Homework #1

Steven Romeiro

Question 1:

a) 100010
111000
001101
$(1100111)_2$

True

$(1100111)_2 = (1100111)_2$

b) 7 2 8 0 5
-5 2 7 4
$(2011)_8$

True

$(2011)_8 = (2011)_8$

c) 1100 | 110011 (100
-1100
000011

False

$(11)_2 \neq (10)_2$

d) 5E2
x F04
1788
000
583E
585588

True

$(585588)_{16} = (585588)_{16}$

e) Conversion $(1011.101)_2 = (11.5)_8$

001 011 . 101

1 3 . 5 → $(13.5)_8 \neq (11.5)_8$

False

f) Conversion $(1011.1101)_2 = (C.B)_{16}$

1011 . 1101

B . D → $(B.D)_{16} \neq (C.B)_{16}$

False

g) Conversion $(5752.777)_8 = (BEA.1FF)_{16}$

5 7 5 2 . 7 7 7

101 111 101 010 . 111 111 111

1011 1110 1010 . 1111 1111 1000

B E A F F 8

$(BEA.FF8)_8 \neq (BEA.1FF)_8$

False

h) DeMorgan's Law is limited to 2 variables:

False

Question 2:

a) Hex $(1FB)_{16}$ to decimal:

1 F B

0001 1111 1011 $\rightarrow 1+2+8+16+32+64+128+256$

$= \boxed{(207)_{10}}$

b) Octal $(374)_8$ to binary:

3 7 4

011 111 100 $\rightarrow$ $\boxed{(11111100)_2}$

c) Binary $(101111110110)_2$ to Hex:

1011 1111 0110

B F 6 $\rightarrow$ $\boxed{(BF6)_{16}}$

d) Decimal $(627)_{10}$ to trinary:

$3\overline{)627} = 209$ R0 $\rightarrow$ $3\overline{)209} = 69$ R2 $\rightarrow$ $3\overline{)69} = 23$ R0

-6 -18 -6

027 29 09

27

$3\overline{)23} = 7$ R2 $\rightarrow$ $3\overline{)7} = 2$ R1 $\rightarrow$ $3\overline{)2} = 0$ R2

-21 -6

2 1

$\boxed{(212020)_3}$

e) What is the base x in $(2400)_x = (1010)_7$

7^3	7^2	7^1	7^0
343	49	7	1

$1 \cdot 343 + 0 \cdot 49 + 1 \cdot 7 + 0 \cdot 1 = (350)_{10}$

5^3	5^2	5^1	5^0
125	25	5	0

$2 \cdot 125 + 4 \cdot 25 + 0 \cdot 5 + 0 \cdot 5 = (350)_5$

x is radix or base 5

Question 3:

a) 8 bits required

b1) $75 - 32 \rightarrow$

$+32 = 00100000$

$-32 = 11100000$

$$\begin{array}{r} 0\ 1\ 0\ 0\ 1\ 0\ 1\ 1 \quad (+75)_{10} \\ +\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 0 \quad (-32)_{10} \\ \hline (0\ 0\ 1\ 0\ 1\ 0\ 1\ 1)_2 \quad (+43)_{10} \end{array}$$

$(00101011)_2$

b2) $-57 + 99 \rightarrow$

$+57 = 00111001$

$-57 = 11000111$

$$\begin{array}{r} 1\ 1\ 0\ 0\ 0\ 1\ 1\ 1 \quad (-57)_{10} \\ +\ 0\ 1\ 1\ 0\ 0\ 0\ 1\ 1 \quad (+99)_{10} \\ \hline (0\ 0\ 1\ 0\ 1\ 0\ 1\ 0)_2 \quad (+42)_{10} \end{array}$$

$(00101010)_2$

b3) $-52 - 84 \rightarrow$

$+84 = 01010100$

$-84 = 10101100$

$+52 = 00110100$

$-52 = 11001100$

$$\begin{array}{r} 1\ 1\ 0\ 0\ 1\ 1\ 0\ 0 \quad (-52)_{10} \\ +\ 1\ 0\ 1\ 0\ 1\ 1\ 0\ 0 \quad (-84)_{10} \\ \hline 0\ 1\ 1\ 1\ 1\ 0\ 0\ 0 \quad (+120)_{10}\ ? \end{array}$$

$(01111000)_2$ is incorrect due to overflow. We exceeded our available bits

b4) $37+93 \rightarrow$

$$\begin{array}{rl} 0\ 0\ 1\ 0\ 0\ 1\ 0\ 1 & (+37)_{10} \\ +\ 0\ 1\ 0\ 1\ 1\ 1\ 0\ 1 & (+93)_{10} \\ \hline 1\ 0\ 0\ 0\ 0\ 0\ 1\ 0 & (-126)_{10}\ ? \end{array}$$

$(10000010)_2$ is the incorrect answer due to overflow. The sign bit was changed when addition of two positive numbers exceeded the available bits

Question 4:

a) Simplify $XY + XY'$

$X(Y+Y')$

$\boxed{X}$

b) $(X+Y)(X+Y') = X + (Y \cdot Y') = \boxed{X}$ Rule

$A+(BC)=(A+B)(A+C)$

c) $Y'Z + X'YZ + XYZ$

$(YZ)(X+X') + Y'Z$

$(YZ) + Y'Z$

$Z(Y+Y')$

$\boxed{Z}$

d) $(X+Y)(X'+Y+Z)(X'+Y+Z)$ Rule $X \cdot X = X$

$(X+Y)(X'+Y+Z)$ Distributive

$XX' + XY + YX' + XZ + YY + YZ$ Rule $XY + YX' = Y$

$XY + Y + YZ + XZ$ Rule $Y + YZ = Y$

$XY + Y + XZ$ Rule $Y + XY = Y$

$\boxed{Y + XZ}$

e) $X + XYZ + X'YZ + X'Y + WX + WX'$; Rule $XY + XY' = X$

$X + XYZ + X'YZ + X'Y + W$; Rule $XY + XY' = X$

$X + YZ + X'Y + W$; Rule $(XY) + (ZY) = Y(X+Z)$ distribute

$X + Y(Z+X') + W$ Rule $X + (X'Y) = X + Y$ Elim

$X + X'Y + YZ + W$ Rule $Y + YZ = Y$ Absorption

$X + Y + YZ + W$

$\boxed{X + Y + W}$

Question 5:

A = 10110110

B = 11001000

a) NAND = $[(A)(B)]' = [(10110110)(11001000)]'$

$= (10000000)' =$ **01111111**

b) NOR = $[(A)+(B)]' = [(10110110)+(11001000)]'$

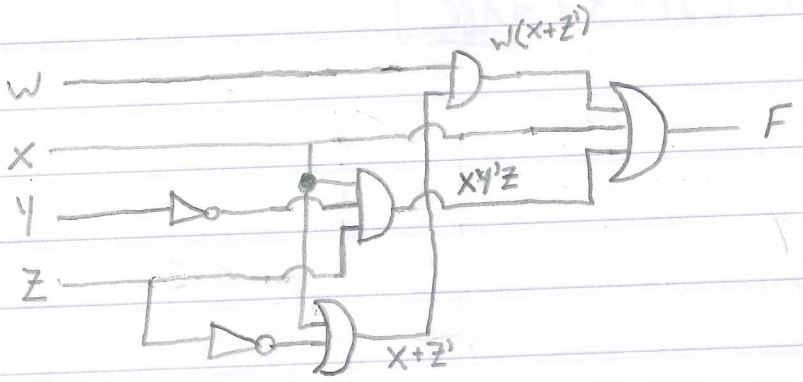
$= (01001001)(00110111) =$ **00000001**

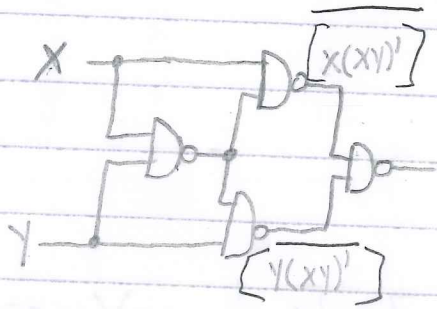
c) XOR = $(10110110) \oplus (11001000)$

$=$ **01111110**

Question 6:

a)



b) 

$F = \overline{[X(XY)'][Y(XY)']}$

$F = \overline{[X(XY)']} + \overline{[Y(XY)']}$

$= X(XY)' + Y(XY)' = X(X'+Y') + Y(X'+Y')$

$= XX' + XY' + YX' + YY' = \boxed{XY' + X'Y}$

Question 7:

a) $((A'+B)'(C'+D')')' = (A'+B)'' + (C'+D')''$

$= (A'+B) + (C'+D') = \boxed{A'+B+C'+D'}$

b) $((AB'C)' + (AB')')' = (AB'C)''(AB')''$

$= (AB'C)(AB') = \boxed{AB'C}$

Question 8:

K = Kyle, P = Patrick, J = Jorge, S = Steven

1 = Marshall Center, 0 = Juniper

K	P	J	S	OUTPUT
0	0	0	0	0 → J & S Agree
0	0	0	1	0 → Majority
0	0	1	0	0 → Majority
0	0	1	1	1 → J & S Agree
0	1	0	0	0 → J & S Agree
0	1	0	1	0 → Tie
0	1	1	0	0 → Tie
0	1	1	1	1 → J & S Agree
1	0	0	0	0 → J & S Agree
1	0	0	1	0 → Tie
1	0	1	0	0 → Tie
1	0	1	1	1 → J & S Agree
1	1	0	0	0 → J & S Agree
1	1	0	1	1 → Majority
1	1	1	0	1 → Majority
1	1	1	1	1 → J & S Agree

$K'P'JS + K'PJS + KP'JS + KPJ'S + KPJS' + KPJS$

$K'P'JS + K'PJS + KP'JS + KPJ'S + KPJS' + KPJS$

$PJS(K+K') + K'P'JS + KP'JS + KPJ'S + KPJS'$

$PJS + K'P'JS + KP'JS + KPJ'S + KPJS'$

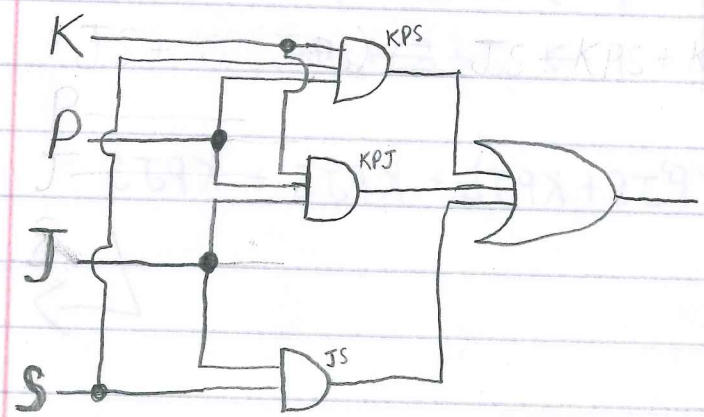
$JS(P + K'P' + KP') + KP(J'S + JS')$

$JS(P + P') + KP(J'S + JS')$

$\boxed{JS + KP(J \oplus S)}$

KP \ JS	00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	0	1	1	1
10	0	0	1	0

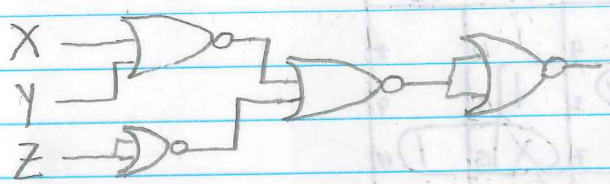
$\boxed{JS + KPS + KPJ}$



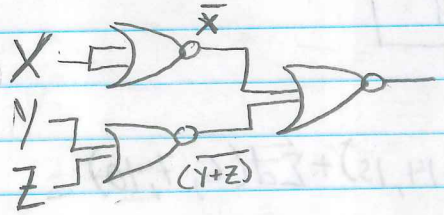
Steven Romeiro

Homework 2

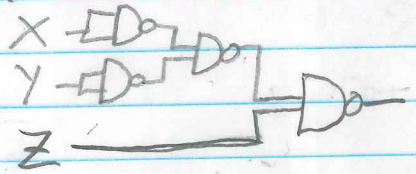
① a) $\overline{(X+Y)} + Z' \equiv \overline{\overline{(X+Y)} + Z'}$



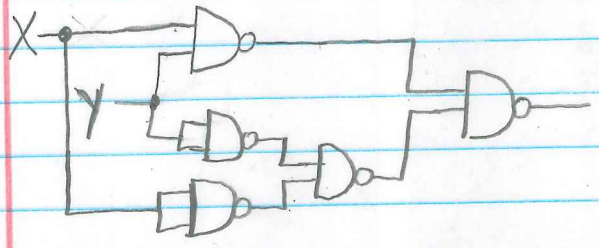
b) $XY + XZ \equiv X(Y+Z) \equiv \overline{\overline{X'} + \overline{(Y+Z)}}$



