Question 1 A

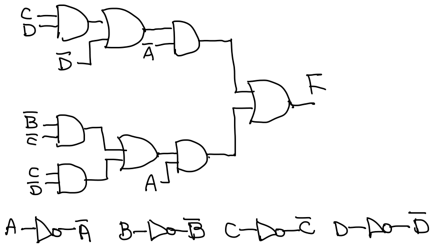
Saturday, 7 March 2020 6:20 pm

a) i) Literals = 9
Terms = 7
Complements = 4

GIC = 20

$\longrightarrow \overline{A}(CD+\overline{D}) + A(\overline{B}\overline{C}+C\overline{D})$

Students may draw logic diagram to determine the GIC.



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

AB \ CD			C	C
	1		1	1
B	1		1	1
A, B				1
A	1	1		1
		D	D	

$F = \Sigma m(0,2,3,4,6,7,8,9,10,14)$

OR

$F = \overline{A}(CD+\overline{D}) + A(\overline{B}\overline{C}+C\overline{D})$

$= \overline{A}CD + \overline{A}\overline{D} + A\overline{B}\overline{C} + AC\overline{D}$

$= \overline{A}CD(B+\overline{B}) + \overline{A}\overline{D}(B+\overline{B})(C+\overline{C}) + A\overline{B}\overline{C}(D+\overline{D}) + AC\overline{D}(B+\overline{B})$

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	1	m_3
0	1	0	0	1	m_4
0	1	0	1	0	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	1	m_9
1	0	1	0	1	m_{10}
1	0	1	1	0	m_{11}
1	1	0	0	0	m_{12}
1	1	0	1	0	m_{13}
1	1	1	0	1	m_{14}
1	1	1	1	0	m_{15}

iv)

AB \ CD			C	C
	1		1	1
B	1		1	1
A, B				1
A	1	1		1
		D	D	

$F = \overline{A}\overline{D} + \overline{A}C + C\overline{D}, A\overline{B}\overline{C}$ ← SOP

PI: $\overline{B}\overline{D}, \overline{A}\overline{D}, \overline{A}C, C\overline{D}, A\overline{B}\overline{C}$

EPI: $\overline{A}\overline{D}, \overline{A}C, C\overline{D}, A\overline{B}\overline{C}$

v)

AB \ CD			C	C
		0		
B		0		
A, B	0	0	0	
A			0	
		D	D	

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

PI = $(A+C+\overline{D}), (\overline{B}+C+\overline{D}), (\overline{A}+\overline{B}+C), (\overline{A}+\overline{B}+\overline{D}), (\overline{A}+\overline{C}+\overline{D})$

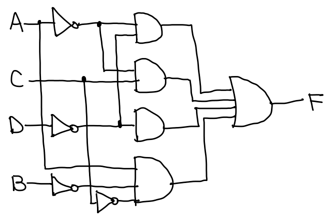
EPI = $(A+C+\overline{D}), (\overline{A}+\overline{B}+C), (\overline{A}+\overline{C}+\overline{D})$

vi) literals = 9
terms = 4
complements = 4

GIC = 17

Reduction of 3 GIC after optimisation

vii) F= $\bar{A}\bar{D}+\bar{A}C+C\bar{D}$, $A\bar{B}\bar{C}$



b)

binary	hexodecimal	octal
110101100.111	1AC.E	654.7

Octal → Binary

$(\overbrace{110}^{6}\,\overbrace{101}^{5}\,\overbrace{100}^{4}\,.\,\overbrace{111}^{7})_2$ ← Binary

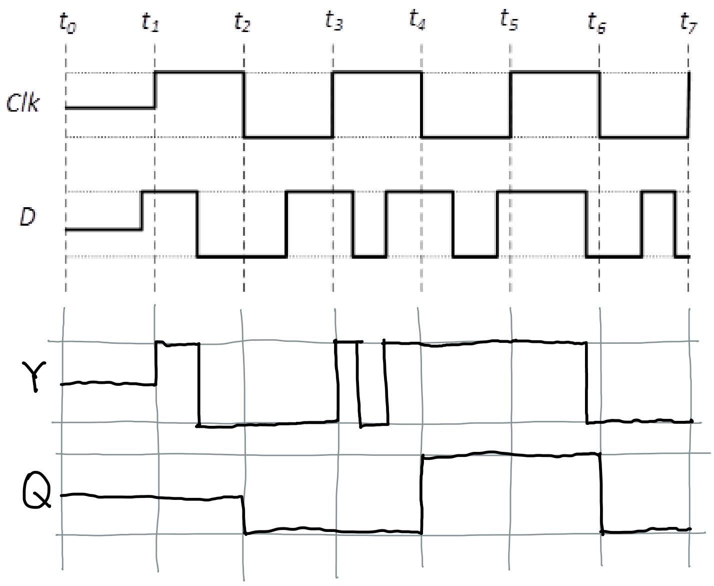
Binary → Hexadecimal

$\underbrace{0001}_{(1}\,\underbrace{1010}_{10 \,\equiv\, A}\,\underbrace{1100}_{12 \,\equiv\, C}\,.\,\underbrace{1110}_{14 \,\equiv\, E}$

