Национальный Исследовательский Университет

Информационных Технологий Механики и Оптики

Курсовая работа по дискретной математике

«Синтез комбинационных схем»

Выполнил:

обучающийся Р3110

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Преподаватель:

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Санкт-Петербург

2020 г.

|  |  |
| --- | --- |
| Условия, при которых f=1 | Условия, при которых f=d |
| 2≤|x1x2x5-x3x4|≤4 | |x1x2x5-x3x4|=5 |

**Составление таблицы истинности**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| N | X1X2X3X4X5 | X1X2X5 | (X1X2X5)10 | X3X4 | (X3X4)10 | |- | | f |
| 0 | 0 0 0 0 0 | 0 0 0 | 0 | 0 0 | 0 | 0 | 0 |
| 1 | 0 0 0 0 1 | 0 0 1 | 1 | 0 0 | 0 | 1 | 0 |
| 2 | 0 0 0 1 0 | 0 0 0 | 0 | 0 1 | 1 | 1 | 0 |
| 3 | 0 0 0 1 1 | 0 0 1 | 1 | 0 1 | 1 | 0 | 0 |
| 4 | 0 0 1 0 0 | 0 0 0 | 0 | 1 0 | 2 | 2 | 1 |
| 5 | 0 0 1 0 1 | 0 0 1 | 1 | 1 0 | 2 | 1 | 0 |
| 6 | 0 0 1 1 0 | 0 0 0 | 0 | 1 1 | 3 | 3 | 1 |
| 7 | 0 0 1 1 1 | 0 0 1 | 1 | 1 1 | 3 | 2 | 1 |
| 8 | 0 1 0 0 0 | 0 1 0 | 2 | 0 0 | 0 | 2 | 1 |
| 9 | 0 1 0 0 1 | 0 1 1 | 3 | 0 0 | 0 | 3 | 1 |
| 10 | 0 1 0 1 0 | 0 1 0 | 2 | 0 1 | 1 | 1 | 0 |
| 11 | 0 1 0 1 1 | 0 1 1 | 3 | 0 1 | 1 | 2 | 1 |
| 12 | 0 1 1 0 0 | 0 1 0 | 2 | 1 0 | 2 | 0 | 0 |
| 13 | 0 1 1 0 1 | 0 1 1 | 3 | 1 0 | 2 | 1 | 0 |
| 14 | 0 1 1 1 0 | 0 1 0 | 2 | 1 1 | 3 | 1 | 0 |
| 15 | 0 1 1 1 1 | 0 1 1 | 3 | 1 1 | 3 | 0 | 0 |
| 16 | 1 0 0 0 0 | 1 0 0 | 4 | 0 0 | 0 | 4 | 1 |
| 17 | 1 0 0 0 1 | 1 0 1 | 5 | 0 0 | 0 | 5 | d |
| 18 | 1 0 0 1 0 | 1 0 0 | 4 | 0 1 | 1 | 3 | 1 |
| 19 | 1 0 0 1 1 | 1 0 1 | 5 | 0 1 | 1 | 4 | 1 |
| 20 | 1 0 1 0 0 | 1 0 0 | 4 | 1 0 | 2 | 2 | 1 |
| 21 | 1 0 1 0 1 | 1 0 1 | 5 | 1 0 | 2 | 3 | 1 |
| 22 | 1 0 1 1 0 | 1 0 0 | 4 | 1 1 | 3 | 1 | 0 |
| 23 | 1 0 1 1 1 | 1 0 1 | 5 | 1 1 | 3 | 2 | 1 |
| 24 | 1 1 0 0 0 | 1 1 0 | 6 | 0 0 | 0 | 6 | 0 |
| 25 | 1 1 0 0 1 | 1 1 1 | 7 | 0 0 | 0 | 7 | 0 |
| 26 | 1 1 0 1 0 | 1 1 0 | 6 | 0 1 | 1 | 5 | d |
| 27 | 1 1 0 1 1 | 1 1 1 | 7 | 0 1 | 1 | 6 | 0 |
| 28 | 1 1 1 0 0 | 1 1 0 | 6 | 1 0 | 2 | 4 | 1 |
| 29 | 1 1 1 0 1 | 1 1 1 | 7 | 1 0 | 2 | 5 | d |
| 30 | 1 1 1 1 0 | 1 1 0 | 6 | 1 1 | 3 | 3 | 1 |
| 31 | 1 1 1 1 1 | 1 1 1 | 7 | 1 1 | 3 | 4 | 1 |