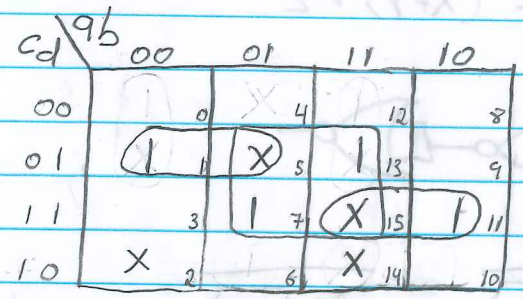
② a) $\overline{(X+Y)} + Z' \equiv \overline{(X'Y')} + Z' \equiv \overline{(X'Y')} \cdot Z$



b) $XY + X'Y' \equiv \overline{(XY + X'Y')} \equiv \overline{(XY)}\,\overline{(X'Y')}$

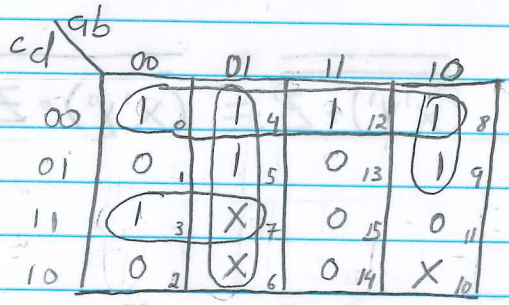


(3) a) $f(a,b,c,d) = \sum_m(1,7,11,13) + \sum d(2,5,14,15)$

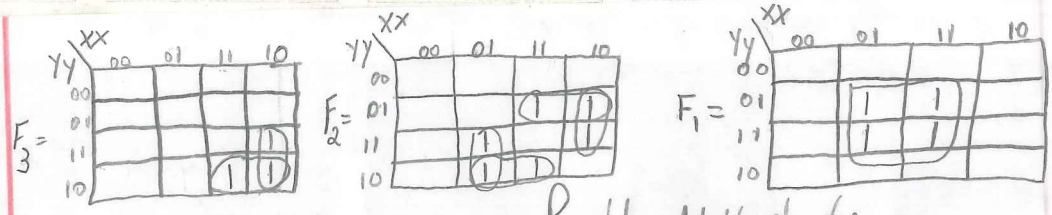


$= \boxed{bd + a'c'd + acd}$

b) $f(a,b,c,d) = \prod M(1,2,11,13,14,15) + \sum d(6,7,10)$



$\boxed{a'b + c'd' + a'cd + ab'c'}$



(5)

Inputs	Possible Multiplications			
$X_2X_1 \cdot Y_2Y_1$				
0 0 · 0 0	0·0	1·0	2·0	3·0
0 1 · 0 1	0·1	1·1	2·1	3·1
1 0 · 1 0	0·2	1·2	2·2	3·2
1 1 · 1 1	0·3	1·3	2·3	3·3

Need 4-bit output – F = OUTPUT

X	Y	F_{4-1}	X	Y	F_{4-1}
00 ·	00	0000	10 ·	00	0000
00 ·	01	0000	10 ·	01	0010
00 ·	10	0000	10 ·	10	0100
00 ·	11	0000	10 ·	11	0110
01 ·	00	0000	11 ·	00	0000
01 ·	01	0001	11 ·	01	0011
01 ·	10	0010	11 ·	10	0110
01 ·	11	0011	11 ·	11	1001

$F_4 = X_1X_2Y_1Y_2$

$F_3 = X_2Y_2\bar{Y}_1 + X_2\bar{X}_1Y_2$

$F_2 = \bar{X}_2X_1Y_2 + X_1Y_2\bar{Y}_1 + X_2\bar{Y}_2Y_1 + X_2\bar{X}_1Y_1$

$F_1 = X_1Y_1$

(6) 5 inputs, output 1 when prime # of 1's in input

$F(A,B,C,D,E)$

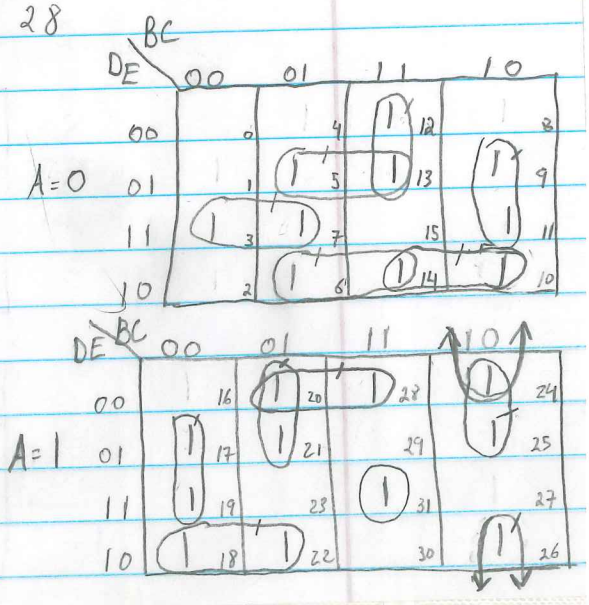
2 1's = 3, 5, 6, 9, 10, 12, 17, 18, 20, 24,

3 1's = 7, 11, 13, 14, 19, 21, 22, 25, 26, 28

5 1's = 31

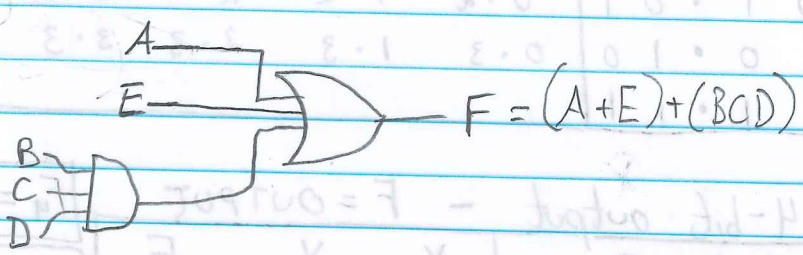
$F(A,B,C,D,E) = A'B'DE + A'CD'E + A'C'DE' + A'BCD' + A'BDE' + A'BC'E + AB'C'E + AB'DE' + AB'CD' + ACD'E' + ABC'D' + ABC'E' + ABCDE$

01011
10011
00111
01110
11100
11001
11010
10101
10110
10



(4) a) $\left[\left[(A\cdot 1)+(A\cdot 1)\right]+E\right]+\left[(BC)(D)\right]$

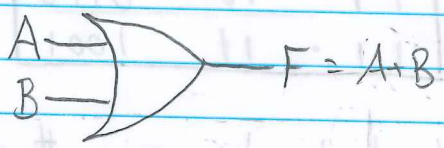
$\equiv((A\cdot 1)+E)+BCD \equiv (A+E)+(BCD)$



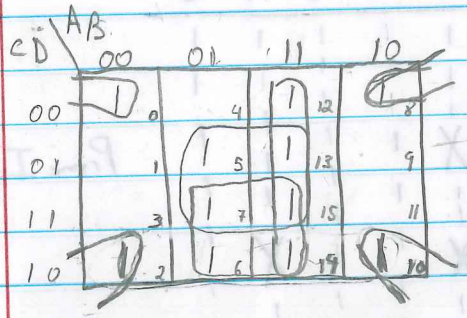
b) $\left[\left[(A\cdot B')+(AB+B)\right]B\right]+A$

$\equiv \left[\left[(A\cdot B')+B\right]B\right]+A \equiv \left[\left[(A+B)+B\right]B\right]+A$

$\equiv (A+B)B+A \equiv B+A$



(7) $F(A,B,C,D) = \sum_m(0,2,5,6,7,8,10,12,13,14,15)$



$F(A,B,C,D) = BD + B'D' + BC + AB$

$\sum_m$: 0000, 0010, 0101, 0110, 0111, 1000, 1010, 1100
1101, 1110, 1111

Groups
1 1's = 2, 8
2 1's = 5, 6, 10, 12
3 1's = 7, 13, 14
4 1's = 15

Groups	#	Column 1	#'s	Column 2	#'s	Column 3	
0	0	0000 ✓	0,2: 00_0	✓	0,2,8,10: _0_0		*
1	2	0010 ✓	0,8: _000	✓			
	8	1000 ✓					
	5	0101 ✓	2,6: 0_10	✓	2,6,10,14: __10		*
2	6	0110 ✓	2,10: _010	✓	8,10,12,14: 1__0		*
	10	1010 ✓	8,10: 10_0	✓			
	12	1100 ✓	8,12: 1_00	✓			
	7	0111 ✓	6,14: _110	✓	6,14,7,15: _11_		*
3	13	1101 ✓	10,14: 1_10	✓	12,13,14,15: 11__		*
	14	1110 ✓	12,13: 110_	✓	5,7,13,15: _1_1		*
4	15	1111 ✓	12,14: 11_0	✓			
			5,7: 01_1	✓			
			6,7: 011_	✓			
			7,15: _111	✓			
			13,15: 11_1	✓			
			14,15: 111_	✓			

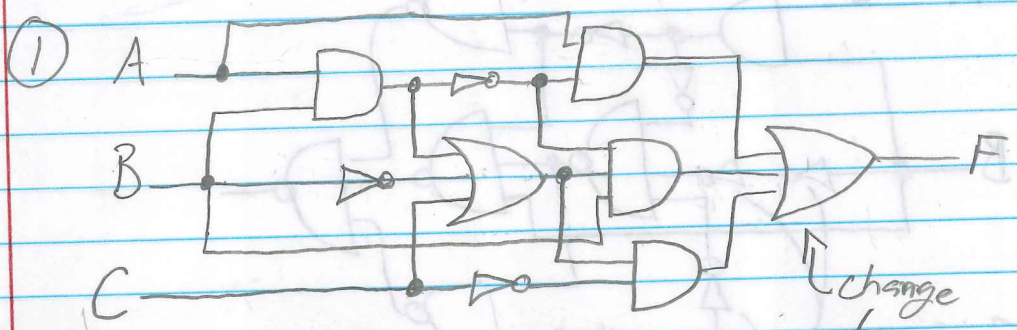
Prime Implicants Chart

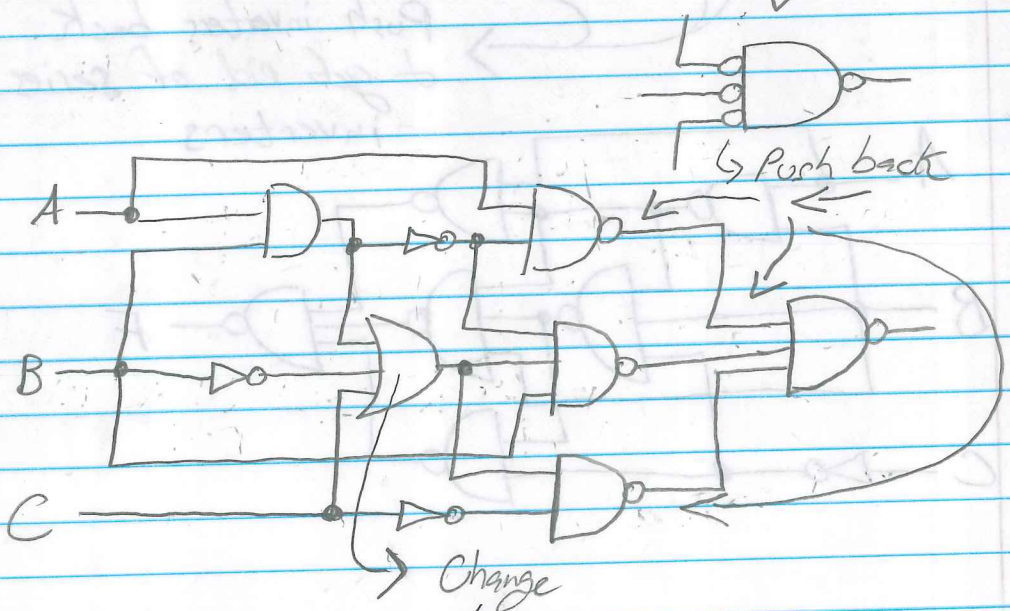
(m) minterms →	0 ✓	2 ✓	5 ✓	6 ✓	7 ✓	8 ✓	10 ✓	12 ✓	13 ✓	14 ✓	15 ✓	
Prime Implicants ↓												
(0,2,8,10) _ 0 _ 0	(X)	X				X	X					Prime Implicant
(2,6,10,14) _ _ 1 0		X		X			X			X		
(8,10,12,14) 1 _ _ 0						X	X	X		X		
(5,7,13,15) _ 1 _ 1			(X)	X					X		X	Prime Implicant
(6,14,7,15) _ 1 1 _				X	X					X	X	Prime Implicant
(12,13,14,15) 1 1 _ _								X	X	X	X	Prime Implicant

