*1 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*2 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −2 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*5 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*6 | | = | |  | | --- | | 24 | | | |  |  |  | | --- | --- | --- | | |  | | --- | | 1 | | ·*x*1 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 2 | | ·*x*2 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 4 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*5 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*6 | | = | |  | | --- | | 22 | | | |  |  |  | | --- | --- | --- | | |  | | --- | | 1 | | ·*x*1 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −1 | | ·*x*2 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 2 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*5 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −1 | | ·*x*6 | | = | |  | | --- | | 10 | | | | |
| |  | | --- | | *x*1, *x*2, *x*3, *x*4, *x*5, *x*6 ≥ 0 | |

Так как количество базисных векторов должен быть 3, то добавляем искусственные переменные, а в целевую функцию добавляем эти переменные, умноженные на −M, где M, очень большое число:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  | | --- | --- | --- | | |  | | --- | | 2 | | ·*x*1 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −3 | | ·*x*2 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 6 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*5 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*6 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −M | | ·*x*7 | | → | *max* | | |  |  |  | | --- | --- | --- | | |  | | --- | | 2 | | ·*x*1 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*2 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −2 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*5 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*6 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*7 | | = | |  | | --- | | 24 | | | |  |  |  | | --- | --- | --- | | |  | | --- | | 1 | | ·*x*1 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 2 | | ·*x*2 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 4 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*5 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*6 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*7 | | = | |  | | --- | | 22 | | | |  |  |  | | --- | --- | --- | | |  | | --- | | 1 | | ·*x*1 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −1 | | ·*x*2 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 2 | | ·*x*3 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*4 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 0 | | ·*x*5 | | |  |  |  | | --- | --- | --- | | |  | | --- | | −1 | | ·*x*6 | | |  |  |  |  | | --- | --- | --- | --- | | + | |  | | --- | | 1 | | ·*x*7 | | = | |  | | --- | | 10 | | | | |
| |  | | --- | | *x*1, *x*2, *x*3, *x*4, *x*5, *x*6, *x*7 ≥ 0 | |  | |

Матрица коэффициентов *A=ǁaijǁ* системы уравнений имеет вид:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  | | --- | | 2 | | |  | | --- | | 1 | | |  | | --- | | −2 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | | |  | | --- | | 1 | | |  | | --- | | 2 | | |  | | --- | | 4 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | | |  | | --- | | 1 | | |  | | --- | | −1 | | |  | | --- | | 2 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | −1 | | |  | | --- | | 1 | | |

Правая часть ограничений системы уравнений имеет вид:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | |  | | --- | | 24 | | | |  | | --- | | 22 | | | |  | | --- | | 10 | | |

Составляем симплексную таблицу. В столбец *x*0 записывается правая часть ограничений. С правой стороны записывается матрица коэффициентов *A*. Последние две строки − это целевая функция, умноженная на −1 и разделенная на две части. Последняя строка − строка с искусственными переменными:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Базис** | **x0** | **x1** | **x2** | **x3** | **x4** | **x5** | **x6** | **x7** | | **x4** | |  | | --- | | 24 | | |  | | --- | | 2 | | |  | | --- | | 1 | | |  | | --- | | −2 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | | **x5** | |  | | --- | | 22 | | |  | | --- | | 1 | | |  | | --- | | 2 | | |  | | --- | | 4 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | | **x7** | |  | | --- | | 10 | | |  | | --- | | 1 | | |  | | --- | | −1 | | |  | | --- | | 2 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | −1 | | |  | | --- | | 1 | | |  | |  | | --- | | 0 | | |  | | --- | | −2 | | |  | | --- | | 3 | | |  | | --- | | −6 | | |  | | --- | | −1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |

Базисные векторы x4, x5, x7, следовательно, все элементы в столбцах x4, x5, x7, ниже горизонтальной линии должны быть нулевыми.

Обнулим все элементы столбца **x4**, кроме ведущего элемента. Для этого сложим строку 4 со строкой 1, умноженной на 1. Обнулим все элементы столбца **x7**, кроме ведущего элемента. Для этого сложим строку 5 со строкой 3, умноженной на -1.

