Факультет Программной Инженерии и Компьютерной Техники

Курсовая работа №1

Часть 1

По дискретной математике

Вариант 84

Выполнил:

Студент группы P3110

Бармичев Григорий Андреевич

Преподаватель:

Поляков Владимир Иванович

f(Х) принимает значение 1 при 2≤|x11x5-x4x2x3|<5 и неопределенное при |x11x5-x4x2x3|=5

# Таблица истинности

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| № | X1X2X3X4X5 | X11X5 | (X11X5)10 | X4X2X3 | (X4X2X3)10 | |-| | f |
| 0 | 00000 | 010 | 2 | 000 | 0 | 2 | 1 |
| 1 | 00001 | 011 | 3 | 000 | 0 | 3 | 1 |
| 2 | 00010 | 010 | 2 | 100 | 4 | 2 | 1 |
| 3 | 00011 | 011 | 3 | 100 | 4 | 1 | 0 |
| 4 | 00100 | 010 | 2 | 001 | 1 | 1 | 0 |
| 5 | 00101 | 011 | 3 | 001 | 1 | 2 | 1 |
| 6 | 00110 | 010 | 2 | 101 | 5 | 3 | 1 |
| 7 | 00111 | 011 | 3 | 101 | 5 | 2 | 1 |
| 8 | 01000 | 010 | 2 | 010 | 2 | 0 | 0 |
| 9 | 01001 | 011 | 3 | 010 | 2 | 1 | 0 |
| 10 | 01010 | 010 | 2 | 110 | 6 | 4 | 1 |
| 11 | 01011 | 011 | 3 | 110 | 6 | 3 | 1 |
| 12 | 01100 | 010 | 2 | 011 | 3 | 1 | 0 |
| 13 | 01101 | 011 | 3 | 011 | 3 | 0 | 0 |
| 14 | 01110 | 010 | 2 | 111 | 7 | 5 | d |
| 15 | 01111 | 011 | 3 | 111 | 7 | 4 | 1 |
| 16 | 10000 | 110 | 6 | 000 | 0 | 6 | 0 |
| 17 | 10001 | 111 | 7 | 000 | 0 | 7 | 0 |
| 18 | 10010 | 110 | 6 | 100 | 4 | 2 | 1 |
| 19 | 10011 | 111 | 7 | 100 | 4 | 3 | 1 |
| 20 | 10100 | 110 | 6 | 001 | 1 | 5 | d |
| 21 | 10101 | 111 | 7 | 001 | 1 | 6 | 0 |
| 22 | 10110 | 110 | 6 | 101 | 5 | 1 | 0 |
| 23 | 10111 | 111 | 7 | 101 | 5 | 2 | 1 |
| 24 | 11000 | 110 | 6 | 010 | 2 | 4 | 1 |
| 25 | 11001 | 111 | 7 | 010 | 2 | 5 | d |
| 26 | 11010 | 110 | 6 | 110 | 6 | 0 | 0 |
| 27 | 11011 | 111 | 7 | 110 | 6 | 1 | 0 |
| 28 | 11100 | 110 | 6 | 011 | 3 | 3 | 1 |
| 29 | 11101 | 111 | 7 | 011 | 3 | 4 | 1 |
| 30 | 11110 | 110 | 6 | 111 | 7 | 1 | 0 |
| 31 | 11111 | 111 | 7 | 111 | 7 | 0 | 0 |

**КДНФ:** f(Х) = (¬x1∧¬x2∧¬x3∧¬x4∧¬x5) ∨ (¬x1∧¬x2∧¬x3∧¬x4∧x5) ∨ (¬x1∧¬x2∧¬x3∧x4∧¬x5) ∨ (¬x1∧¬x2∧¬x3∧x4∧x5) ∨ (¬x1∧¬x2∧x3∧x4∧¬x5) ∨ (¬x1∧¬x2∧x3∧x4∧x5) ∨ (¬x1∧x2∧¬x3∧x4∧¬x5) ∨ (¬x1∧x2∧¬x3∧x4∧x5) ∨ (¬x1∧x2∧x3∧x4∧x5) ∨ (x1∧¬x2∧¬x3∧x4∧¬x5) ∨ (x1∧¬x2∧¬x3∧x4∧x5) ∨ (x1∧¬x2∧x3∧x4∧x5) ∨ (x1∧x2∧¬x3∧¬x4∧¬x5) ∨ (x1∧x2∧x3∧¬x4∧¬x5) ∨ (x1∧x2∧x3∧¬x4∧x5)