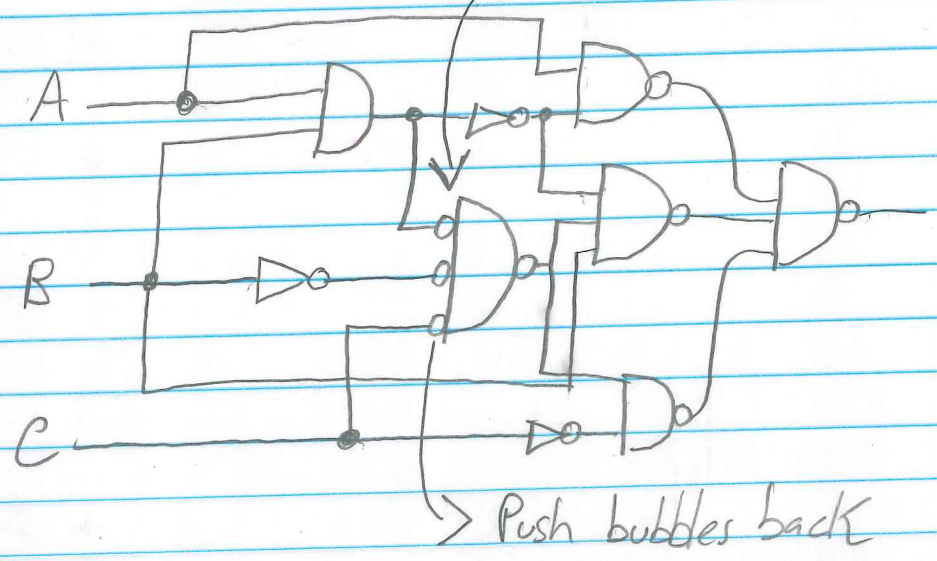
$$F(A,B,C,D) = B'D' + BD + BC + AB$$

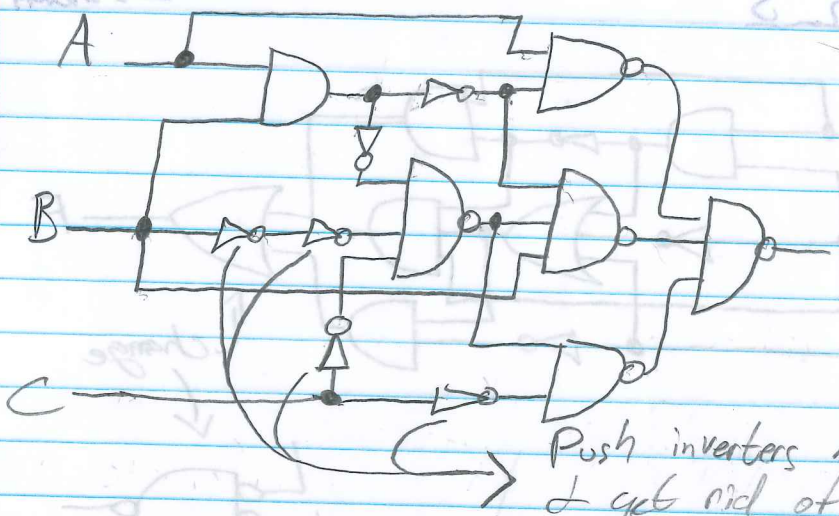
Homework 3

Esthaven Romero

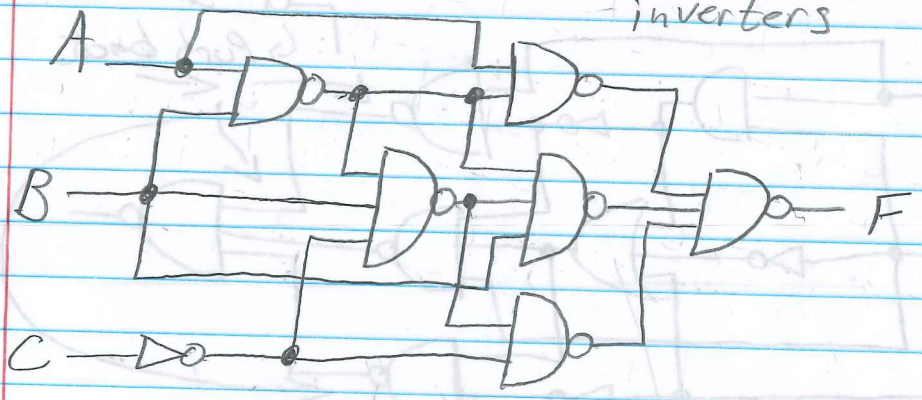
① 



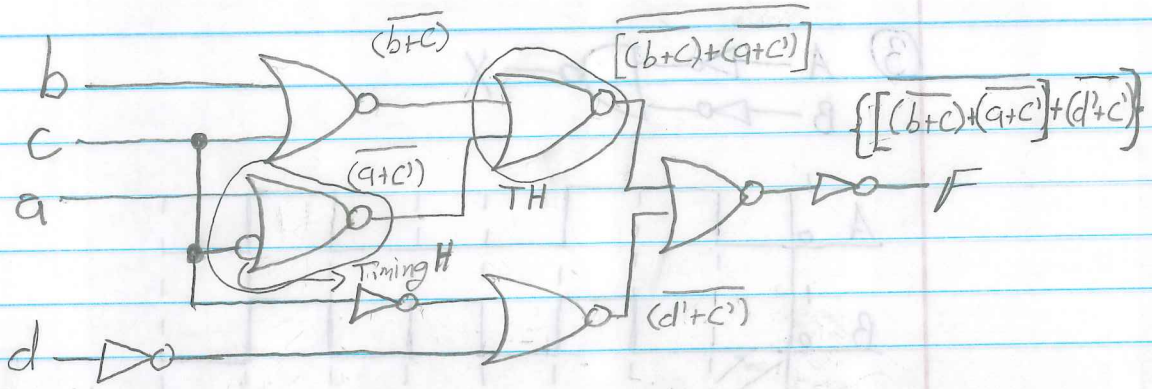




Push inverters back & get rid of series inverters



(2)



$F = \{\overline{[(\overline{b+c})+(\overline{a+c'})]}+(\overline{d'+c'})\} = \{[(\overline{\overline{b+c}})(\overline{\overline{a+c'}})]+(\overline{d'+c'})\}$

$= [(b+c)(a+c')]+(dc) = [ba+bc'+ca+cc']+dc$

$= [ba+bc'+ca]+dc = ba+bc'+ca+dc$

$ba = ba(c+c')(d+d') = abcd+abc'd+abcd'+abc'd'$

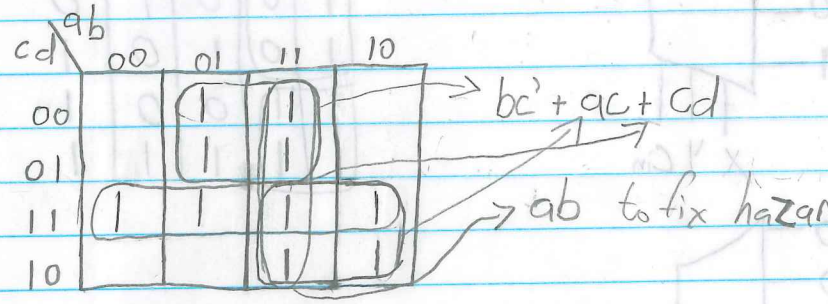
$bc' = bc'(a+a')(d+d') = abc'd+abc'd'+a'bc'd+a'bc'd'$

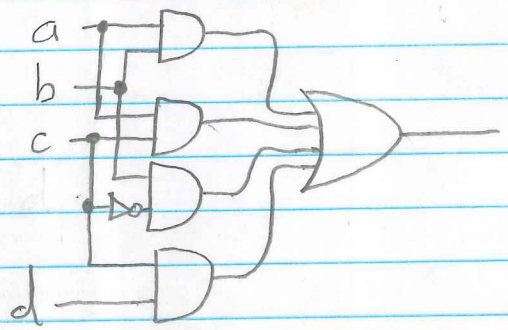
$ca = ca(b+b')(d+d') = abcd+abcd'+ab'cd+ab'cd'$

$dc = dc(a+a')(b+b') = abcd+ab'cd+a'bcd+a'b'cd$

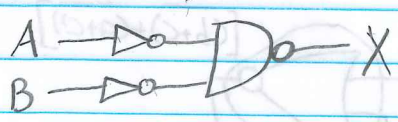
$= abcd+abc'd+abcd'+abc'd'+a'bc'd+a'bc'd'+ab'cd$
$+ab'cd'+a'b'cd+a'bcd$

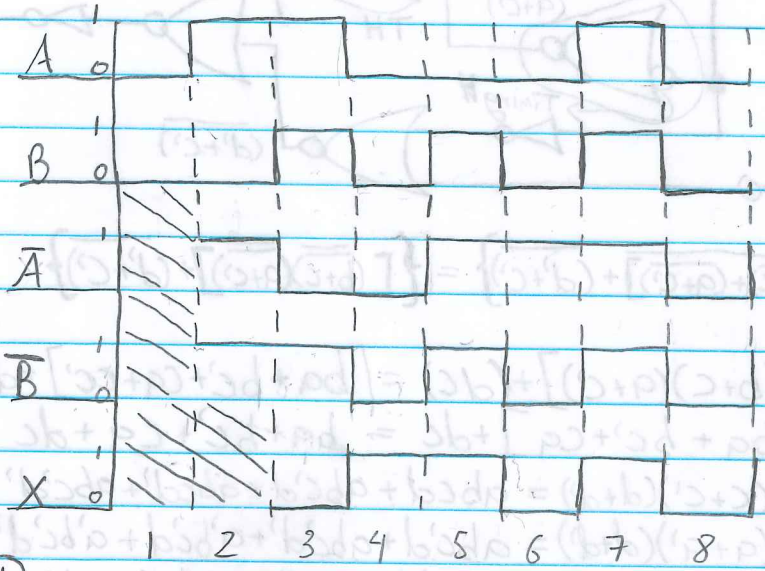
$\Sigma m(15,13,14,12,5,4,11,10,3,7)$





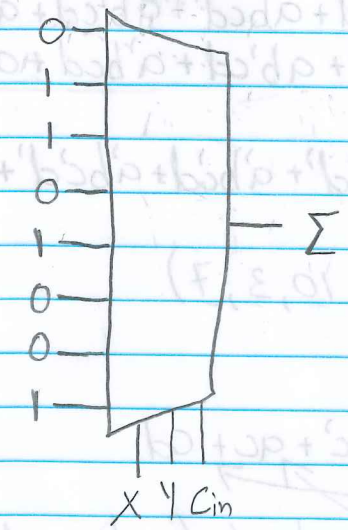
③



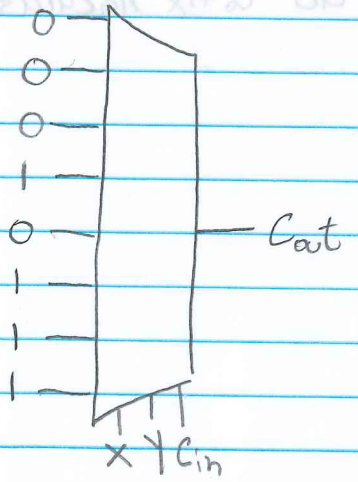


④

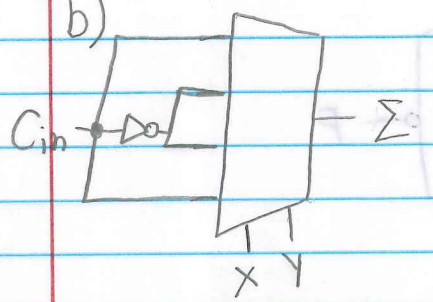
a)



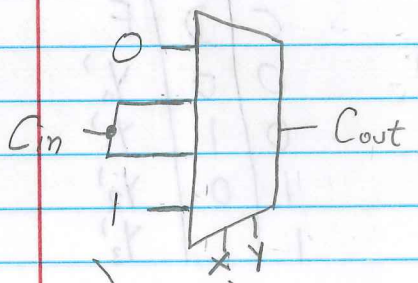
X	Y	C_{in}	Σ	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1



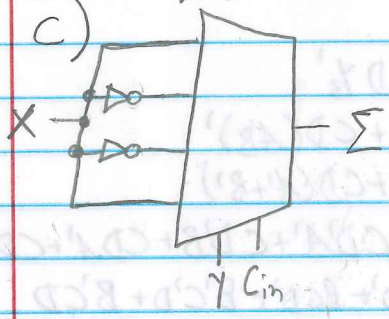
b)



