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*(ИРИТ)*

*Дисциплина: "Теория автоматов"*

*Курсовой проект*

*тема: " Синтез логических схем на логических элементах*

 *малой степени интеграции.”*

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*Задание*

*Произвести синтез комбинационной схемы (КС) для преобразования параллельного двоично-десятичного кода с весами x1 = 5, x2 = 3, x3 = 1, x4 = 1 в двоично-десятичный код с другими весами разрядов f1 = 7, f2 = 4, f3 = 2, f4 = 1 и построить схему с использованием базисов И, ИЛИ, НЕ; НЕИ, НЕИЛИ.*

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*Заключение*

*Введение*

1. *Составление таблицы истинности*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *№ набора**Аргументы* | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* |
| *x1* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *1* |
| *x2* | *0* | *0* | *0* | *0* | *1* | *1* | *1* | *1* | *0* | *0* | *0* | *0* | *1* | *1* | *1* | *1* |
| *x3* | *0* | *0* | *1* | *1* | *0* | *0* | *1* | *1* | *0* | *0* | *1* | *1* | *0* | *0* | *1* | *1* |
| *x4* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* |
| *Десятичные**Цифр* | *0* | *1* | *+* | *2* | *3* | *4* | *+* | *5* | *+* | *6* | *+* | *7* | *8* | *9* | *+* | *+* |
| *f1* | *0* | *0* | *+* | *0* | *0* | *0* | *+* | *0* | *+* | *0* | *+* | *0* | *1* | *1* | *+* | *+* |
| *f2* | *0* | *0* | *+* | *0* | *0* | *1* | *+* | *1* | *+* | *1* | *+* | *1* | *0* | *0* | *+* | *+* |
| *f3* | *0* | *0* | *+* | *1* | *1* | *0* | *+* | *0* | *+* | *1* | *+* | *1* | *0* | *1* | *+* | *+* |
| *f4* | *0* | *1* | *+* | *0* | *1* | *0* | *+* | *1* | *+* | *0* | *+* | *1* | *1* | *0* | *+* | *+* |

1. *Абстрактный синтез*
	1. *Составление таблицы соответствий*

|  |  |
| --- | --- |
| *zдоп* | *Rпар* |
| *z0 z0 z0 z0* | *c c c R0* |
| *z0 z0 z0 z1* | *c c c R1* |
| *z0 z0 z1 z1* | *c c c R2* |
| *z0 z1 z0 z0* | *c c c R3* |
| *z0 z1 z0 z1* | *c c c R4* |
| *z0 z1 z1 z1* | *c c c R5* |
| *z1 z0 z0 z1* | *c c c R6* |
| *z1 z0 z1 z1* | *c c c R7* |
| *z1 z1 z0 z0* | *c c c R8* |
| *z1 z1 z0 z1* | *c c c R9* |

|  |  |  |
| --- | --- | --- |
| *zдоп* | *Rпосл* | *Rпар* |
| *z0 z0 z0 z0* | *r0 r0 r0 r0* | *R0* |
| *z0 z0 z0 z1* | *r0 r0 r0 r1* | *R1* |
| *z0 z0 z1 z1* | *r0 r0 r1 r0* | *R2* |
| *z0 z1 z0 z0* | *r0 r0 r1 r1* | *R3* |
| *z0 z1 z0 z1* | *r0 r1 r0 r0* | *R4* |
| *z0 z1 z1 z1* | *r0 r1 r0 r1* | *R5* |
| *z1 z0 z0 z1* | *r0 r1 r1 r0* | *R6* |
| *z1 z0 z1 z1* | *r0 r1 r1 r1* | *R7* |
| *z1 z1 z0 z0* | *r1 r0 r0 r1* | *R8* |
| *z1 z1 z0 z1* | *r1 r0 r1 r0* | *R9* |

