**НИУ ИТМО**

**Факультет ПИиКТ**

Дискретная математика

Курсовая работа

«Синтез комбинационных схем»

Вариант 132

Выполнил Бахаруев П. С.

Группа P3114

Преподаватель

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Санкт - Петербург

2019-2020 гг.

5<=(x4x5 + x1x2x3)<=8;

(x1x2x3) = 1

# Составление таблицы истинности

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| N | X1 | X2 | X3 | X4 | X5 | x4 x5 | (x4 x5)10 | x1x2x3 | (x1x2x3)10 | (+) | f |
| 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 000 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 01 | 1 | 000 | 0 | 1 | 0 |
| 2 | 0 | 0 | 0 | 1 | 0 | 10 | 2 | 000 | 0 | 2 | 0 |
| 3 | 0 | 0 | 0 | 1 | 1 | 11 | 3 | 000 | 0 | 3 | 0 |
| 4 | 0 | 0 | 1 | 0 | 0 | 00 | 0 | 001 | 1 | 1 | d |
| 5 | 0 | 0 | 1 | 0 | 1 | 01 | 1 | 001 | 1 | 2 | d |
| 6 | 0 | 0 | 1 | 1 | 0 | 10 | 2 | 001 | 1 | 3 | d |
| 7 | 0 | 0 | 1 | 1 | 1 | 11 | 3 | 001 | 1 | 4 | d |
| 8 | 0 | 1 | 0 | 0 | 0 | 00 | 0 | 010 | 2 | 2 | 0 |
| 9 | 0 | 1 | 0 | 0 | 1 | 01 | 1 | 010 | 2 | 3 | 0 |
| 10 | 0 | 1 | 0 | 1 | 0 | 10 | 2 | 010 | 2 | 4 | 0 |
| 11 | 0 | 1 | 0 | 1 | 1 | 11 | 3 | 010 | 2 | 5 | 1 |
| 12 | 0 | 1 | 1 | 0 | 0 | 00 | 0 | 011 | 3 | 3 | 0 |
| 13 | 0 | 1 | 1 | 0 | 1 | 01 | 1 | 011 | 3 | 4 | 0 |
| 14 | 0 | 1 | 1 | 1 | 0 | 10 | 2 | 011 | 3 | 5 | 1 |
| 15 | 0 | 1 | 1 | 1 | 1 | 11 | 3 | 011 | 3 | 6 | 1 |
| 16 | 1 | 0 | 0 | 0 | 0 | 00 | 0 | 100 | 4 | 4 | 0 |
| 17 | 1 | 0 | 0 | 0 | 1 | 01 | 1 | 100 | 4 | 5 | 1 |
| 18 | 1 | 0 | 0 | 1 | 0 | 10 | 2 | 100 | 4 | 6 | 1 |
| 19 | 1 | 0 | 0 | 1 | 1 | 11 | 3 | 100 | 4 | 7 | 1 |
| 20 | 1 | 0 | 1 | 0 | 0 | 00 | 0 | 101 | 5 | 5 | 1 |
| 21 | 1 | 0 | 1 | 0 | 1 | 01 | 1 | 101 | 5 | 6 | 1 |
| 22 | 1 | 0 | 1 | 1 | 0 | 10 | 2 | 101 | 5 | 7 | 1 |
| 23 | 1 | 0 | 1 | 1 | 1 | 11 | 3 | 101 | 5 | 8 | 1 |
| 24 | 1 | 1 | 0 | 0 | 0 | 00 | 0 | 110 | 6 | 6 | 1 |
| 25 | 1 | 1 | 0 | 0 | 1 | 01 | 1 | 110 | 6 | 7 | 1 |
| 26 | 1 | 1 | 0 | 1 | 0 | 10 | 2 | 110 | 6 | 8 | 1 |
| 27 | 1 | 1 | 0 | 1 | 1 | 11 | 3 | 110 | 6 | 9 | 0 |
| 28 | 1 | 1 | 1 | 0 | 0 | 00 | 0 | 111 | 7 | 7 | 1 |
| 29 | 1 | 1 | 1 | 0 | 1 | 01 | 1 | 111 | 7 | 8 | 1 |
| 30 | 1 | 1 | 1 | 1 | 0 | 10 | 2 | 111 | 7 | 9 | 0 |
| 31 | 1 | 1 | 1 | 1 | 1 | 11 | 3 | 111 | 7 | 10 | 0 |