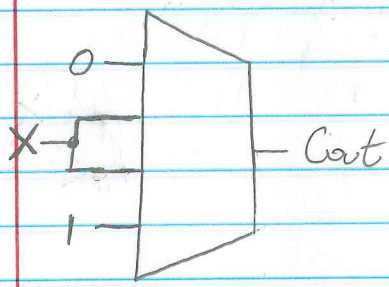
X	Y	C_{in}	Σ	C_{out}	
0	0	0	0	0	$\Sigma = C_{in}$, $C_{out} = 0$
0	0	1	1	0	
0	1	0	1	0	$\Sigma = \overline{C_{in}}$, $C_{out} = C_{in}$
0	1	1	0	1	
1	0	0	1	0	$\Sigma = \overline{C_{in}}$, $C_{out} = C_{in}$
1	0	1	0	1	
1	1	0	0	1	$\Sigma = C_{in}$, $C_{out} = 1$
1	1	1	1	1	



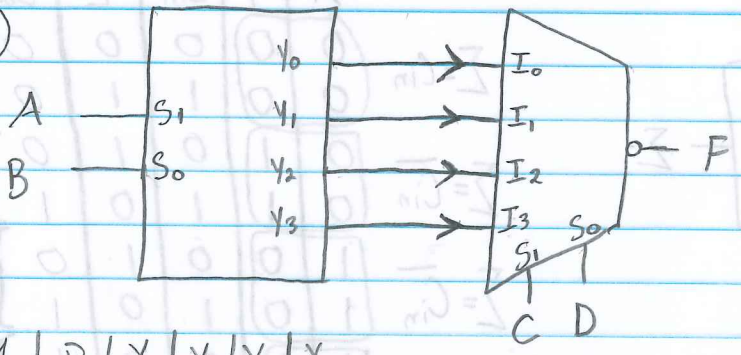
c)



X	Y	C_{in}	Σ	C_{out}	
0	0	0	0	0	$\Sigma = X$, $C_{out} = 0$
0	0	1	1	0	$\Sigma = \overline{X}$, $C_{out} = X$
0	1	0	1	0	$\Sigma = \overline{X}$, $C_{out} = X$
0	1	1	0	1	$\Sigma = X$, $C_{out} = 1$
1	0	0	1	0	$\Sigma = X$, $C_{out} = 0$
1	0	1	0	1	$\Sigma = \overline{X}$, $C_{out} = X$
1	1	0	0	1	$\Sigma = \overline{X}$, $C_{out} = X$
1	1	1	1	1	$\Sigma = X$, $C_{out} = 1$



⑤



A	B	Y_0	Y_1	Y_2	Y_3	
0	0	1	0	0	0	$\rightarrow Y_0 = A'B'$
0	1	0	1	0	0	$\rightarrow Y_1 = A'B$
1	0	0	0	1	0	$\rightarrow Y_2 = AB'$
1	1	0	0	0	1	$\rightarrow Y_3 = AB$

C	D	F
0	0	Y_0'
0	1	Y_1'
1	0	Y_2'
1	1	Y_3'

$F = C'D'Y_0' + C'DY_1' + CD'Y_2' + CDY_3'$

$F = C'D'(A'B')' + C'D(A'B)' + CD'(AB')' + CD(AB)'$

$F = C'D'(A+B) + C'D(A+B') + CD'(A'+B) + CD(A'+B')$

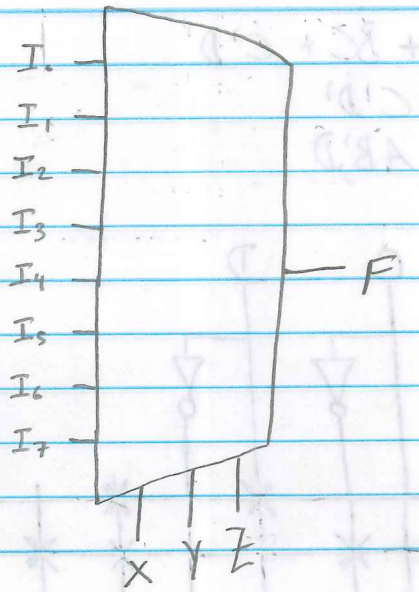
$F = C'D'A + C'D'B + C'DA + C'DB' + CD'A' + CD'B + CDA' + CDB'$

$F = AC'D' + AC'D + A'CD' + A'CD + BC'D' + BCD' + B'C'D + B'CD$

$F = AC'(D'+D) + A'C(D'+D) + BD'(C'+C) + B'D(C'+C)$

$\boxed{F = AC' + A'C + BD' + B'D}$

(6)



X	Y	Z	F
0	0	0	I_0
0	0	1	I_1
0	1	0	I_2
0	1	1	I_3
1	0	0	I_4
1	0	1	I_5
1	1	0	I_6
1	1	1	I_7

$$F = I_0\bar{X}\bar{Y}\bar{Z} + I_1\bar{X}\bar{Y}Z + I_2\bar{X}Y\bar{Z} + I_3\bar{X}YZ + I_4X\bar{Y}\bar{Z} + I_5X\bar{Y}Z + I_6XY\bar{Z} + I_7XYZ$$

$$F = \bar{X}(\underbrace{I_0\bar{Y}\bar{Z}}_{1} + \underbrace{I_1\bar{Y}Z}_{2} + \underbrace{I_2Y\bar{Z}}_{3} + \underbrace{I_3YZ}_{4}) + X(\underbrace{I_4\bar{Y}\bar{Z}}_{5} + \underbrace{I_5\bar{Y}Z}_{6} + \underbrace{I_6Y\bar{Z}}_{7} + \underbrace{I_7YZ}_{8})$$

AND Terms = 1 2 3 4 5 6 7 8

PAL Design on Logisim

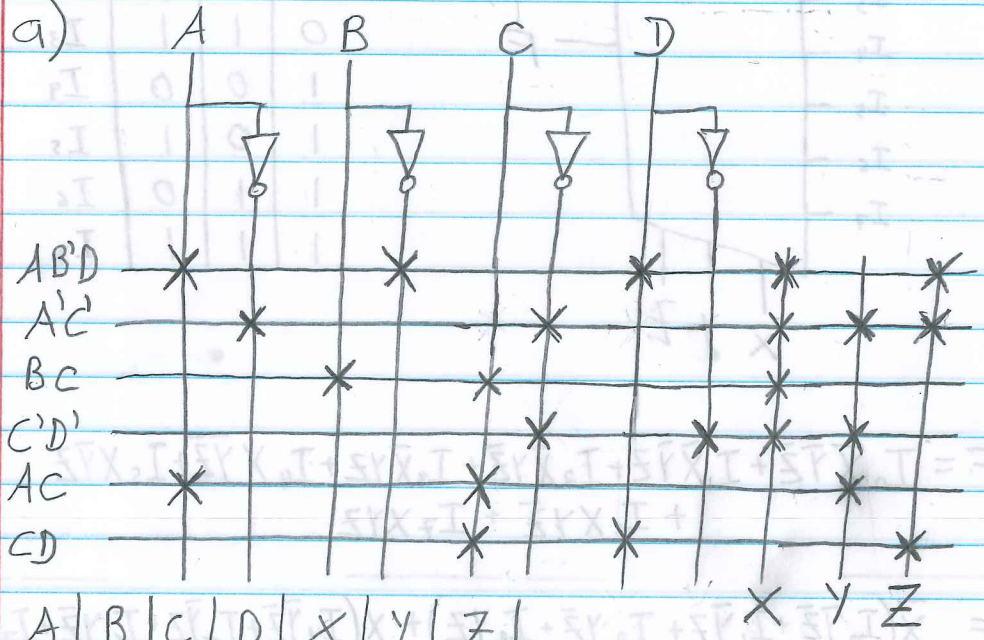
Next Page

(7) $X = AB'D + A'C' + BC + C'D'$

$Y = A'C' + AC + C'D'$

$Z = CD + A'C' + AB'D$

a)



b)

A	B	C	D	X	Y	Z
0	0	0	0	1	1	1
0	0	0	1	1	1	1
0	0	1	0	0	0	0
0	0	1	1	0	0	1
0	1	0	0	1	1	1
0	1	0	1	1	1	1
0	1	1	0	1	0	0
0	1	1	1	1	0	1
1	0	0	0	1	1	0
1	0	0	1	1	0	1
1	0	1	0	0	1	0
1	0	1	1	1	1	1
1	1	0	0	1	1	0
1	1	0	1	0	0	0
1	1	1	0	1	1	0
1	1	1	1	1	1	1

Homework #4

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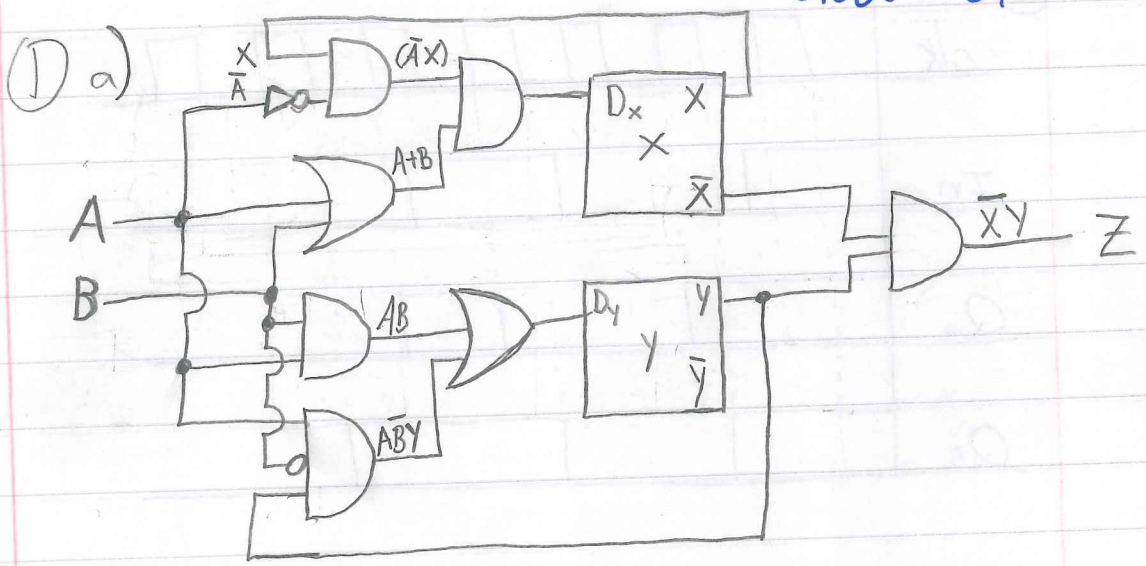
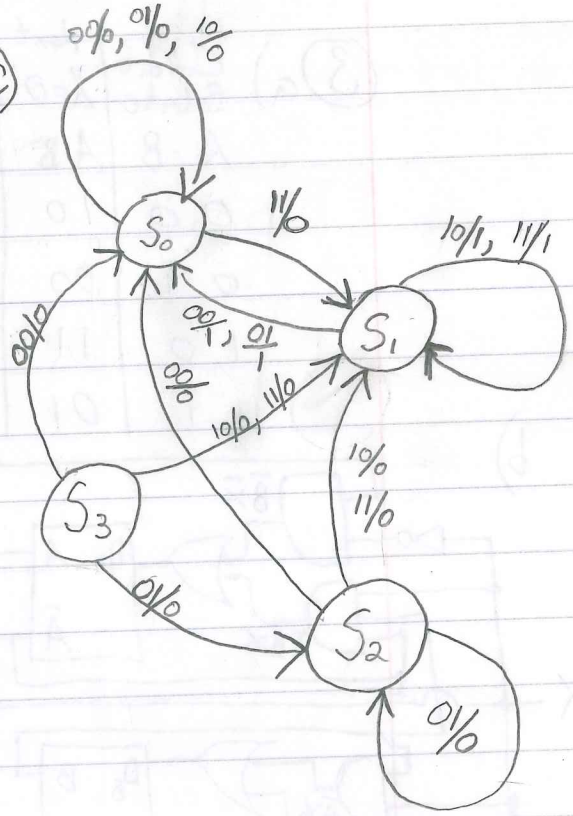
1) a)



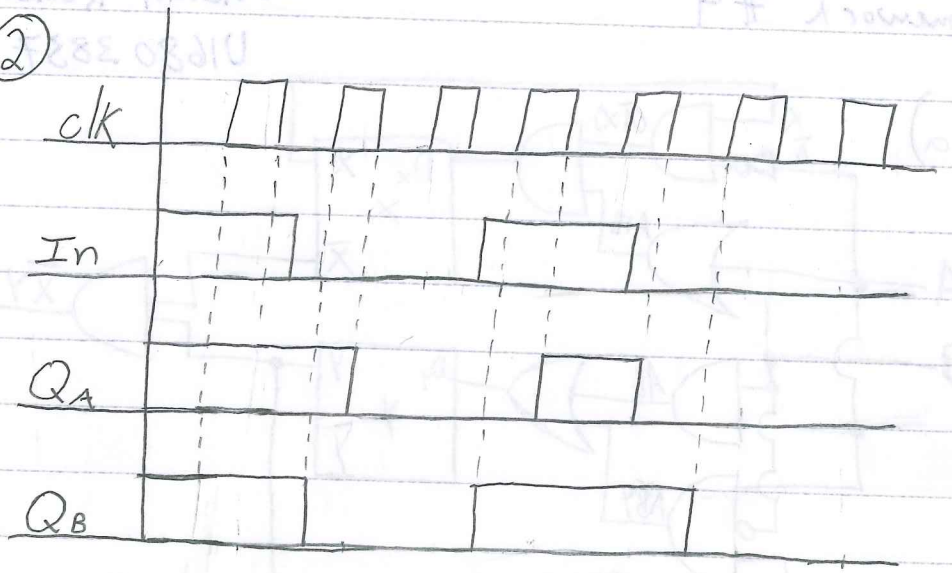
b)

Current State		Inputs		Next State		OUT
X	Y	A	B	X^+	Y^+	Z
S_0						
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	0
0	0	1	1	0	1	1
S_1						
0	1	0	0	0	0	1
0	1	0	1	0	0	1
0	1	1	0	0	1	1
0	1	1	1	1	0	0
S_2						
1	0	0	0	1	0	0
1	0	0	1	0	0	0
1	0	1	0	1	0	0
1	0	1	1	0	1	0
S_3						
1	1	0	0	0	0	0
1	1	0	1	0	0	0
1	1	1	0	0	1	0
1	1	1	1	0	1	0

c)



(2)

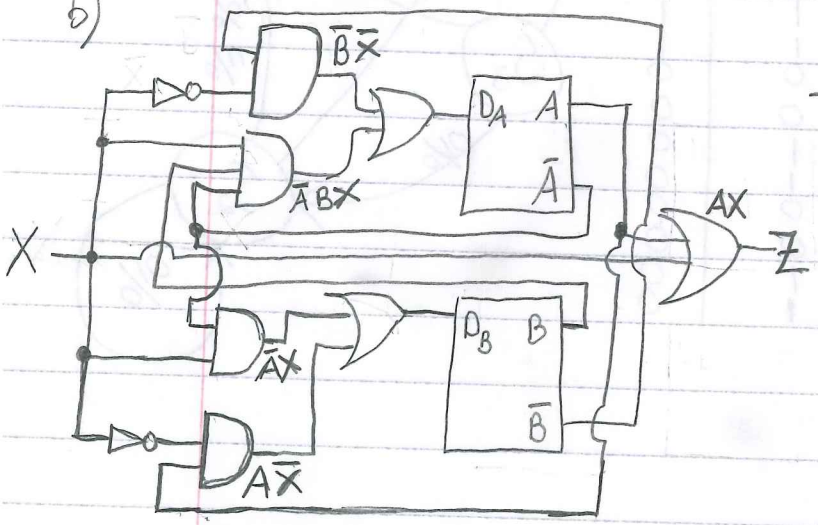


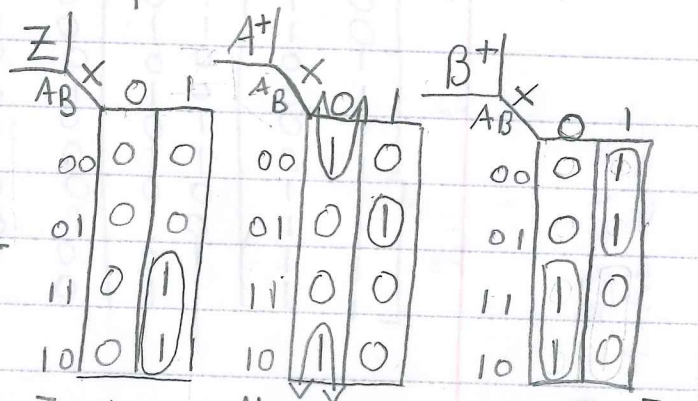
(3) a)

Current State		Next state X=0		Next state X=1		Output Z	
A	B	A	B	A	B	X=0	X=1
0	0	1	0	0	1	0	0
0	1	0	0	1	1	0	0
1	0	1	1	0	0	0	1
1	1	0	1	0	0	0	1

CS		input	out	NS	
A	B	X	Z	A^+	B^+
0	0	0	0	1	0
0	0	1	0	0	1
0	1	0	0	0	0
0	1	1	0	1	1
1	0	0	0	1	0
1	0	1	1	0	0
1	1	0	0	0	1
1	1	1	1	0	0

b)





$Z = AX$ $A^+ = \bar{B}\bar{X} + \bar{A}BX$ $B^+ = A\bar{X} + \bar{A}X$

Note: Could have used a XOR for D_B but chose not to.

(4)

IN		CS	NS
A	B	Q	Q^+
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

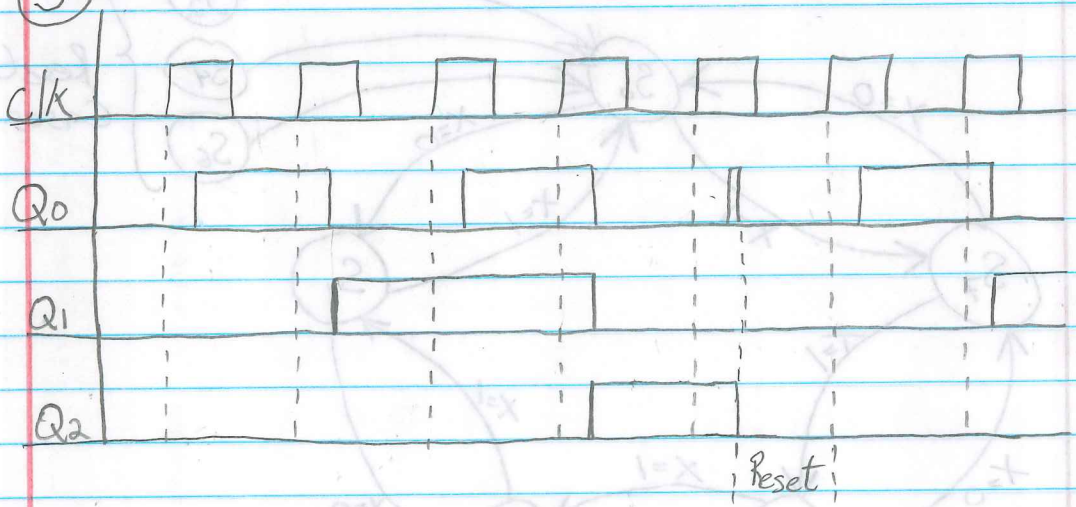
Q \ AB	00	01	11	10
0	(1)	0	(1)	0
1	0	(1)	0	0

$$Q^+ = \bar{A}\bar{B}\bar{Q} + \bar{A}B\bar{Q} + AB\bar{Q}$$

CS	NS	Input	
Q	Q^+	A	B
0	0	0	0 } XX
		1	0
0	1	0	0 } XX
		1	1
1	0	0	0 } XX
		1	1
1	1	0	1 } 01

Q \ AB	00	01	11	10
0	1	0	1	0
1	0	1	0	0

(5)

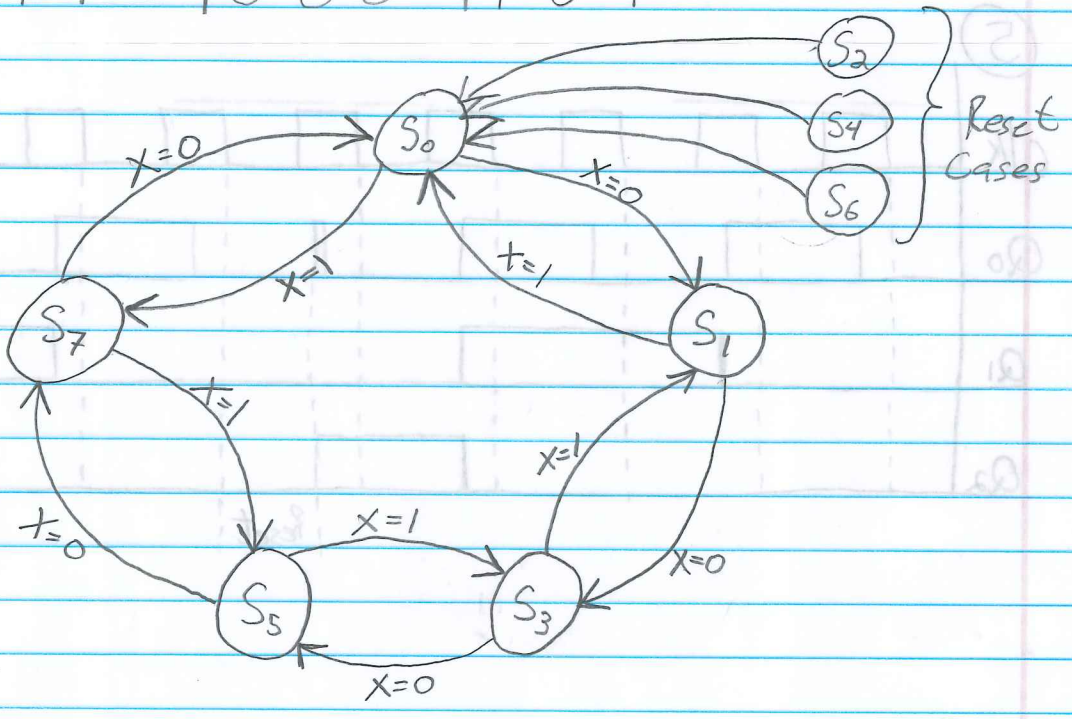


(6) $X=0$: 0, 1, 3, 5, 7

$X=1$: 7, 5, 3, 1, 0

Return to 0 when in 2, 4, 6

	CS			NS $X=0$			NS $X=1$			
	A	B	C	A^+	B^+	C^+	A^+	B^+	C^+	
$S_0 \rightarrow$	0	0	0	0	0	1	1	1	1	
$S_1 \rightarrow$	0	0	1	0	1	1	0	0	0	
$S_2 \rightarrow$	0	1	0	0	0	0	0	0	0	→ Reset Case
$S_3 \rightarrow$	0	1	1	1	0	1	0	0	1	
$S_4 \rightarrow$	1	0	0	0	0	0	0	0	0	→ Reset Case
$S_5 \rightarrow$	1	0	1	1	1	1	0	1	1	
$S_6 \rightarrow$	1	1	0	0	0	0	0	0	0	→ Reset Case
$S_7 \rightarrow$	1	1	1	0	0	0	1	0	1	



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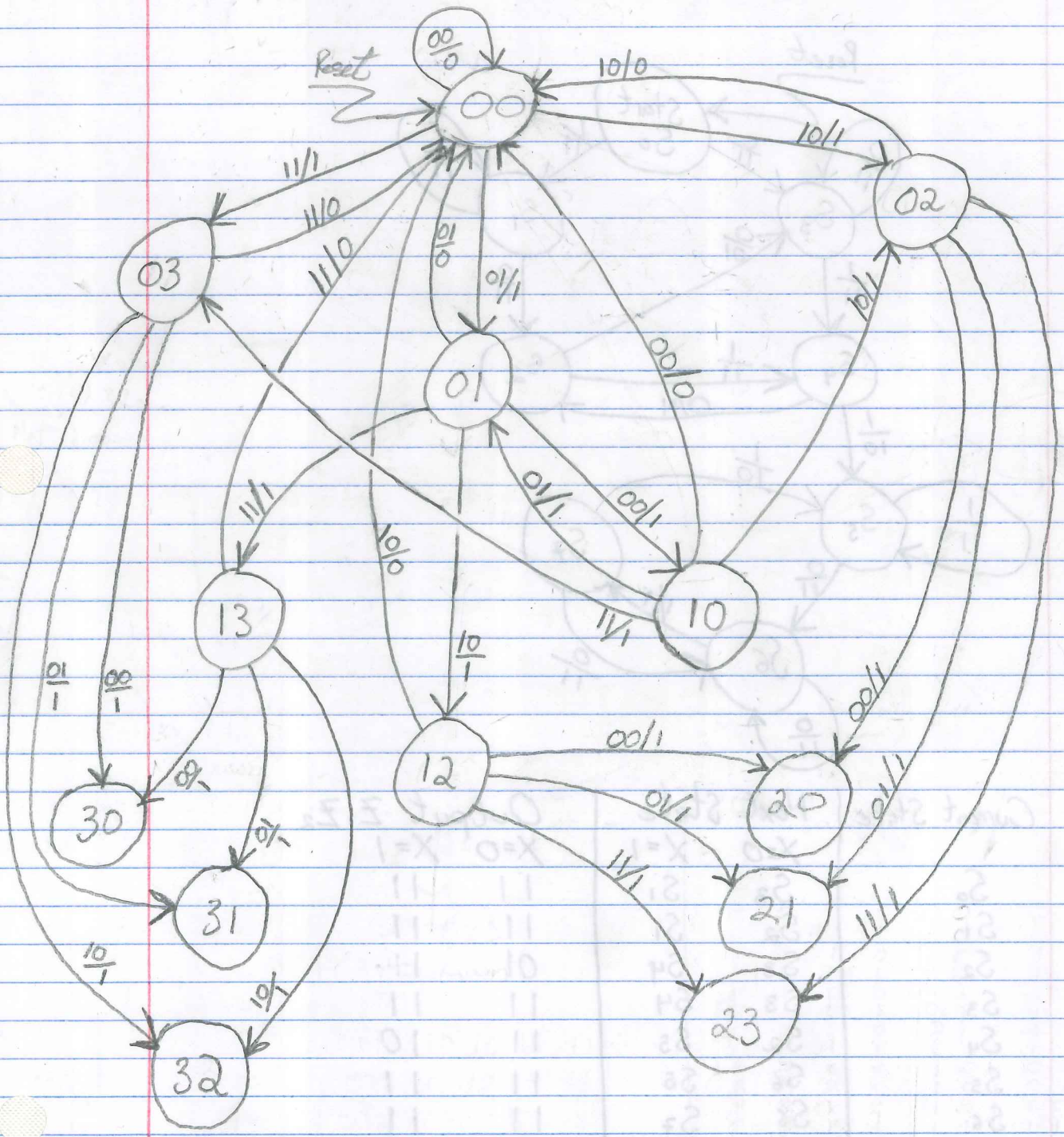
Homework 5

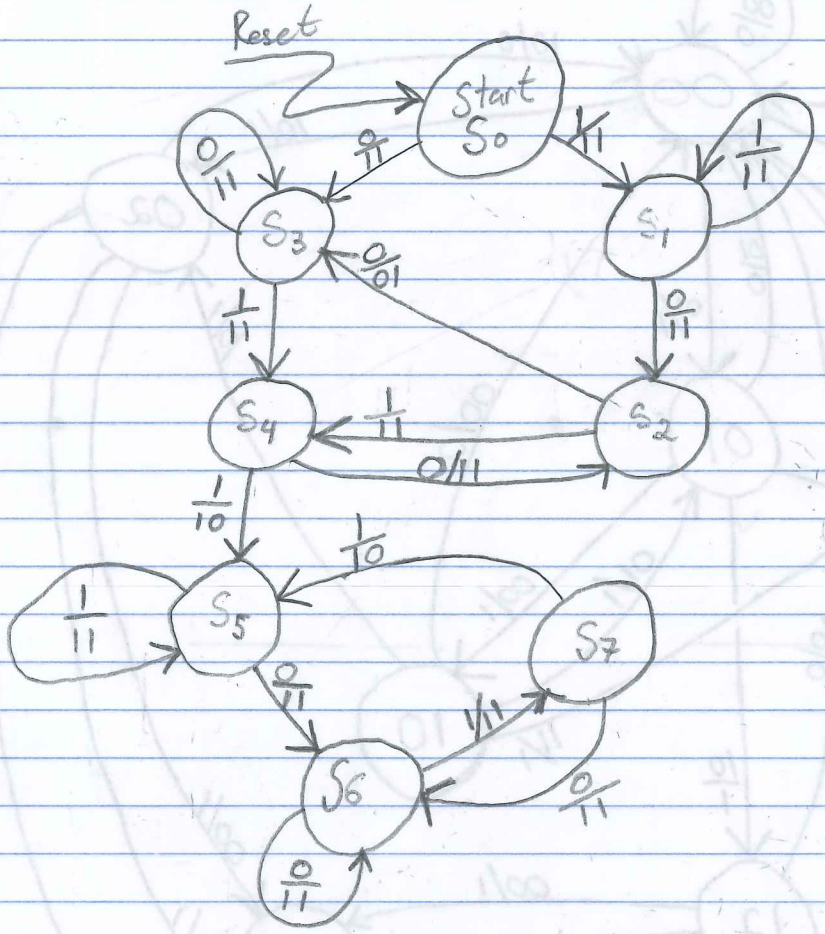
(1) Inputs $X_1 X_2$ & output Z
Outputs $Z=1$ in all cases except on consecutive



(2) Example input: 1 0 0 1 1 0 0 1 1 0 1 0 1 1

Z1 out: 1 1 0 1 1 1 1 1 1 1 1 1 1 1

Z2 out: 1 1 1 1 0 1 1 1 0 1 1 1 1 0

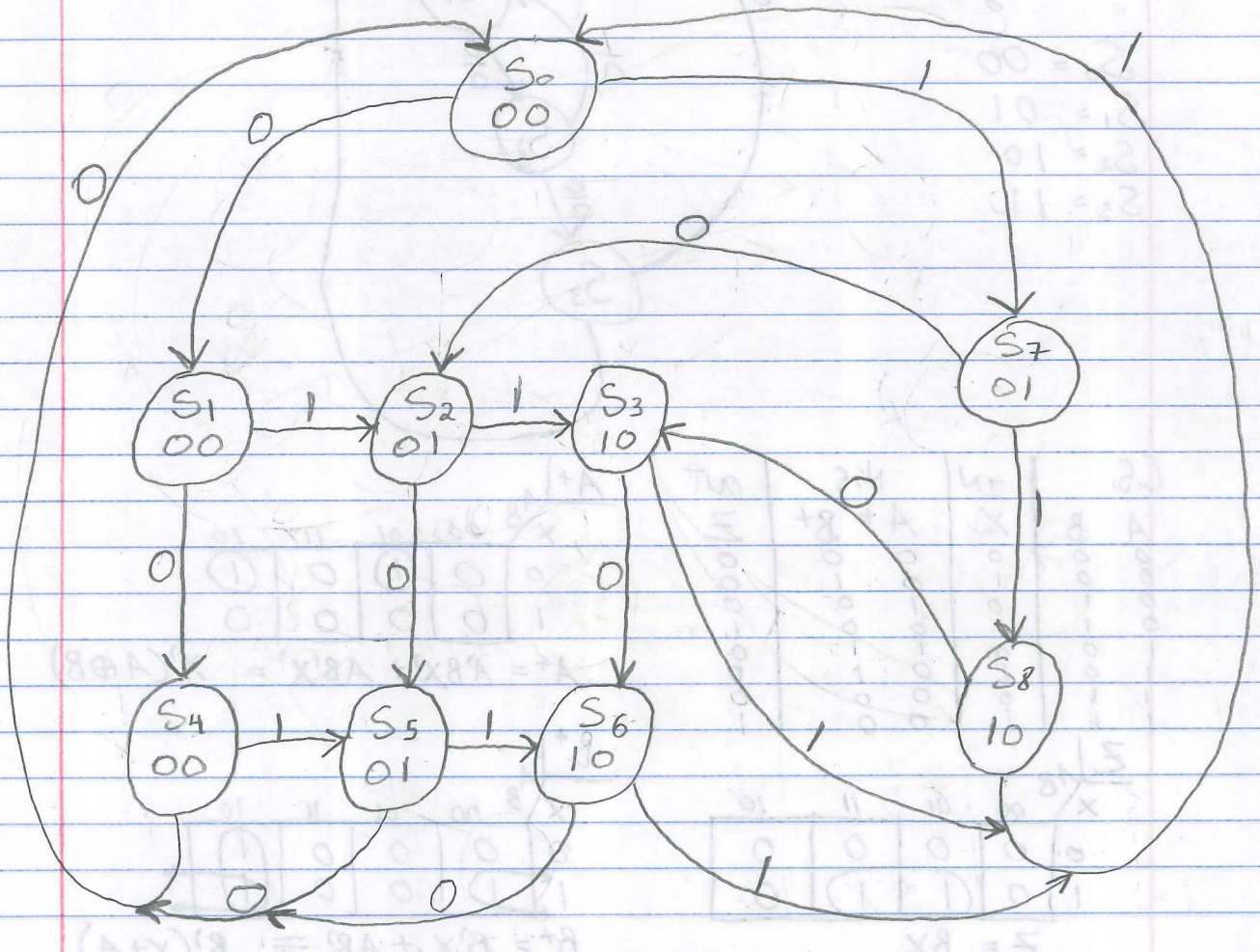


Current State	Next State		Output $Z_1 Z_2$	
	X=0	X=1	X=0	X=1
S_0	S_3	S_1	11	11
S_1	S_2	S_1	11	11
S_2	S_3	S_4	01	11
S_3	S_3	S_4	11	11
S_4	S_2	S_5	11	10
S_5	S_6	S_5	11	11
S_6	S_6	S_7	11	11
S_7	S_6	S_5	11	10

③ Moore machine inputs X, outputs YZ

Ex: X: 0 0 1 1 0 1 0 0 1 1 1 0 1 1

YZ: 0 0 1 2 0 1 1 1 2 0 1 0 1 2



Current State	Next State		Output
	X=0	X=1	YZ
S_0	S_1	S_7	00
S_1	S_4	S_2	00
S_2	S_5	S_3	01
S_3	S_7	S_0	10
S_4	S_0	S_5	00
S_5	S_0	S_6	01
S_6	S_0	S_0	10
S_7	S_2	S_8	01
S_8	S_3	S_0	10

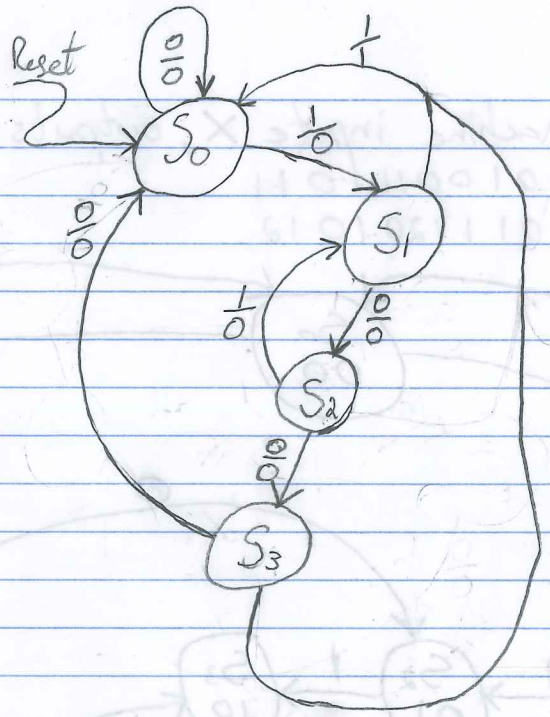
101001

X = 0 | 0 1 1 0 0 | 0 0 1 0 1 1 0
out = 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0

(4)

State Assignment

$S_0 = 00$
$S_1 = 01$
$S_2 = 10$
$S_3 = 11$



C.S.		IN	N.S		OUT
A	B	X	A^+	B^+	Z
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	0	0
0	1	1	1	1	0
1	0	0	0	0	0
1	0	1	0	1	0
1	1	0	1	0	0
1	1	1	1	1	1

A^+ (X \ AB)

X \ AB	00	01	11	10
0	0	1	0	1
1	0	0	0	0

$A^+ = A'BX' + AB'X' = X'(A \oplus B)$

Z (X \ AB)

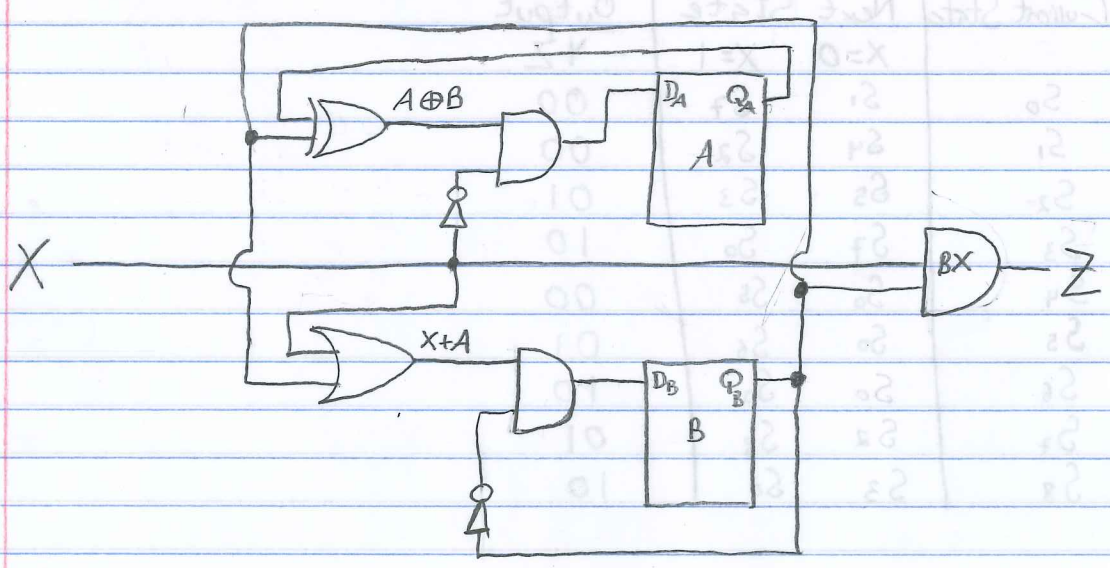
X \ AB	00	01	11	10
0	0	0	0	0
1	0	1	1	0

$Z = BX$

B^+ (X \ AB)

X \ AB	00	01	11	10
0	0	0	0	1
1	1	0	0	1

$B^+ = B'X + AB' = B'(X + A)$

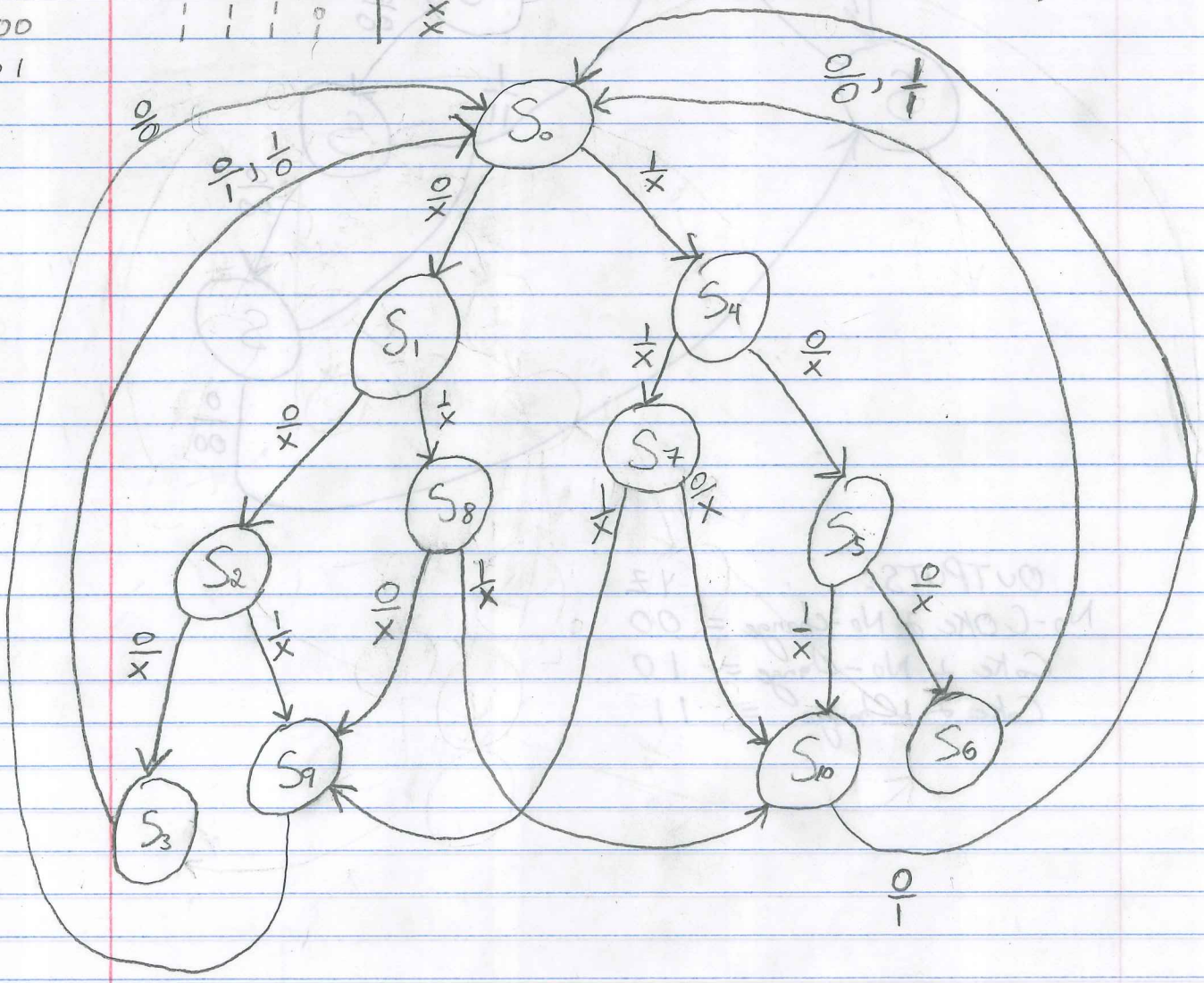


C.S.	N.S. X=0	N.S. X=1	OUT X=0	OUT X=1
S_0	S_1	S_4	X	X
S_1	S_2	S_8	X	X
S_2	S_3	S_9	X	X
S_3	S_0	S_0	1	0
S_4	S_5	S_7	X	X
S_5	S_6	S_{10}	X	X
S_6	S_0	S_0	0	1
S_7	S_{10}	S_9	X	X
S_8	S_9	S_{10}	X	X
S_9	S_0	—	0	X
S_{10}	S_0	—	1	X

0 - 0000
1 - 0001
2 - 0010
3 - 0011
4 - 0100
5 - 0101
6 - 0110
7 - 0111
8 - 1000
9 - 1001

(5)

A	B	C	D	OUT Z
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X



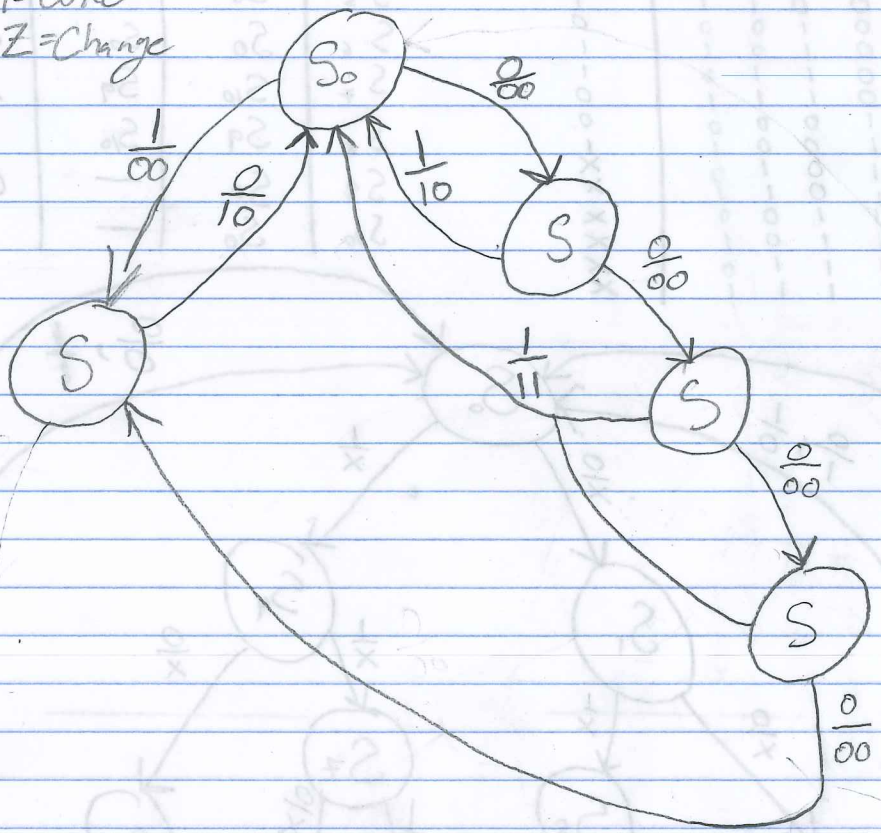
(6)

inputs : Dollar = 1 , Quarter = 0

outputs : Coke = 1, No Coke = 0, Change = 0, No Change = 0

* Output Y = Coke
* Output Z = Change

format
$\frac{X_{in}}{YZ}$



OUTPUTS: YZ

No-Coke & No-change = 00

Coke & No-change = 10

Coke & Change = 11

Homework #6

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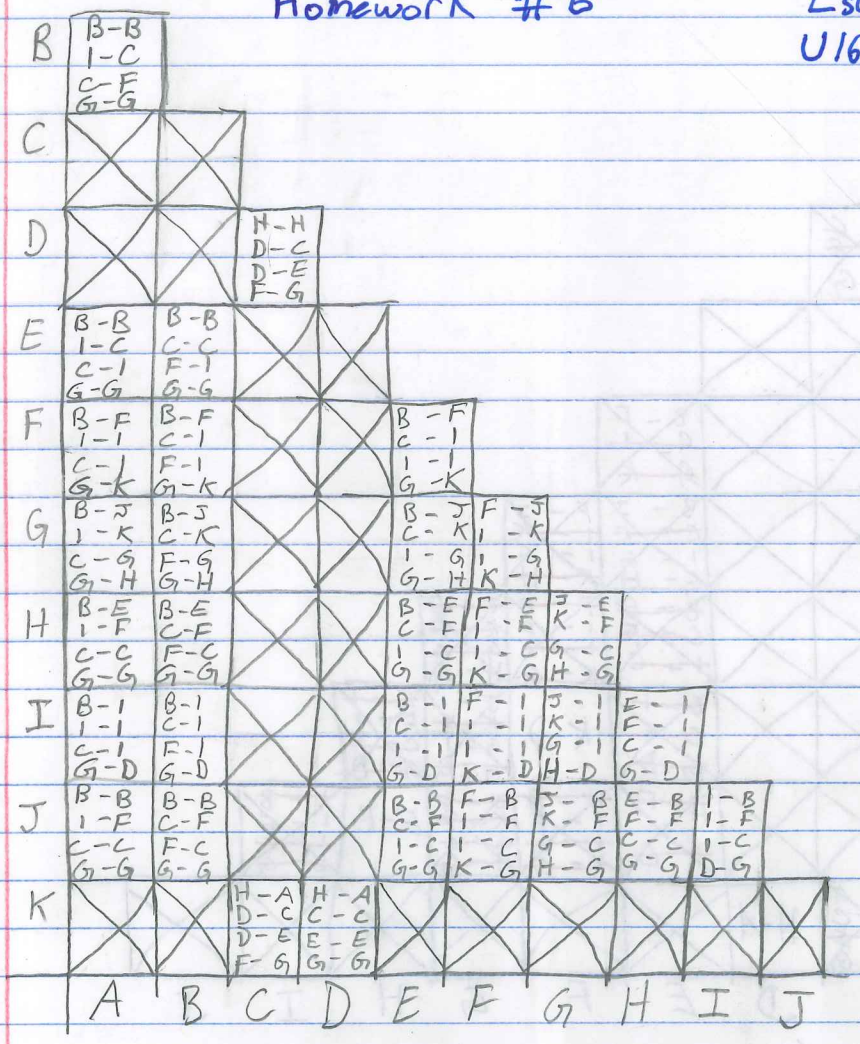
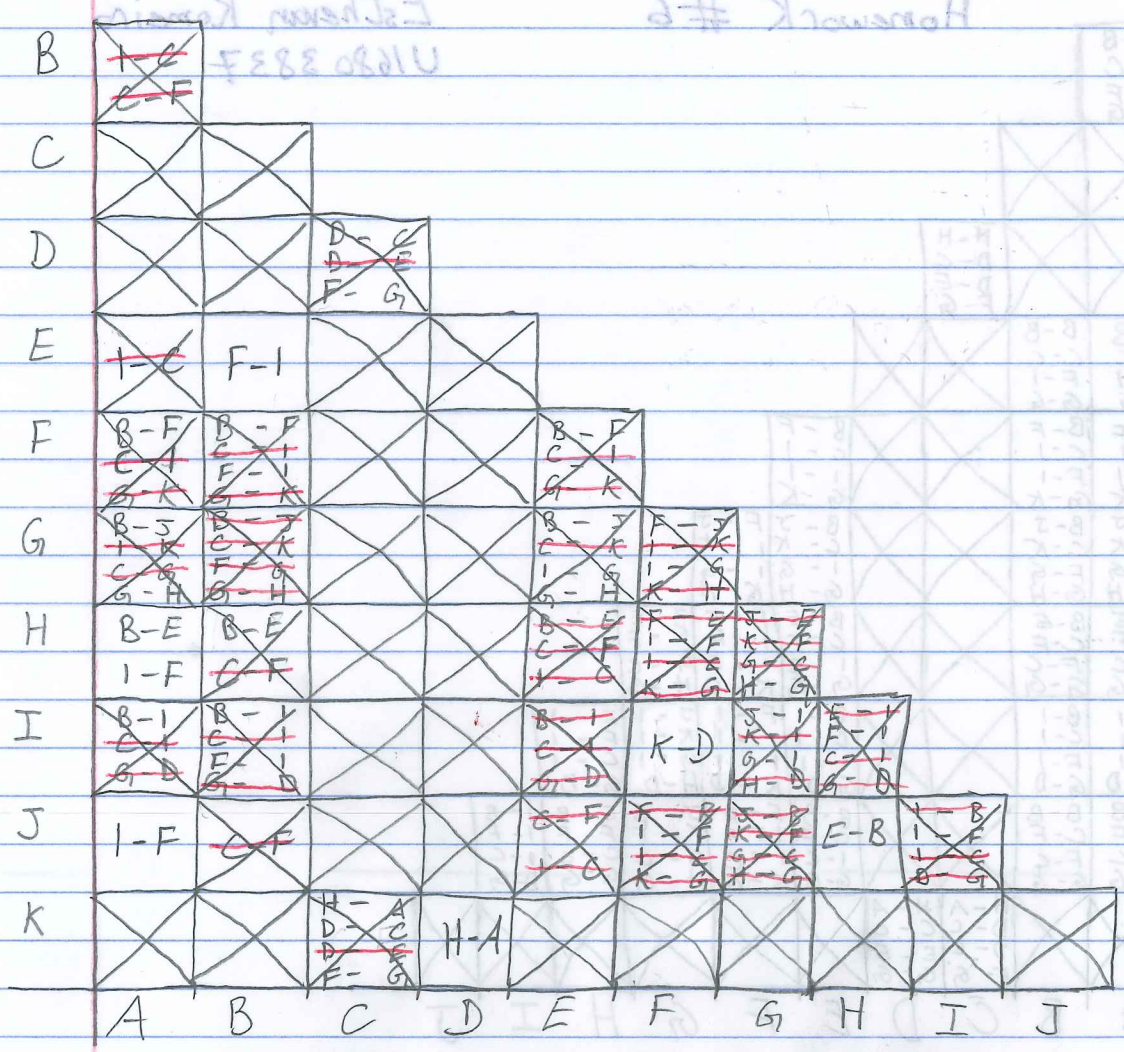
(1)



Eliminate all repetitions i.e. B-B → Cleaned up Chart



$A \equiv H$ if $B \equiv E$ and $1 \equiv F$ ✓
$A \equiv J$ if $1 \equiv F$ ✓
$B \equiv E$ if $1 \equiv F$ ✓
$D \equiv K$ if $H \equiv A$ ✓
$1 \equiv F$ if $K \equiv D$ ✓

$\therefore A \equiv H \equiv J$
$B \equiv E$
$D \equiv K$
$1 \equiv F$

Reduced State Table

Present State	NEXT STATE				Output
	XY=00	XY=01	XY=11	XY=10	Z
A	B	1	C	G	0
B	B	C	1	G	0
C	A	D	D	1	1
D	A	C	B	G	1
G	A	D	G	A	0
I	1	1	1	D	0

(2)

	A	B	C	D	E	F
B	B-G					
C	F-C B-G	F-C				
D	F-A	F-A G-B	C-A G-B			
E						
F	B-A	F-A G-A	C-A G-A	B-A		
G	B-A	G-A	C-F G-A	A-F B-A		A-F

$A \equiv B$ if $B \equiv G$ ✓
$A \equiv C$ if $F \equiv C$ ✓ and $B \equiv G$ ✓
$A \equiv D$ if $F \equiv A$ ✓
$A \equiv F$ if $B \equiv A$ ✓
$A \equiv G$ if $B \equiv A$ ✓
$B \equiv C$ if $F \equiv C$ ✓
$B \equiv D$ if $F \equiv A$ ✓ and $G \equiv B$ ✓
$B \equiv F$ if $F \equiv A$ ✓ and $G \equiv A$ ✓
$B \equiv G$ if $G \equiv A$ ✓
$C \equiv D$ if $C \equiv A$ ✓ and $G \equiv B$ ✓
$C \equiv F$ if $C \equiv A$ ✓ and $G \equiv A$ ✓
$C \equiv G$ if $C \equiv F$ ✓ and $G \equiv A$ ✓
$D \equiv F$ if $B \equiv A$ ✓
$D \equiv G$ if $A \equiv F$ ✓ and $B \equiv A$ ✓
$F \equiv G$ if $A \equiv F$ ✓

$A \equiv B \equiv C \equiv D \equiv F \equiv G$
$B \equiv C \equiv D \equiv F \equiv G$
$C \equiv D \equiv F \equiv G$
$D \equiv F \equiv G$
$F \equiv G$

$\therefore A \equiv B \equiv C \equiv D \equiv F \equiv G$
E

Reduced State Table

Present State	Next State		Output	
	X=0	X=1	X=0	X=1
A	A	A	0	0
E	E	A	1	0

(3) Guideline 1: States which have the same next states for a given input → Columns for each input

(A, C) ×2 (B, C) ×2 (A, D)

Guideline 2: States which are the next states of a given state → row for each input

(A, C) (B, D) (A, B, D), (D, A, C)

Guidelines 3: States with the same outputs for a given input → row of outputs match

(A, D)

Preference is given to guideline 1 conditions over guideline 2. Furthermore, conditions that are required 2 or more times are given preference over those that are only required once

Q_2 \ Q_1	0	1
0	A	C
1	D	B

A = 00, D = 01, C = 10, B = 11

Original Tables →

X_1X_2 \ Q_1Q_2	00	01	11	10
00	A	D	B	A
01	A	D	D	A
11	C	A	B	B
10	C	C	D	D

Q_1^+

X_1X_2 \ Q_1Q_2	00	01	11	10
00	0	0	1	0
01	0	0	0	0
11	1	0	1	1
10	1	1	0	0

$$Q_1^+ = \bar{Q}_1\bar{Q}_2X_1 + \bar{Q}_1X_1\bar{X}_2 + Q_1X_1X_2 + Q_1Q_2\bar{X}_1\bar{X}_2$$

Q_2^+

X_1X_2 \ Q_1Q_2	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	0	1	1
10	0	0	1	1

$$Q_2^+ = Q_2\bar{X}_1 + Q_1X_1$$

→ 2 KMAPS

Z_0

Q_1Q_2 / X_1X_2	A 00	D 01	B 11	C 10
00	0	0	1	1
01	0	0	1	1
11	0	0	1	0
10	0	0	1	0

$$Z_0 = Q_1Q_2 + Q_1\bar{X}_1$$

Z_1

Q_1Q_2 / X_1X_2	A 00	D 01	B 11	C 10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	0
00	1	1	1	0

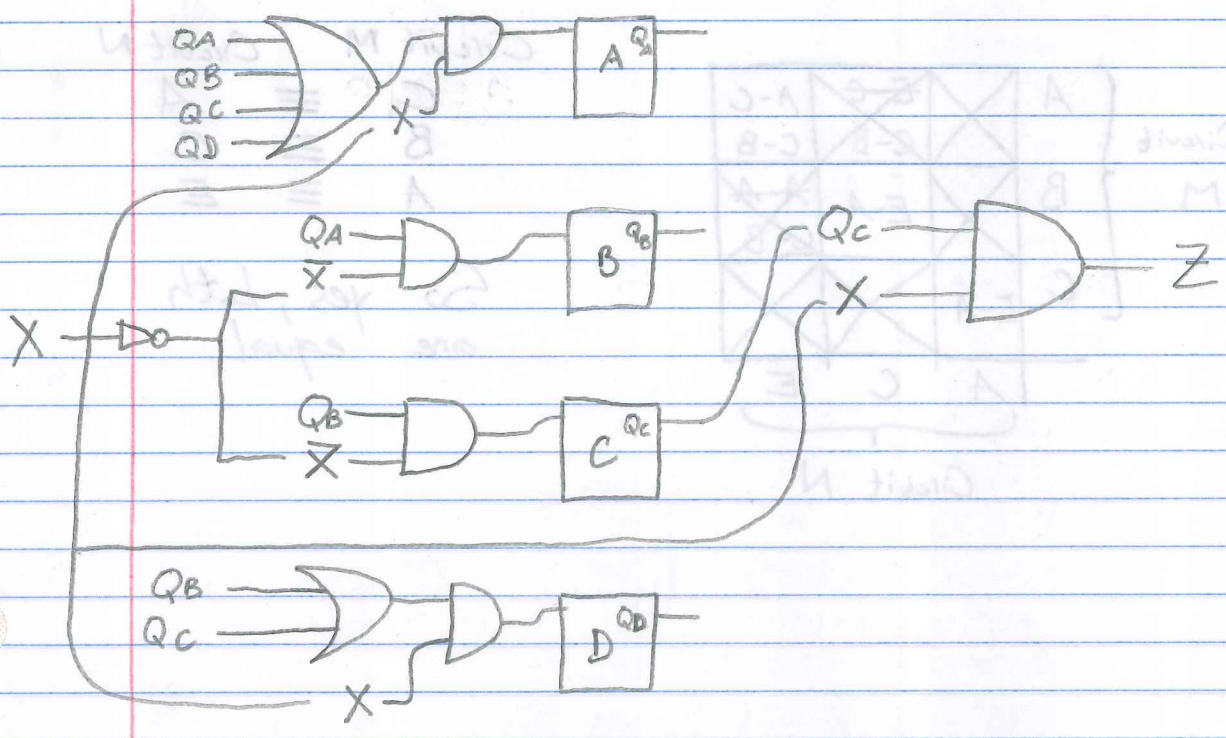
$$Z_1 = \bar{Q}_1 + \bar{X}_1 + Q_1Q_2$$

(4)

$$Q_A^+ = X(A+B+C+D) \quad \text{where FF } Q_A = A$$
$$Q_B^+ = \bar{X}A \quad \text{" } Q_B = B$$
$$Q_C^+ = \bar{X}B \quad \text{" } Q_C = C$$
$$Q_D^+ = \bar{X}(C+D) \quad \text{" } Q_D = D$$

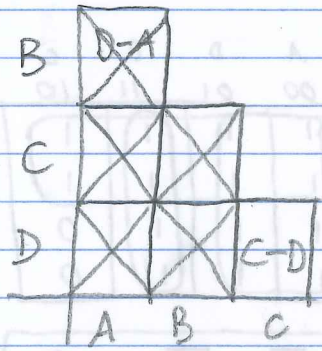
$\therefore$

$$Q_A^+ = X(Q_A + Q_B + Q_C + Q_D)$$
$$Q_B^+ = \bar{X}Q_A$$
$$Q_C^+ = \bar{X}Q_B$$
$$Q_D^+ = \bar{X}(Q_C + Q_B)$$
$$Z = XQ_C$$



(5)

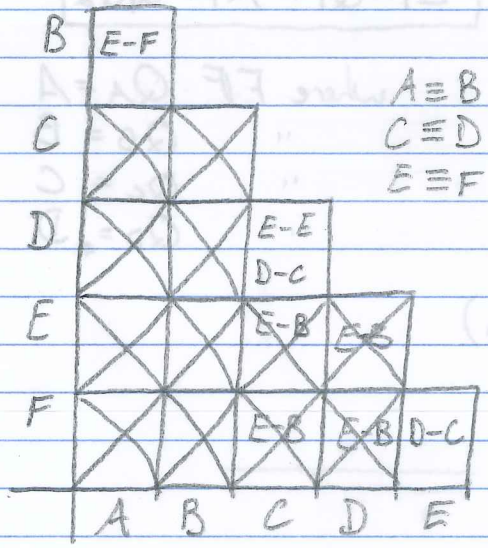
M



$C \equiv D$

Reduced State Table M

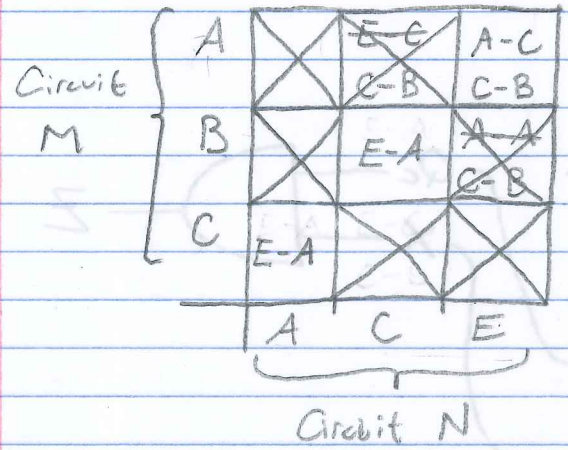
Present State	Next State		Out
	X=0	X=1	Z
A	C	B	0
B	A	B	0
C	A	C	1



$A \equiv B$
$C \equiv D$
$E \equiv F$

Reduced State Table N

Present State	Next State		Out
	X=0	X=1	Z
A	E	A	1
C	E	C	0
E	A	C	0



Circuit M ≡ Circuit N

$C \equiv A$

$B \equiv C$

$A \equiv E$

So yes, both are equal