* 1. *Синтез конечного автомата Мура*

*Состояния автомата*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *z0* | *z0* | *z0* | *z0* |  |
|  | *c* | *c* | *c* | *R0* |  |
| *0* | *0* | *0* | *0* | *0* |
|  | *z0* | *z0* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R1* |  |
| *0* | *0* | *0* | *0* | *1* |
|  | *z0* | *z0* | *z1* | *z1* |  |
|  | *c* | *c* | *c* | *R2* |  |
| *0* | *0* | *0* | *1* | *2* |
|  | *z0* | *z1* | *z0* | *z0* |  |
|  | *c* | *c* | *c* | *R3* |  |
| *0* | *0* | *1* | *3* | *3* |
|  | *z0* | *z1* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R4* |  |
| *0* | *0* | *1* | *3* | *4* |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *z0* | *z1* | *z1* | *z1* |  |
|  | *c* | *c* | *c* | *R5* |  |
| *0* | *0* | *1* | *2* | *5* |
|  | *z1* | *z0* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R6* |  |
| *0* | *0* | *3* | *3* | *4* |
|  | *z1* | *z0* | *z1* | *z1* |  |
|  | *c* | *c* | *c* | *R7* |  |
| *0* | *1* | *3* | *4* | *6* |
|  | *z1* | *z1* | *z0* | *z0* |  |
|  | *c* | *c* | *c* | *R8* |  |
| *0* | *1* | *2* | *7* | *8* |
|  | *z1* | *z1* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R9* |  |
| *0* | *1* | *2* | *7* | *9* |

*Таблица соответствий*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *A**z* | *R0* | *R1* | *R2* | *R3* | *R4* | *R5* | *R6* | *R7* | *R8* | *R9* |
| *a0* | *a1* | *a2* | *a3* | *a4* | *a5* | *a6* | *a7* | *a8* | *a9* |
| *z0* | *a0* | *a3* | *a7* | *a3* | *+* | + | + | *a8* | + | + |
| *z1* | *a1* | *a2* | *a5* | *a4* | *a6* | *+* | + | *a9* | + | + |

*Построение графа*



* 1. *Синтез конечного автомата Мили*

*Состояния автомата*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *z0* | *z0* | *z0* | *z0* |  |
|  | *c* | *c* | *c* | *R0* |  |
| *0* | *0* | *0* | *0* | *0* |
|  | *z0* | *z0* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R1* |  |
| *0* | *0* | *0* | *0* | *1* |
|  | *z0* | *z0* | *z1* | *z1* |  |
|  | *c* | *c* | *c* | *R2* |  |
| *0* | *0* | *0* | *1* | *2* |
|  | *z0* | *z1* | *z0* | *z0* |  |
|  | *c* | *c* | *c* | *R3* |  |
| *0* | *0* | *1* | *3* | *4* |
|  | *z0* | *z1* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R4* |  |
| *0* | *0* | *1* | *3* | *5* |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *z0* | *z1* | *z1* | *z1* |  |
|  | *c* | *c* | *c* | *R5* |  |
| *0* | *0* | *1* | *2* | *2* |
|  | *z1* | *z0* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R6* |  |
| *0* | *1* | *3* | *4* | *4* |
|  | *z1* | *z0* | *z1* | *z1* |  |
|  | *c* | *c* | *c* | *R7* |  |
| *0* | *1* | *3* | *5* | *5* |
|  | *z1* | *z1* | *z0* | *z0* |  |
|  | *c* | *c* | *c* | *R8* |  |
| *0* | *1* | *2* | *6* | *6* |
|  | *z1* | *z1* | *z0* | *z1* |  |
|  | *c* | *c* | *c* | *R9* |  |
| *0* | *1* | *2* | *6* | *6* |

*Таблица соответствий*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *A**z* | *a0* | *a1* | *a2* | *a3* | *a4* | *a5* | *a6* |
| *z0* | *a0**R0* | *a3**с* | *a6**с* | *a4**R3* | *+**+* | +*+* | *a6**R8* |
| *z1* | *a1**R1* | *a2**R2* | *a2**R5* | *a5**R4* | *a4**R6* | *a5**R7* | *a6**R9* |

*Построение графа*



1. *Структурный синтез*
	1. *Составление таблиц кодирования состояний*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *A**z* | *a0* | *a1* | *a2* | *a3* | *a4* | *a5* | *a6* |
| *z0* | *a0**R0* | *a3**с* | *a6**с* | *a4**R3* | *+**+* | +*+* | *a6**R8* |
| *z1* | *a1**R1* | *a2**R2* | *a2**R5* | *a5**R4* | *a4**R6* | *a5**R7* | *a6**R9* |

|  |  |  |
| --- | --- | --- |
| *x**z* | *x0* | *x1* |
| *z0* | *0* | *0* |
| *z1* | *0* | *1* |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Переход* | *Обознач.* | *D-триггер* | *JK-триггер* | *RS-триггер* |
| *J* | *K* | *R* | *S* |
| *0->0* | *0* | *0* | *0* | + | *+* | *0* |
| *1->1* | *1* | *1* | + | *0* | *0* | *+* |
| *0->1* | *α* | *1* | *1* | + | *0* | *1* |
| *1->0* | *β* | *0* | + | *1* | *1* | *0* |

