Question 1 E

Saturday, 7 March 2020 6:20 pm

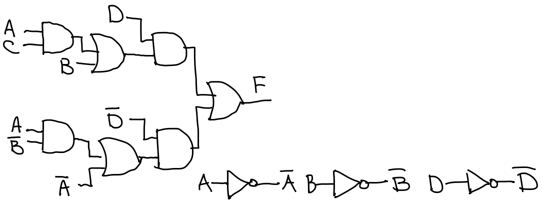
a) i)

Literals = 8
Terms = 6
Complements = 3

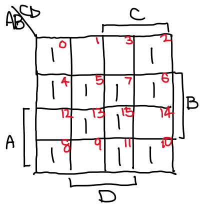
GIC = 17

$\leftarrow D(AC+B)+\bar{D}(\bar{A}+A\bar{B})$

Students may draw logic diagram to determine GIC



ii) Students can use the K-map to find the minterms for F or algebraic expansion



OR

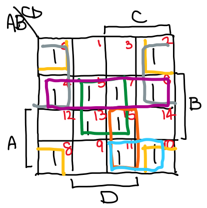
$$F = D(AC+B)+\bar{D}(\bar{A}+A\bar{B})$$
$$= ACD+BD+\bar{A}\bar{D}+A\bar{B}\bar{D}$$
$$= ACD(B+\bar{B})+BD(A+\bar{A})(C+\bar{C})+\bar{A}\bar{D}(B+\bar{B})(C+\bar{C})+A\bar{B}D(C+\bar{C})$$

$F=\sum m(0,2,4,5,6,7,8,10,11,13,15)$

iii)

A	B	C	D	F	m_i
0	0	0	0	1	m_0
0	0	0	1	0	m_1
0	0	1	0	1	m_2
0	0	1	1	0	m_3
0	1	0	0	1	m_4
0	1	0	1	1	m_5
0	1	1	0	1	m_6
0	1	1	1	1	m_7
1	0	0	0	1	m_8
1	0	0	1	0	m_9
1	0	1	0	1	m_{10}
1	0	1	1	1	m_{11}
1	1	0	0	0	m_{12}
1	1	0	1	1	m_{13}
1	1	1	0	0	m_{14}
1	1	1	1	1	m_{15}

iv)



$F = \bar{B}\bar{D}+BD+\bar{A}\bar{D}+ACD$

or $F = \bar{B}\bar{D}+BD+\bar{A}\bar{D}+A\bar{B}C$

or $F = \bar{B}\bar{D}+BD+\bar{A}B+ACD$

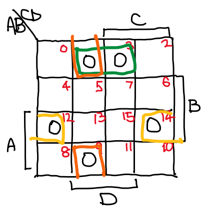
or $F = \bar{B}\bar{D}+BD+\bar{A}B+A\bar{B}C$

SOP — any one is correct.

PI : $\bar{B}\bar{D}$, BD, $\bar{A}\bar{D}$, ACD, $A\bar{B}C$, $\bar{A}B$

EPI : $\bar{B}\bar{D}$, BD

v)



$F=(\bar{A}+\bar{B}+D)(B+C+\bar{D})(A+B+\bar{D})$ ← POS

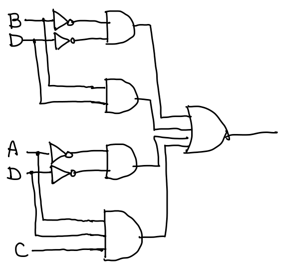
PI: $\bar{A}+\bar{B}+D$, $B+C+\bar{D}$, $A+B+\bar{D}$

EPI: $\bar{A}+\bar{B}+D$, $B+C+\bar{D}$, $A+B+\bar{D}$

vi) literals = 9
terms = 4
complements = 3
GIC = 16

Reduction of 1 GIC after optimisation

vii) $F = \bar{B}\bar{D} + BD + \bar{A}\bar{D} + ACD$



b)