**ККНФ:** f(Х) = (x1∨x2∨x3∨¬x4∨¬x5) ∧ (x1∨x2∨¬x3∨x4∨x5) ∧ (x1∨¬x2∨x3∨x4∨x5) ∧ (x1∨¬x2∨x3∨x4∨¬x5) ∧ (x1∨¬x2∨¬x3∨x4∨x5) ∧ (x1∨¬x2∨¬x3∨x4∨¬x5) ∧ (¬x1∨x2∨x3∨x4∨x5) ∧ (¬x1∨x2∨x3∨x4∨¬x5) ∧ (¬x1∨x2∨¬x3∨x4∨¬x5) ∧ (¬x1∨x2∨¬x3∨¬x4∨x5) ∧ (¬x1∨¬x2∨x3∨¬x4∨x5) ∧ (¬x1∨¬x2∨x3∨¬x4∨¬x5) ∧ (¬x1∨¬x2∨¬x3∨¬x4∨x5) ∧ (¬x1∨¬x2∨¬x3∨¬x4∨¬x5)

# Минимизация булевой функции методом Квайна–Мак-Класки

|  |  |  |  |
| --- | --- | --- | --- |
| K0 | K1 | K2 | Z(f) |
| 1. 00000 ✓ 2. 00001 ✓ 3. 00010 ✓ 4. 00101 ✓ 5. 00110 ✓ 6. 00111 ✓ 7. 01010 ✓ 8. 01011 ✓ 9. 01110 ✓ 10. 01111 ✓ 11. 10010 ✓ 12. 10011 ✓ 13. 10100 ✓ 14. 10111 ✓ 15. 11000 ✓ 16. 11001 ✓ 17. 11100 ✓ 18. 11101 ✓ | 1. 0000x 1-2 2. 000x0 1-3 3. 00x01 2-4 4. 00x10 3-5 ✓ 5. 0x010 3-7 ✓ 6. x0010 3-11 7. 001x1 4-6 8. 0011x 5-6 ✓ 9. 0x110 5-9 ✓ 10. 0x111 6-10 ✓ 11. x0111 6-14 12. 0101x 7-8 ✓ 13. 01x10 7-9 ✓ 14. 01x11 8-10 ✓ 15. 0111x 9-10 ✓ 16. 1001x 11-12 17. 10x11 12-14 18. 1x100 13-17 19. 1100x 15-16 ✓ 20. 11x00 15-17 ✓ 21. 11x01 16-18 ✓ 22. 1110x 17-18 ✓ | 1. 0xx10 4-13 ✓ 2. 0x11x 8-15 ✓ 3. 01x1x 12-15 ✓ 4. 11x0x 19-22 ✓ | 1. 0000x 2. 000x0 3. 00x01 4. x0010 5. 001x1 6. x0111 7. 1001x 8. 10x11 9. 1x100 10. 0xx10 11. 0x11x 12. 01x1x 13. 11x0x |

# Таблица импликант

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Простые импликанты (максимальные кубы) | 0-кубы | | | | | | | | | | | | | | |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| 0000x | \* | \* |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 000x0 | \* |  | \* |  |  |  |  |  |  |  |  |  |  |  |  |
| 00x01 |  | \* |  | \* |  |  |  |  |  |  |  |  |  |  |  |
| x0010 |  |  | \* |  |  |  |  |  |  | \* |  |  |  |  |  |
| 001x1 |  |  |  | \* |  | \* |  |  |  |  |  |  |  |  |  |
| x0111 |  |  |  |  |  | \* |  |  |  |  |  | \* |  |  |  |
| 1001x |  |  |  |  |  |  |  |  |  | \* | \* |  |  |  |  |
| 10x11 |  |  |  |  |  |  |  |  |  |  | \* | \* |  |  |  |
| 1x100 |  |  |  |  |  |  |  |  |  |  |  |  |  | \* |  |
| 0xx10 |  |  | \* |  | \* |  | \* |  |  |  |  |  |  |  |  |
| 0x11x |  |  |  |  | \* | \* |  |  | \* |  |  |  |  |  |  |
| 01x1x |  |  |  |  |  |  | \* | (\*) | \* |  |  |  |  |  |  |
| 11x0x |  |  |  |  |  |  |  |  |  |  |  |  | (\*) | \* | (\*) |