|  |  |  |  |
| --- | --- | --- | --- |
| *Q**A* | *Q1* | *Q2* | *Q3* |
| *a0* | *0* | *0* | *0* |
| *a1* | *0* | *0* | *1* |
| *a2* | *0* | *1* | *0* |
| *a3* | *0* | *1* | *1* |
| *a4* | *1* | *0* | *0* |
| *a5* | *1* | *0* | *1* |
| *a6* | *1* | *1* | *0* |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *y**R* | *y1* | *y2* | *y3* | *y4* |
| *r0* | *0* | *0* | *0* | *0* |
| *r1* | *0* | *0* | *0* | *1* |
| *r2* | *0* | *0* | *1* | *0* |
| *r3* | *0* | *0* | *1* | *1* |
| *r4* | *0* | *1* | *0* | *0* |
| *r5* | *0* | *1* | *0* | *1* |
| *r6* | *0* | *1* | *1* | *0* |
| *r7* | *0* | *1* | *1* | *1* |
| *r8* | *1* | *0* | *0* | *0* |
| *r9* | *1* | *0* | *0* | *1* |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *№* | *x* | *Q1* | *Q2* | *Q3* | *Q1* | *Q2* | *Q3* | *y1* | *y2* | *y3* | *y4* | *q1* | *q2* | *q3* |
| *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| *1* | *0* | *0* | *0* | *1* | *0* | *1* | *1* | *+* | *+**+* | *+* | *+* | *0* | *α* | *1* |
| *2* | *0* | *0* | *1* | *0* | *1* | *1* | *0* | *+* | *+* | *+* | *+* | *α* | *1* | *0* |
| *3* | *0* | *0* | *1* | *1* | *1* | *0* | *0* | *0* | *00* | *1* | *1* | *α* | *β* | *β* |
| *4* | *0* | *1* | *0* | *0* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* |
| *5* | *0* | *1* | *0* | *1* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* |
| *6* | *0* | *1* | *1* | *0* | *1* | *1* | *0* | *1* | *0* | *0* | *0* | *1* | *1* | *0* |
| *7* | *0* | *1* | *1* | *1* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* |
| *8* | *1* | *0* | *0* | *0* | *0* | *0* | *1* | *0* | *0* | *0* | *1* | *0* | *0* | *α* |
| *9* | *1* | *0* | *0* | *1* | *0* | *1* | *0* | *0* | *0* | *1* | *0* | *0* | *α* | *β* |
| *10* | *1* | *0* | *1* | *0* | *0* | *1* | *0* | *0* | *1* | *0* | *1* | *0* | *1* | *0* |
| *11* | *1* | *0* | *1* | *1* | *1* | *0* | *1* | *0* | *1* | *0* | *0* | *α* | *β* | *1* |
| *12* | *1* | *1* | *0* | *0* | *1* | *0* | *0* | *0* | *1* | *1* | *0* | *1* | *0* | *0* |
| *13* | *1* | *1* | *0* | *1* | *1* | *0* | *1* | *0* | *1* | *1* | *1* | *1* | *0* | *1* |
| *14* | *1* | *1* | *1* | *0* | *1* | *1* | *0* | *1* | *0* | *0* | *1* | *1* | *1* | *0* |
| *15* | *1* | *1* | *1* | *1* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* | *+* |

*y1 (x Q1 Q2 Q3) =* v*(6, 14)*

*y2(x Q1 Q2 Q3) =* v(*10, 11, 12, 13)*

*y3(x Q1 Q2 Q3) =* v*(3, 9, 12, 13)*

*y4(x Q1 Q2 Q3) =* v*(3, 8, 10, 13, 14)*

*Запрещенные наборы – 1, 2, 4, 5, 7,15*

*q1*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  |  | *α* | *α* |
| *01* | *+* | *+* | *+* | *1* |
| *11* | *1* | *1* | *+* | *1* |
| *10* |  |  | *α* |  |

*q2*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *α* | *β* | *1* |
| *01* | *+* | *+* | *+* | *1* |
| *11* |  |  | *+* | *1* |
| *10* |  | *α* | *β* | *1* |

*q3*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *1* | *β* |  |
| *01* | *+* | *+* | *+* |  |
| *11* |  | *1* | *+* |  |
| *10* | *α* | *β* | *1* |  |