binary	hexadecimal	octal
11101010.111	EA.E	352.7

Octal → binary

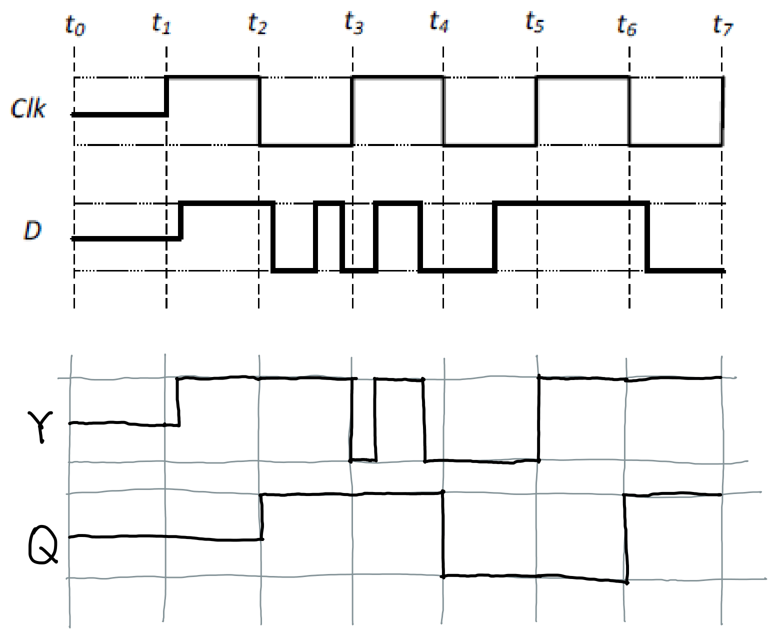
$\underbrace{011}_{3}\underbrace{101}_{5}\underbrace{010}_{2}.\underbrace{111}_{7}$ ← binary ← octal

Binary → Hexadecimal

$\underbrace{1110}_{14 \equiv E}\underbrace{1010}_{10 \equiv A}.\underbrace{1110}_{14 \equiv E}$ ← Hex

c) A – D latch

B – Positive edge-triggered D flip-flop



Question 2 E

Saturday, 7 March 2020   8:31 pm

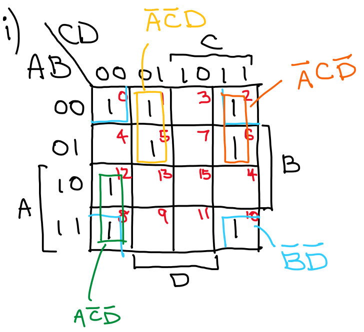
a) i) $X+Y = X\oplus Y + XY$

$$X\oplus Y + XY = X\bar{Y} + \bar{X}Y + XY$$
$$= X\bar{Y} + XY + XY + \bar{X}Y$$
$$= X(\bar{Y}+Y) + Y(X+\bar{X})$$
$$= X+Y$$

ii) $H(A,B,C) = A\bar{B} + AB\bar{C} + \bar{A}B$

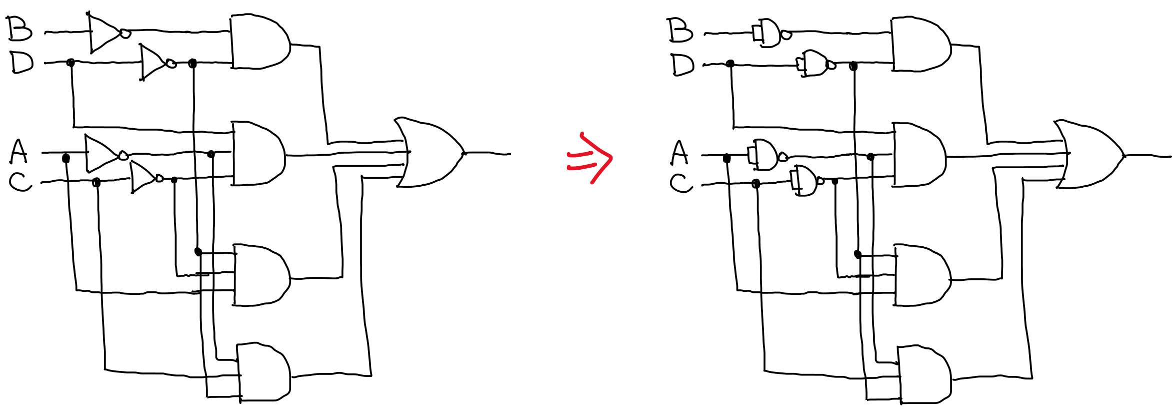
$$= \underbrace{A\oplus B}_{X} + \underbrace{AB\bar{C}}_{Y} \qquad \boxed{X+Y = X\oplus Y + XY}$$
$$= A\oplus B\oplus AB\bar{C} + (A\oplus B)(AB\bar{C})$$
$$= A\oplus B\oplus AB\bar{C} + (A\bar{B}+\bar{A}B)(AB\bar{C})$$
$$= A\oplus B\oplus AB\bar{C}$$

b) i)



$$G = \Pi M(3,4,7,9,11,13,14,15)$$
$$= \Sigma m(0,1,2,5,6,8,10,12)$$
$$= \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + AB\bar{C}\bar{D}$$
$$\bar{A}\bar{B}C\bar{D} + A\bar{B}\bar{C}\bar{D}$$
$$= \bar{A}\bar{B}\bar{D}(\bar{C}+C) + \bar{A}\bar{C}D(\bar{B}+B) + \bar{A}C\bar{D}(B+\bar{B}) + A\bar{B}\bar{D}(\bar{C}+C) + A\bar{C}\bar{D}(\bar{B}+B)$$
$$= \bar{A}\bar{B}\bar{D} + \bar{A}\bar{C}D + \bar{A}C\bar{D} + A\bar{B}\bar{D} + A\bar{C}\bar{D}$$
$$= \bar{B}\bar{D}(\bar{A}+A) + \bar{A}\bar{C}D + A\bar{C}\bar{D} + \bar{A}C\bar{D}$$
$$= \bar{B}\bar{D} + \bar{A}\bar{C}D + A\bar{C}\bar{D} + \bar{A}C\bar{D}$$