**Ядро покрытия:**

## Упрощенная таблица

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Простые импликанты (максимальные кубы) | 0-кубы | | | | | | | | | |
|  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
|  | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
|  | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
|  | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
|  | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
|  |  | a | b | c | d | e | f | g | h | i |
| 0000x | A | \* | \* |  |  |  |  |  |  |  |
| 000x0 | B | \* |  | \* |  |  |  |  |  |  |
| 00x01 | C |  | \* |  | \* |  |  |  |  |  |
| x0010 | D |  |  | \* |  |  |  | \* |  |  |
| 001x1 | E |  |  |  | \* |  | \* |  |  |  |
| x0111 | F |  |  |  |  |  | \* |  |  | \* |
| 1001x | G |  |  |  |  |  |  | \* | \* |  |
| 10x11 | H |  |  |  |  |  |  |  | \* | \* |
| 0xx10 | I |  |  | \* |  | \* |  |  |  |  |
| 0x11x | J |  |  |  |  | \* | \* |  |  |  |

# Метод Петрика

**Запишем булево выражение, определяющее условие покрытия всех вершин:**

Y=(A∨B) (A∨C) (B∨D) (B∨I) (C∨E) (I∨J) (E∨F∨J) (D∨G) (G∨H) (F∨H)

**Выражение в ДНФ:**

Y=AEFGI∨AEGHI∨ADEHI∨ACDHJ∨ADEHJ∨ACFGI∨ADEFGJ∨ACDFGJ∨ACGHIJ∨ABEFGJ∨ABEGHJ∨ACDFHI∨BCFGJ∨BCGHJ∨BCDHJ∨BCFGI∨BCEGHI∨BCDFHI∨BCDEHI

Рассмотрим следующее минимальное покрытие:

Этому покрытию соответствует МДНФ следующего вида:

f(Х) = (¬x1∧x2∧x4) ∨ (x1∧x2∧¬x4) ∨ (¬x1∧¬x2∧¬x3∧¬x4) ∨ (¬x1∧¬x2∧x3∧x5) ∨ (x1∧¬x2∧¬x3∧x4) ∨ (x1∧¬x2∧x4∧x5) ∨ (¬x1∧x4∧¬x5)

# Минимизация булевой функции на картах Карно.

## Определение МДНФ

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | x4, x5 | | | |
|  |  | 00 | 01 | 11 | 10 |
| x2, x3 | 00 |  |  | 1 | 1 |
| 01 | d |  | 1 |  |
| 11 | 1 | d |  |  |
| 10 | 1 | 1 |  |  |
| x1 = 1 | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | x4, x5 | | | |
|  |  | 00 | 01 | 11 | 10 |
| x2, x3 | 00 | 1 | 1 |  | 1 |
| 01 |  | 1 | 1 | 1 |
| 11 |  |  | 1 | 1 |
| 10 |  |  | 1 | d |
| x1 = 0 | | | | | |

f(Х) = (¬x1∧x2∧x4) ∨ (x1∧x2∧¬x4) ∨ (¬x1∧¬x2∧¬x3∧¬x4) ∨ (¬x1∧¬x2∧x3∧x5) ∨

(x1∧¬x2∧¬x3∧x4) ∨ (x1∧¬x2∧x4∧x5) ∨ (¬x1∧x4∧¬x5)

## Определение МКНФ

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | x4, x5 | | | |
|  |  | 00 | 01 | 11 | 10 |
| x2, x3 | 00 |  |  | 0 |  |
| 01 | 0 |  |  |  |
| 11 | 0 | 0 |  |  |
| 10 | 0 | 0 |  | d |
| x1 = 0 | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | x4, x5 | | | |
|  |  | 00 | 01 | 11 | 10 |
| x2, x3 | 00 | 0 | 0 |  |  |
| 01 | d | 0 |  | 0 |
| 11 |  | d | 0 | 0 |
| 10 |  |  | 0 | 0 |
| x1 = 1 | | | | | |

f(Х) = (x1∨x2∨x3∨¬x4∨¬x5) ∧ (x1∨¬x2∨x4) ∧ (¬x1∨x2∨x4) ∧ (¬x1∨¬x2∨¬x4) ∧ (x1∨¬x3∨x4∨x5) ∧ (¬x1∨¬x3∨¬x4∨x5)

# Преобразование минимальных форм булевой функции

**Факторное преобразование для МДНФ**:

f(Х) = (¬x1∧x2∧x4) ∨ (x1∧x2∧¬x4) ∨ (¬x1∧¬x2∧¬x3∧¬x4) ∨ (¬x1∧¬x2∧x3∧x5) ∨

(x1∧¬x2∧¬x3∧x4) ∨ (x1∧¬x2∧x4∧x5) ∨ (¬x1∧x4∧¬x5)