*y1 =*

*y2 =*

*y3 =*

*y4 =*

*Минимизация с помощью карт Карно*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *+* |  | *+* |
| *01* | *+* | *+* | *+* | *1* |
| *11* |  |  | *+* | *1* |
| *10* |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *+* |  | *+* |
| *01* | *+* | *+* | *+* |  |
| *11* | *1* | *1* | *+* |  |
| *10* |  |  | *1* | *1* |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *+* | *1* | *+* |
| *01* | *+* | *+* | *+* |  |
| *11* | *1* | *1* | *+* |  |
| *10* |  | *1* |  |  |

*y1 = y2 =*



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *+* | *1* | *+* |
| *01* | *+* | *+* | *+* |  |
| *11* |  | *1* | *+* | *1* |
| *10* | 1 |  |  | *1* |

*y3 = y4 =*

*Выбор типа триггера*

*Синтез на D - триггере*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  |  | *1* | *1* |
| *01* | *+* | *+* | *+* | 1 |
| *11* | *1* | *1* | *+* | *1* |
| *10* |  |  | *1* |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *1* |  | *1* |
| *01* | *+* | *+* | *+* | *1* |
| *11* |  |  | *+* | *1* |
| *10* |  | *1* |  | *1* |

 *D1 = D2 =*



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *1* |  |  |
| *01* | *+* | *+* | *+* |  |
| *11* |  | *1* | *+* |  |
| *10* | *1* |  | *1* |  |

 *D3 =*

*Синтез на JK – триггере*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  |  | *1* | *1* |
| *01* | *+* | *+* | *+* | х |
| *11* | *х* | *х* | *+* | *х* |
| *10* |  |  | *1* |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* | *х* | *х* | *х* | *х* |
| *01* | *+* | *+* | *+* |  |
| *11* |  |  | *+* |  |
| *10* | х | *х* | *х* | *х* |

 *J1 = K1 =*



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* | *х* | *1* | *1* |  |
| *01* | *+* | *+* | *+* |  |
| *11* | *х* | *х* | *+* |  |
| *10* | х | *х* | *1* |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *1* | *х* | *х* |
| *01* | *+* | *+* | *+* | *х* |
| *11* |  |  | *+* | *х* |
| *10* |  | *1* | *х* | *х* |

 *J2 = K2 =*



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *х* | *х* |  |
| *01* | *+* | *+* | *+* |  |
| *11* |  | *х* | *+* |  |
| *10* | *1* | *х* | *х* |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* | *х* |  | *1* | *х* |
| *01* | *+* | *+* | *+* | х |
| *11* | *х* |  | *+* | *х* |
| *10* | *х* | *1* |  | *х* |

*J3 = K3 =*

*Синтез на RS – триггере*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* | *х* | *х* |  |  |
| *01* | *+* | *+* | *+* | х |
| *11* | *х* | *х* | *+* | *х* |
| *10* | х | *х* |  | *х* |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  |  | *1* | *1* |
| *01* | *+* | *+* | *+* | х |
| *11* | *х* | *х* | *+* | *х* |
| *10* |  |  | *1* |  |

*R1 = S1 =*



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* | *х* |  | *1* |  |
| *01* | *+* | *+* | *+* |  |
| *11* | *х* | *х* | *+* |  |
| *10* | х |  | *1* |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *1* |  | *х* |
| *01* | *+* | *+* | *+* | *х* |
| *11* |  |  | *+* | *х* |
| *10* |  | *1* |  | *х* |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* |  | *х* |  |  |
| *01* | *+* | *+* | *+* |  |
| *11* |  | *х* | *+* |  |
| *10* | *1* |  | *х* |  |

*R2 = S2 =*



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Q2Q3**xQ1* | *00* | *01* | *11* | *10* |
| *00* | *х* |  | *1* | *х* |
| *01* | *+* | *+* | *+* | х |
| *11* | *х* |  | *+* | *х* |
| *10* |  | *1* |  | *х* |

*R3 = = S3 =*

*На основаниии минимизации выбираем для q1, q2 и q3 JK – триггер.Комбинационная схема*

*DD1 – 533ЛН1*

*DD2 – 533ЛИ1*

*DD3 – 533ЛИ1*

*DD4 – 533ЛИ3*

*DD5 – 533ЛИ3*

*DD6 – К155ЛН1*

*DD7 – К155ЛН1*

*DD8 – 533ТВ9*

*DD9 – 533ТВ9*