ii) $G = \bar{B}\bar{D} + \bar{A}\bar{C}D + A\bar{C}\bar{D} + \bar{A}C\bar{D}$



c) i)

A	B	C	D	Z	
0	0	0	0	0	
0	0	0	1	0	$Z = C$
0	0	1	0	1	
0	0	1	1	1	
0	1	0	0	1	
0	1	0	1	1	$Z = \bar{C} + D$
0	1	1	0	0	
0	1	1	1	1	
1	0	0	0	0	
1	0	0	1	1	$Z = D$
1	0	1	0	0	
1	0	1	1	1	
1	1	0	0	0	
1	1	0	1	1	$Z = D$
1	1	1	0	0	
1	1	1	1	1	

AB \ CD	00	01	11	10
00			1	1
01	1	1	1	
11		1	1	
10		1	1	

AB select

$I_0 = C$
$I_1 = \bar{C} + D$
$I_3 = D$
$I_2 = D$

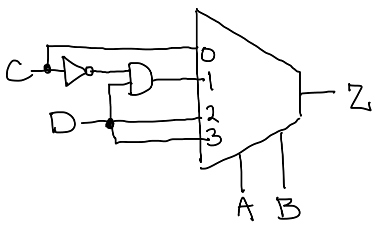
CD select

$I_0 = \bar{A}B$
$I_1 = A + B$
$I_2 = \bar{A}\bar{B}$
$I_3 = 1$

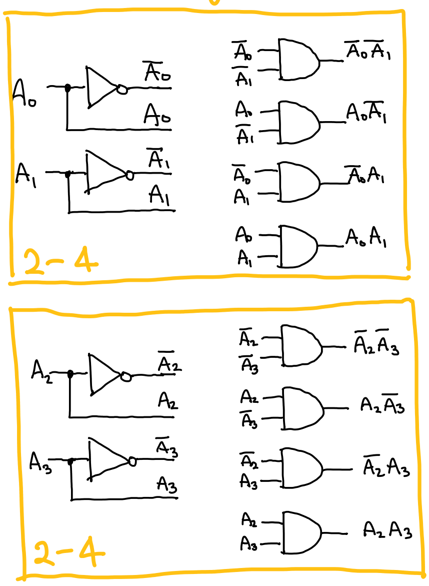
Note: Using CD as select would not give the simplest design.

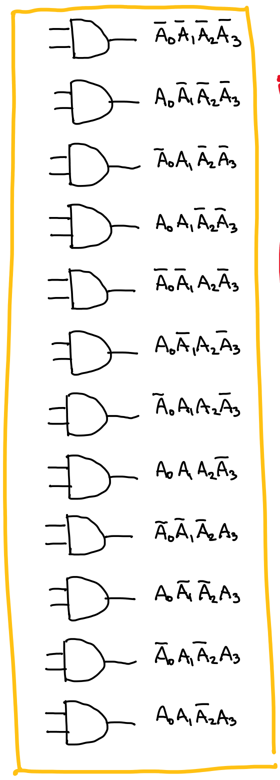
ii) $Z = \sum m(2, 3, 4, 5, 7, 9, 11, 13, 15)$

iii)



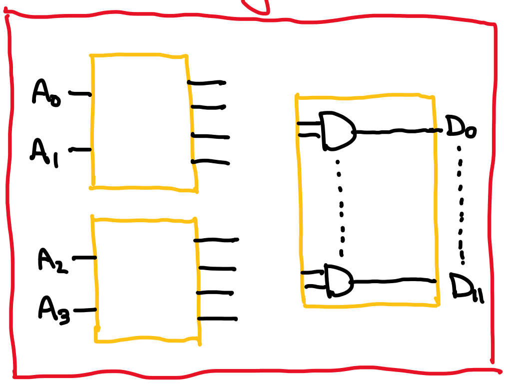
d) Not required!





12 AND gates

Block diagram



$GIC = 4 + 4\times2 + 4\times2 + 12\times2$
$= \underline{44}$

Refer to Week 3 slide 51

- Input n is even, $n = 4$.
  Use 2^n AND gates driven by two decoders of output size $2^{n/2} = 4$
  Since BCD is only from 0 to X, $16 - X - 1$ AND gates will be redundant.