Декомпозиция невозможна

x1∧((x2∧¬x4)∨(¬x2∧x4∧(¬x3∨x5)))∨¬x1∧(x4∧((x2)∨(¬x5))∨¬x2∧((¬x3∧¬x4)∨(x3∧x5)))

**Факторное преобразование для МКНФ**: f(Х) = (x1∨x2∨x3∨¬x4∨¬x5) ∧ (x1∨¬x2∨x4) ∧ (¬x1∨x2∨x4) ∧ (¬x1∨¬x2∨¬x4) ∧ (x1∨¬x3∨x4∨x5) ∧ (¬x1∨¬x3∨¬x4∨x5)  
Декомпозиция невозможна (x1∨(x2∨x3∨¬x4∨¬x5)∧(¬x2∨x4)) ∧ (¬x1∨(x2∨x4)∧(¬x2∨¬x4)) ∧ (¬x3∨x5∨(x1∨x4)∧(¬x1∨¬x4))

# Синтез комбинационных схем в булевом базисе

## Схема по упрощенной МДНФ

SQ=30 Т=6τ

Изображение выглядит как прямоугольный, снимок экрана, дизайн

Автоматически созданное описание

## Схема по упрощенной МКНФ

SQ=34 Т=7τ

Изображение выглядит как снимок экрана, прямоугольный, Симметрия, дизайн

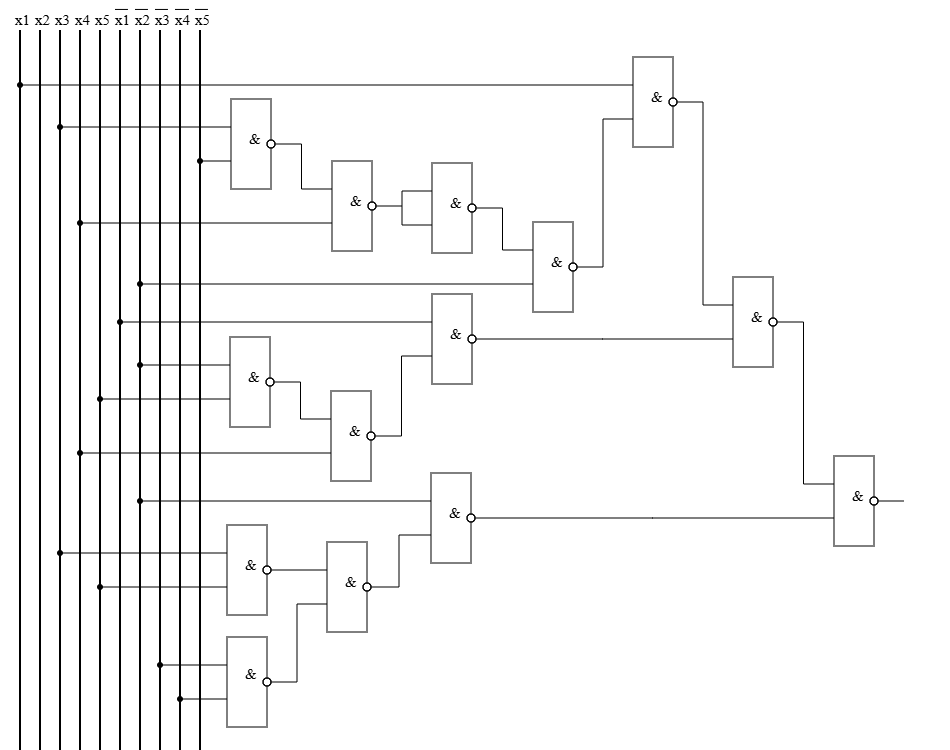
Автоматически созданное описание

## Сокращенный булев базис (И-НЕ)

### Схема по упрощенной МДНФ в базисе (И-НЕ)

(x1|(¬x2|¬(x4|(x3|¬x5))))|(¬x1|((x4|(¬x2|x5))|(¬x2|((¬x3|¬x4)|(x3|x5)))

SQ=30 Т=7τ



### Схема по упрощенной МКНФ в базисе (И-НЕ)

¬( ¬((¬x1|¬((¬x2|¬x3|x4|x5)|(x2|¬x4)))|(x1|((¬x2|¬x4)|(x2|x4))))| (x3|¬(¬x5|((¬x1|¬x4)|(x1|x4))))

SQ=40 Т=9τ