# Представление булевой функции в аналитическом виде

# Минимизация булевой функции методом Квайна-Мак-Класки

Нахождение простых импликант (максимальных кубов).

Получение кубов различной размерности кубического комплекса K(f) и выделение из них простых импликант:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| K0(f) N(f) | K1(f) | K2(f) | K3(f) | Z(f) |
| 1. 00100 | 1. 0010x | 1. 001xx | 1. X01xx | 1. 01x11 |
| 1. 00101 | 1. 001x0 | 1. x010x |  | 1. 1x010 |
| 1. 00110 | 1. X0100 | 1. X01x0 |  | 1. 110x0 |
| 1. 00111 | 1. 001x1 | 1. X01x1 |  | 1. 0x11x |
| 1. 01011 | 1. X010 | 1. 0x11x |  | 1. 10xx1 |
| 1. 01110 | 1. 0011x | 1. X011x |  | 1. 1xx01 |
| 1. 01111 | 1. 0x110 | 1. 10xx1 |  | 1. 10x1x |
| 1. 10001 | 1. X0110 | 1. 1xx01 |  | 1. 1x10x |
| 1. 10010 | 1. 0x111 | 1. 10x1x |  | 1. 11x0x |
| 1. 10011 | 1. X0111 | 1. 101xx |  | 1. X01xx |
| 1. 10100 | 1. 01x11 | 1. 1x10x |  |  |
| 1. 10101 | 1. 0111x | 1. 11x0x |  |  |
| 1. 10110 | 1. 100x1 |  |  |  |
| 1. 10111 | 1. 10x01 |  |  |  |
| 1. 11000 | 1. 1x001 |  |  |  |
| 1. 11001 | 1. 1001x |  |  |  |
| 1. 11010 | 1. 10x10 |  |  |  |
| 1. 11100 | 1. 1x010 |  |  |  |
| 1. 11101 | 1. 10x11 |  |  |  |
|  | 1. 1010x |  |  |  |
|  | 1. 101x0 |  |  |  |
|  | 1. 1x100 |  |  |  |
|  | 1. 101x1 |  |  |  |
|  | 1. 1x101 |  |  |  |
|  | 1. 1011x |  |  |  |
|  | 1. 1100x |  |  |  |
|  | 1. 110x0 |  |  |  |
|  | 1. 11x00 |  |  |  |
|  | 1. 11x01 |  |  |  |
|  | 1. 1110x |  |  |  |

# Составление импликантной таблицы:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Простые**  **импликанты**  **(максимальные кубы)** | **0 – кубы** | | | | | | | | | | | | | | |
| 0  1  0  1  1 | 0  1  1  1  0 | 0  1  1  1  1 | 1  0  0  0  1 | 1  0  0  1  0 | 1  0  0  1  1 | 1  0  1  0  0 | 1  0  1  0  1 | 1  0  1  1  0 | 1  0  1  1  1 | 1  1  0  0  0 | 1  1  0  0  1 | 1  1  0  1  0 | 1  1  1  0  0 | 1  1  1  0  1 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1. 01x11 | (\*) |  | \* |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. 1x010 |  |  |  |  | \* |  |  |  |  |  |  |  | \* |  |  |
| 1. 110x0 |  |  |  |  |  |  |  |  |  |  | \* |  | \* |  |  |
| 1. 0x11x |  | (\*) | \* |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. 10xx1 |  |  |  | \* |  | \* |  | \* |  | \* |  |  |  |  |  |
| 1. 1xx01 |  |  |  | \* |  |  |  | \* |  |  |  | \* |  |  | \* |
| 1. 10x1x |  |  |  |  | \* | \* |  |  | \* | \* |  |  |  |  |  |
| 1. 1x10x |  |  |  |  |  |  | \* | \* |  |  |  |  |  | \* | \* |
| 1. 11x0x |  |  |  |  |  |  |  |  |  |  | \* | \* |  | \* | \* |
| 1. X01xx |  |  |  |  |  |  | \* | \* | \* | \* |  |  |  |  |  |

Упрощенная импликантная таблица:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Простые**  **импликанты**  **(максимальные кубы)** |  | 1  0  0  0  1 | 1  0  0  1  0 | 1  0  0  1  1 | 1  0  1  0  0 | 1  0  1  0  1 | 1  0  1  1  0 | 1  0  1  1  1 | 1  1  0  0  0 | 1  1  0  0  1 | 1  1  0  1  0 | 1  1  1  0  0 | 1  1  1  0  1 |
|  |  | a | b | c | d | e | f | g | h | i | j | k | l |
| 1x010 | A |  | \* |  |  |  |  |  |  |  | \* |  |  |
| 110x0 | B |  |  |  |  |  |  |  | \* |  | \* |  |  |
| 10xx1 | C | \* |  | \* |  | \* |  | \* |  |  |  |  |  |
| 1xx01 | D | \* |  |  |  | \* |  |  |  | \* |  |  | \* |
| 10x1x | E |  | \* | \* |  |  | \* | \* |  |  |  |  |  |
| 1x10x | F |  |  |  | \* | \* |  |  |  |  |  | \* | \* |
| 11x0x | G |  |  |  |  |  |  |  | \* | \* |  | \* | \* |
| X01xx | H |  |  |  | \* | \* | \* | \* |  |  |  |  |  |

Множество существенных импликант (максимальных кубов) образует ядро покрытия как его обязательную часть:

Определение минимального покрытия методом Петрика:

Выпишем булево выражение Y, определяющее условие покрытия всех 0-кубов, не покрываемых существенными импликантами.

Возможные варианты покрытия:

(9 вариантов)

Одно из минимальных покрытий функции :

(От руки 1)

Число букв в МДНФ совпадает с ценой покрытия Sa, а суммарное число букв и число термов совпадает с ценой покрытия Sb.

1. **Минимизация булевой функции на картах Карно**

**4.1 Определение МДНФ**

Для минимизации булевой функции от пяти переменных используем две четырехмерные карты Карно, различающиеся по переменной X1: (единичные покрытия)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | X4X5 | | | | | | X2X3 |  | **00** | **01** | **11** | **10** | | **00** |  |  |  |  | | **01** |  |  |  |  | | **11** |  |  | 1 | 1 | | **10** |  |  | 1 |  | | X1 = 0 | | | | | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | X4X5 | | | | | | X2X3 |  | **00** | **01** | **11** | **10** | | **00** |  | 1 | 1 | 1 | | **01** | 1 | 1 | 1 | 1 | | **11** | 1 | 1 |  |  | | **10** | 1 | 1 |  | 1 | | X1 = 1 | | | | | |

Цены минимальных покрытий, полученных методом Квайна Мак-Класски и с помощью карт Карно, совпадают, так как цена мин. покрытия булевой функции не зависит от метода ее нахождения

(От руки 1)

**4.2 Определение МКНФ**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | X4X5 | | | | | | X2X3 |  | **00** | **01** | **11** | **10** | | **00** | 0 | 0 | 0 | 0 | | **01** |  |  |  |  | | **11** | 0 | 0 |  |  | | **10** | 0 | 0 |  | 1 | | X1 = 0 | | | | | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | X4X5 | | | | | | X2X3 |  | **00** | **01** | **11** | **10** | | **00** | 0 |  |  |  | | **01** |  |  |  |  | | **11** |  | 0 | 0 |  | | **10** |  |  | 0 |  | | X1 = 1 | | | | | |