**Представить булевую функцию в аналитическом виде с помощью КДНФ и ККНФ**

**КДНФ:**

**ККНФ:**

**Минимизация булевой функции методом Квайна-Мак-Класки**

**Нахождение простых импликант (максимальных кубов):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **K0 ∪ N(f)** | | **K1(f)** | | | **K2(f)** | | | **Z(f)** |
| 1. 00100 | v | **1. 001X0** |  | 1-4 | **1. 100XX** | 4-11 | 5-9 | **1. 100XX** |
| 2. 01000 | v | **2. X0100** |  | 1-8 | **2. 10X0X** | 4-13 | 6-10 | **2. 10X0X** |
| 3. 10000 | v | **3. 0100X** |  | 2-5 | **3. 10XX1** | 9-17 | 10-16 | **3. 10XX1** |
| 4. 00110 | v | 4. 1000X | v | 3-6 | **4. 1X10X** | 13-20 | 14-18 | **4. 1X10X** |
| 5. 01001 | v | 5. 100X0 | v | 3-7 | **5. 1X1X1** | 17-23 | 18-22 | **5. 1X1X1** |
| 6. 10001 | v | 6. 10X00 | v | 3-8 | **6. 111XX** | 20-24 | 21-23 | **6. 111XX** |
| 7. 10010 | v | **7. 0011X** |  | 4-9 |  |  |  | **7. 001X0** |
| 8. 10100 | v | **8. 010X1** |  | 5-10 |  |  |  | **8. X0100** |
| 9. 00111 | v | 9. 100X1 | v | 6-11 |  |  |  | **9. 0100X** |
| 10. 01011 | v | 10. 10X01 | v | 6-12 | **K3(f)** = ∅ |  |  | **10. 0011X** |
| 11. 10011 | v | 11. 1001X | v | 7-11 |  |  |  | **11. 010X1** |
| 12. 10101 | v | **12. 1X010** |  | 7-13 |  |  |  | **12. 1X010** |
| 13. 11010 | v | 13. 1010X | v | 8-12 |  |  |  | **13. X0111** |
| 14. 11100 | v | 14. 1X100 | v | 8-14 |  |  |  | **14. 11X10** |
| 15. 10111 | v | **15. X0111** |  | 9-15 |  |  |  |  |
| 16. 11101 | v | 16. 10X11 | v | 11-15 |  |  |  |  |
| 17. 11110 | v | 17. 101X1 | v | 12-15 |  |  |  |  |
| 18. 11111 | v | 18. 1X101 | v | 12-16 |  |  |  |  |
|  |  | **19. 11X10** |  | 13-17 |  |  |  |  |
|  |  | 20. 1110X | v | 14-16 |  |  |  |  |
|  |  | 21. 111X0 | v | 14-17 |  |  |  |  |
|  |  | 22. 1X111 | v | 15-18 |  |  |  |  |
|  |  | 23. 111X1 | v | 16-18 |  |  |  |  |
|  |  | 24. 1111X | v | 17-18 |  |  |  |  |

**Импликантная таблица:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Простые импликанты  (максимальные кубы) | | 0-кубы | | | | | | | | | | | | | | |
| 0  0  1  0  0 | 0  0  1  1  0 | 0  0  1  1  1 | 0  1  0  0  0 | 0  1  0  0  1 | 0  1  0  1  1 | 1  0  0  0  0 | 1  0  0  1  0 | 1  0  0  1  1 | 1  0  1  0  0 | 1  0  1  0  1 | 1  0  1  1  1 | 1  1  1  0  0 | 1  1  1  1  0 | 1  1  1  1  1 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | 100XX |  |  |  |  |  |  | \* | \* | \* |  |  |  |  |  |  |
| 2 | 10X0X |  |  |  |  |  |  |  |  |  | \* | \* |  |  |  |  |
| 3 | 10XX1 |  |  |  |  |  |  |  |  | \* |  | \* | \* |  |  |  |
| 4 | 1X10X |  |  |  |  |  |  |  |  |  | \* | \* |  |  |  |  |
| 5 | 1X1X1 |  |  |  |  |  |  |  |  |  |  | \* | \* |  |  | \* |
| 6 | 111XX |  |  |  |  |  |  |  |  |  |  |  |  | \* | \* | \* |
| 7 | 001X0 | \* | \* |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | X0100 | \* |  |  |  |  |  |  |  |  | \* |  |  |  |  |  |
| 9 | 0100X |  |  |  | \* | \* |  |  |  |  |  |  |  |  |  |  |
| 10 | 0011X |  | \* | \* |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | 010X1 |  |  |  |  | \* | \* |  |  |  |  |  |  |  |  |  |
| 12 | 1X010 |  |  |  |  |  |  |  | \* |  |  |  |  |  |  |  |
| 13 | X0111 |  |  | \* |  |  |  |  |  |  |  |  | \* |  |  |  |
| 14 | 11X10 |  |  |  |  |  |  |  |  |  |  |  |  |  | \* |  |