Симплекс таблица примет вид:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Базис** | **x0** | **x1** | **x2** | **x3** | **x4** | **x5** | **x6** | **x7** | | **x4** | |  | | --- | | 24 | | |  | | --- | | 2 | | |  | | --- | | 1 | | |  | | --- | | −2 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | | **x5** | |  | | --- | | 22 | | |  | | --- | | 1 | | |  | | --- | | 2 | | |  | | --- | | 4 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | | **x7** | |  | | --- | | 10 | | |  | | --- | | 1 | | |  | | --- | | −1 | | |  | | --- | | 2 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | −1 | | |  | | --- | | 1 | | |  | |  | | --- | | 24 | | |  | | --- | | 0 | | |  | | --- | | 4 | | |  | | --- | | −8 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | |  | | --- | | −10 | | |  | | --- | | −1 | | |  | | --- | | 1 | | |  | | --- | | −2 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |

**Шаг 1**

Запишем текущий опорный план:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | *X=* |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 24 | | |  | | --- | | 22 | | |  | | --- | | 0 | | |  | | --- | | 10 | | |  | |

Данный опорный план не является оптимальным, так как в последней строке есть отрицательные элементы. Самый большой по модулю отрицательный элемент (-2), следовательно, в базис входит вектор *x*3. Определяем, какой вектор выходит из базиса. Для этого вычисляем *min(ai,0*/*ai,3),* при *ai,3>0, i=*1...3. *min* (22:4, 10:2) = 5 соответствует строке 3. Из базиса выходит вектор *x*7. Сделаем исключение Гаусса для столбца x3, учитывая, что ведущий элемент соответствует строке 3. Обнулим все элементы этого столбца, кроме ведущего элемента. Для этого сложим строки 1, 2, 4, 5 со строкой 3, умноженной на 1, -2, 4, 1, соответственно. Далее делим строку с ведущим элементом на ведущий элемент.

Симплекс таблица примет следующий вид:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Базис** | **x0** | **x1** | **x2** | **x3** | **x4** | **x5** | **x6** | **x7** | | **x4** | |  | | --- | | 34 | | |  | | --- | | 3 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | −1 | | |  | | --- | | 1 | | | **x5** | |  | | --- | | 2 | | |  | | --- | | −1 | | |  | | --- | | 4 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |  | | --- | | 2 | | |  | | --- | | −2 | | | **x3** | |  | | --- | | 5 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 1 | |  | | 2 | | | |  |  |  |  |  | | --- | --- | --- | --- | --- | | − | |  | | --- | | 1 | |  | | 2 | | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | | − | |  | | --- | | 1 | |  | | 2 | | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 1 | |  | | 2 | | | |  | |  | | --- | | 64 | | |  | | --- | | 4 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | −4 | | |  | | --- | | 4 | | |  | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |

**Шаг 2**

Запишем текущий опорный план:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | *X=* |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 5 | | |  | | --- | | 34 | | |  | | --- | | 2 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | |

Данный опорный план не является оптимальным, так как в последней строке есть отрицательные элементы. Самый большой по модулю отрицательный элемент (-4), следовательно, в базис входит вектор *x*6. Определяем, какой вектор выходит из базиса.

Для этого вычисляем *min(ai,0*/*ai,6),* при *ai,6>0, i=*1...3. *min* (2:2) = 1 соответствует строке 2. Из базиса выходит вектор *x*5. Сделаем исключение Гаусса для столбца x6, учитывая, что ведущий элемент соответствует строке 2. Обнулим все элементы этого столбца, кроме ведущего элемента. Для этого сложим строки строки 1, 3, 4 со строкой 2, умноженной на 1/2, 1/4, 2, соответственно. Далее делим строку с ведущим элементом на ведущий элемент.

Симплекс таблица примет следующий вид:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Базис** | **x0** | **x1** | **x2** | **x3** | **x4** | **x5** | **x6** | **x7** | | **x4** | |  | | --- | | 35 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 5 | |  | | 2 | | | |  | | --- | | 2 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 1 | |  | | 2 | | | |  | | --- | | 0 | | |  | | --- | | 0 | | | **x6** | |  | | --- | | 1 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | | − | |  | | --- | | 1 | |  | | 2 | | | |  | | --- | | 2 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 1 | |  | | 2 | | | |  | | --- | | 1 | | |  | | --- | | −1 | | | **x3** | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 11 | |  | | 2 | | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 1 | |  | | 4 | | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 1 | |  | | 2 | | | |  | | --- | | 1 | | |  | | --- | | 0 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | |  | | --- | | 1 | |  | | 4 | | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | |  | | --- | | 68 | | |  | | --- | | 2 | | |  | | --- | | 8 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 2 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 0 | | |  | | --- | | 1 | | |

**Шаг 3**

Запишем текущий опорный план:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | *X=* |  | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 0 | 0 |  | 35 | 0 | 1 | 0 | |  | |

Текущий опорный план является оптимальным, так как в строках 4−5 под переменными *x*1, *x*2, *x*3, *x*4, *x*5, *x*6 нет отрицательных элементов.

Решение можно записать так:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *x*1= |  | *0 ,  x*2= |  | *0 ,  x*3= |  | *,  x*4= | 35 |

Значение целевой функции в данной точке: