Solution to Midterm Exam

Oct. 16. 2014

1. a) $101.101_2 = 5.625_{10}$

   b) $666.666_{10} = 1010011010.1010101001_2$

   c) i) $10100011011101111011010011 10_2 = A377B4E_{16}$

   ii) $67AC789AB6BF786_{16} = 110\ 0111\ 1010\ 1100\ 0111\ 1000\ 1001\ 1010\ 1011\ 0110\ 1011\ 1111\ 0111\ 1000\ 0110_2$

   d) $665_7 = 2331_5$

   e) i) $-11101111_2 = 00010001_2$

   ii) $-00010000_2 = 11110000_2$

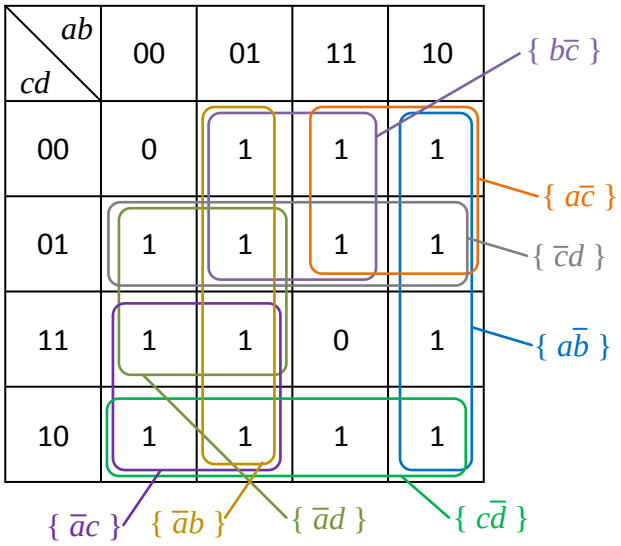
   f) i) $11111110_2 + 00111111_2 = 00111101_2$

   ii) $00111111_2 + 11111110_2 = 100000010_2$

2. (a) Truth table

a	b	c	d	f
0	0	0	0	0
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	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

< Karnaugh map >



(b) $f(a,b,c,d) = a\bar{b} + \bar{a}d + b\bar{c} + c\bar{d}$

(c) $f(a,b,c,d) = (a+b+c+d)\cdot(\bar{a}+\bar{b}+\bar{c}+\bar{d})$

(d) NAND-NAND $f(a,b,c,d) = \overline{\left(\overline{a\bar{b}}\cdot\overline{\bar{a}d}\cdot\overline{b\bar{c}}\cdot\overline{c\bar{d}}\right)}$

(e) OR-NAND $f(a,b,c,d) = \overline{\left((\bar{a}+b)\cdot(a+\bar{d})\cdot(\bar{b}+c)\cdot(\bar{c}+d)\right)}$

(f) NOR-OR $f(a,b,c,d) = \overline{(\bar{a}+b)} + \overline{(a+\bar{d})} + \overline{(\bar{b}+c)} + \overline{(\bar{c}+d)}$

(g) NOR-NOR $f(a,b,c,d) = \overline{\overline{(a+b+c+d)} + \overline{(\bar{a}+\bar{b}+\bar{c}+\bar{d})}}$

(h) AND-NOR $f(a,b,c,d) = \overline{\bar{a}\bar{b}\bar{c}\bar{d} + abcd}$

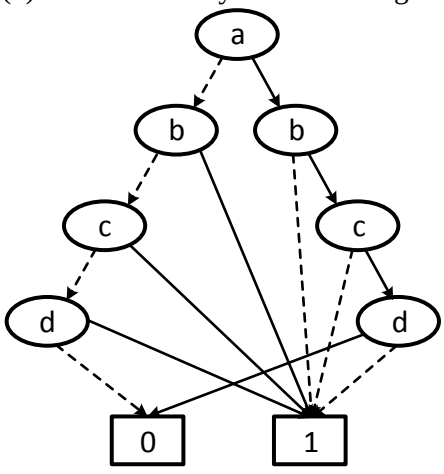
(i) NAND-AND $f(a,b,c,d) = \overline{(\bar{a}\bar{b}\bar{c}\bar{d})}\cdot\overline{(abcd)}$

(j) AND-XOR

$f(a,b,c,d) = a\oplus b\oplus c\oplus d\oplus ab\oplus ac\oplus ad\oplus bc\oplus bd\oplus cd\oplus abc\oplus abd\oplus acd\oplus bcd$

$f(a,b,c,d) = d\oplus c\oplus cd\oplus b\oplus bd\oplus bc\oplus bcd\oplus a\oplus ad\oplus ac\oplus acd\oplus ab\oplus abd\oplus abc$

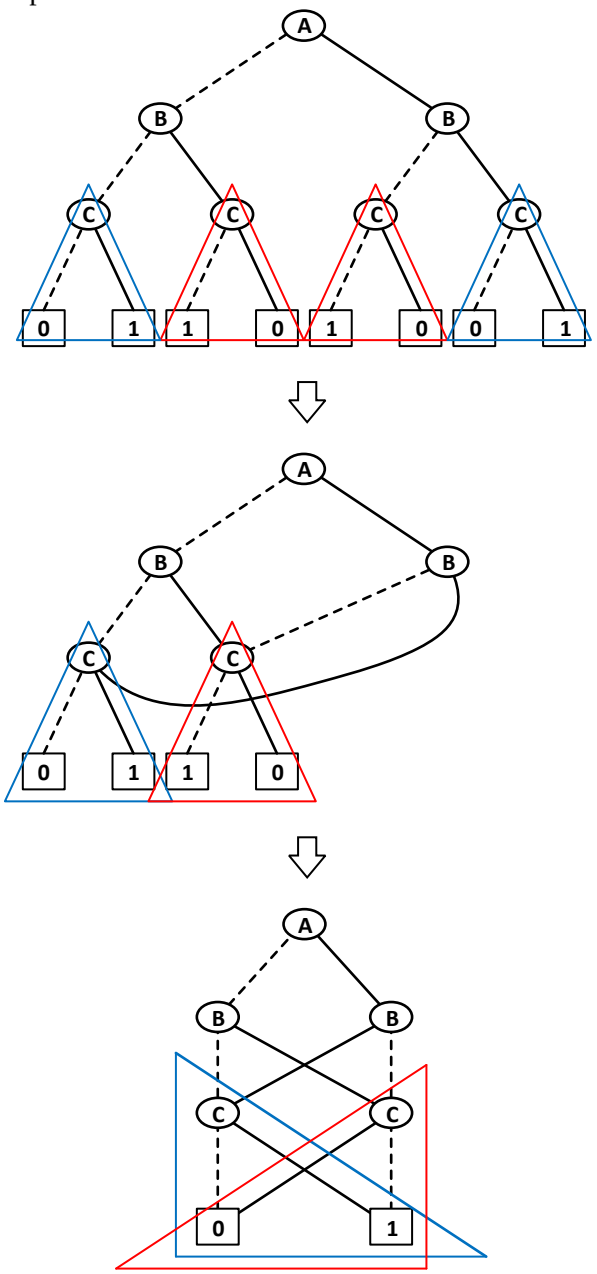
(k) Reduced Binary Decision Diagram



3. $f(A,B,C,D,E,F,G,H,I,J,K,L) = A \oplus B \oplus C \oplus D \oplus E \oplus F \oplus G \oplus H \oplus I \oplus J \oplus K \oplus L$

Example: **XOR in 3 variables**

a	b	c	a⊕b⊕c
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



4. !! !" !#

X2	X3	X1	g1	g2	g3	g4	g5	g6	f1	f2	f3
0	0	0	0(1)	0(3)	1(1)	0(1)	1(1)	0(5)	0(4)	1(2)	1(2)
0	0	1	0(1)	1(5)	0(1)	0(3)	1(1)	0(1)	1(6)	0(4)	1(2)
0	1	0	1(1)	0(1)	0(1)	0(1)	0(1)	1(3)	1(2)	0(2)	1(4)
0	1	1	1(1)	0(1)	0(1)	1(3)	0(1)	0(1)	1(2)	1(4)	0(2)
1	0	0	0(1)	1(3)	0(1)	0(1)	0(1)	1(5)	1(4)	0(2)	1(6)
1	0	1	0(1)	0(5)	0(1)	1(3)	0(1)	0(1)	0(6)	1(4)	0(2)
1	1	0	0(1)	0(1)	0(1)	0(1)	0(1)	0(3)	0(2)	0(2)	0(4)
1	1	1	0(1)	0(1)	0(1)	1(3)	0(1)	0(1)	0(2)	1(4)	0(2)

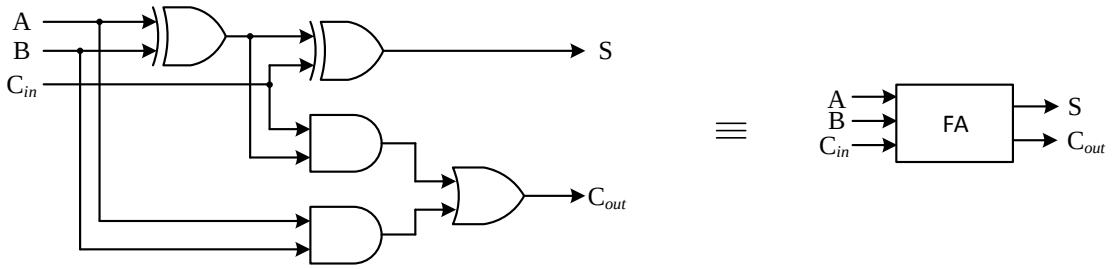
X1	X2	X3
4	2	2
2	2	4
4	2	6
2	2	4
6	4	2
2	4	2
6	4	2
2	4	2

***timings only**

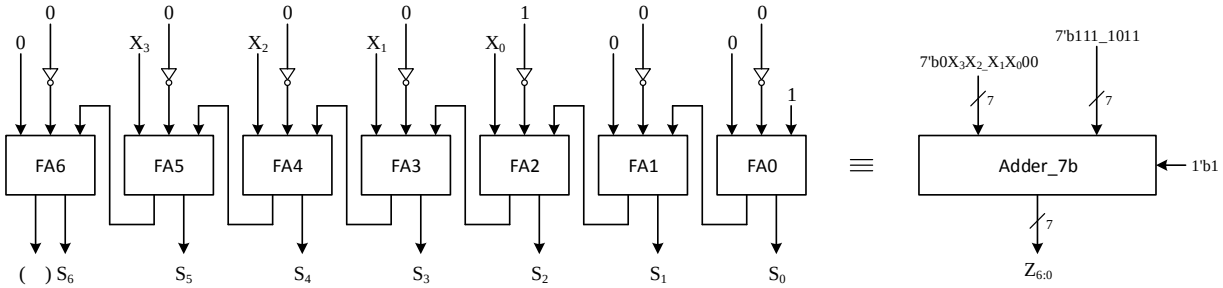
Grading #4

# Correct	Points
24,23	20
22,21	19
20,19	18
18,17	17
16	16
15	15
14	14
13	13
12	12
11	11
10	10
9	9
8	8
7	7
6	6
5	5
4	4
3	3
2	2
1	1
0	0

5. i. FA Circuit (4 pt)



ii. Calculate -4 and put in circuit correctly (2 pt)



iii. 4X correctly (2 pt)

iv. 7-bit output for sign extension (2 pt)