Импликанты 1, 6, 9 и 11 — существенные.

**Приведенная импликантная таблица:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Простые импликанты  (максимальные кубы) | | 0-кубы | | | | | |
| 0  0  1  0  0 | 0  0  1  1  0 | 0  0  1  1  1 | 1  0  1  0  0 | 1  0  1  0  1 | 1  0  1  1  1 |
| a | b | c | d | e | f |
| 10X0X | A |  |  |  | \* | \* |  |
| 10XX1 | B |  |  |  |  | \* | \* |
| 1X10X | C |  |  |  | \* | \* |  |
| 1X1X1 | D |  |  |  |  | \* | \* |
| 001X0 | E | \* | \* |  |  |  |  |
| X0100 | F | \* |  |  | \* |  |  |
| 0011X | G |  | \* | \* |  |  |  |
| 1X010 | H |  |  |  |  |  |  |
| X0111 | I |  |  | \* |  |  | \* |
| 11X10 | J |  |  |  |  |  |  |

**Определение минимального покрытия. Метод Петрика:**

Выпишем булево выражение Y, определяющие условие покрытия всех 0-кубов, не покрываемых сущевственными импликантами.

**Возможны следующие варианты покрытия:**

; ; ; ; ; ;

; ; ; ; ;

**Минимальные покрытия:**

**Этим покрытиям соответствуют МДНФ следующего вида:**

**Минимизация булевой функции на картах Карно. Определение МДНФ**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | x1x2 |  |  |  |  |  |  | x1x2 |  |  |  |  |
| x3x4 |  | 00 | 01 | 11 | 10 |  | x3x4 |  | 00 | 01 | 11 | 10 |
|  | 00 |  | 1 |  | 1 |  |  | 00 |  | 1 |  | d |
|  | 01 |  |  | d | 1 |  |  | 01 |  | 1 |  | 1 |
|  | 11 | 1 |  | 1 |  |  |  | 11 | 1 |  | 1 | 1 |
|  | 10 | 1 |  | 1 | 1 |  |  | 10 |  |  | d | 1 |
|  |  |  | x5=0 |  |  |  |  |  |  | x5=1 |  |  |

Получаем

**МДНФ имеет следующий вид:**

**Определение МКНФ:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | x4x5 |  |  |  |  |  |  | x4x5 |  |  |  |  |
| x2x3 |  | 00 | 01 | 11 | 10 |  | x2x3 |  | 00 | 01 | 11 | 10 |
|  | 00 | 0 | 0 | 0 | 0 |  |  | 00 |  | d |  |  |
|  | 01 |  | 0 |  |  |  |  | 01 |  |  |  | 0 |
|  | 11 | 0 | 0 | 0 | 0 |  |  | 11 |  | d |  |  |
|  | 10 |  |  |  | 0 |  |  | 10 | 0 | 0 | 0 | d |
|  |  |  | x1=0 |  |  |  |  |  |  | x1=1 |  |  |

Получаем

**МКНФ имеет следующий вид:**

**Преобразование минимальных форм булевой функции.**

**Факторное преобразование для МДНФ:**

SQ=32

SQ=29

Декомпозиция: введем вспомогательную функцию

**Факторное преобразование для МКНФ:**

SQ=28

SQ=27

**Синтез комбинационных схем в булевом базисе**