$(1\ A\ C\ .\ E)_{16}$ ← Hex

c) A – D latch

B – Positive edge triggered D-flip flop



Question 2 A

Saturday, 7 March 2020 8:31 pm

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

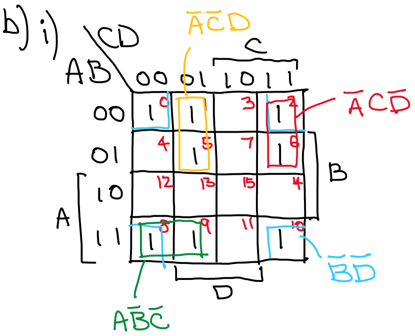
$$X\oplus Y + XY = X\bar{Y} + \bar{X}Y + XY$$
$$= X\bar{Y} + XY + XY + \bar{X}Y$$
$$= X(\bar{Y}+Y) + Y(X+\bar{X})$$
$$= X+Y$$

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

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

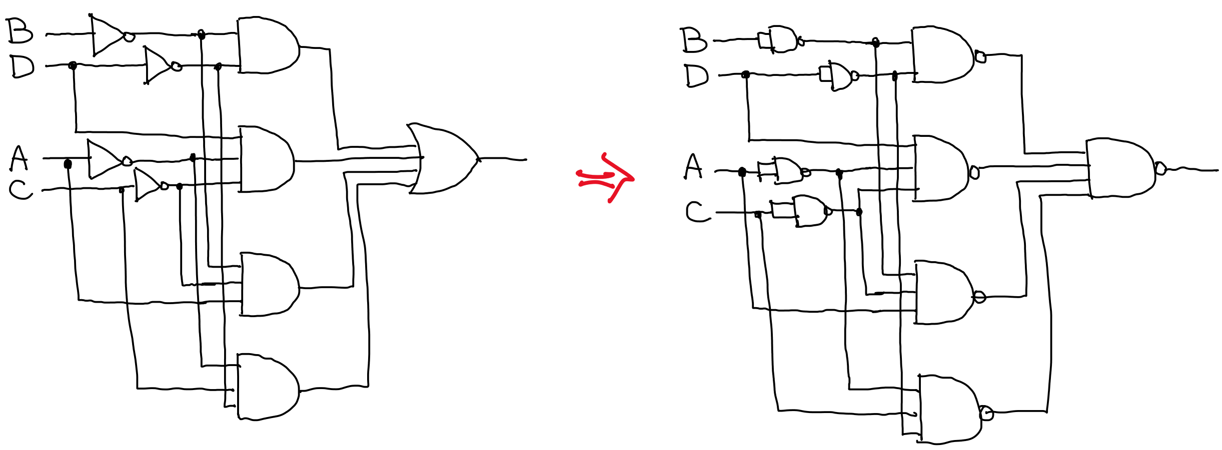
$\boxed{X+Y = X\oplus Y + XY}$

b) i)



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

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



c) i)

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

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

AB select

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

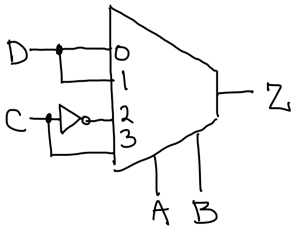
CD select

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

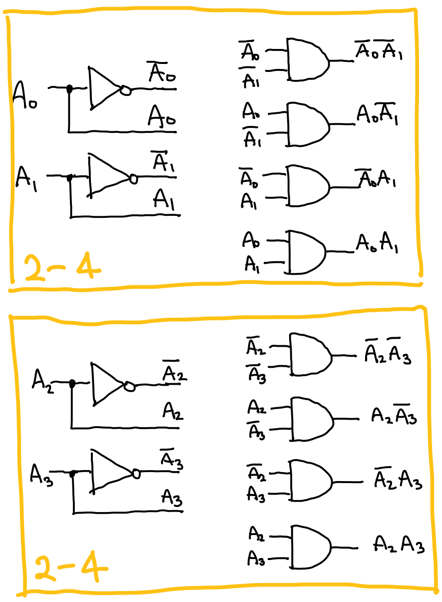
Note: Using CD as select would not give the simplest design.

ii) $Z = \Sigma m(1, 3, 5, 7, 10, 11, 12, 13)$

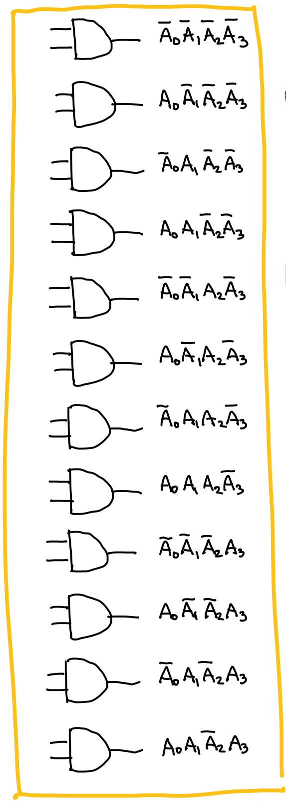
iii)



d) Not required!

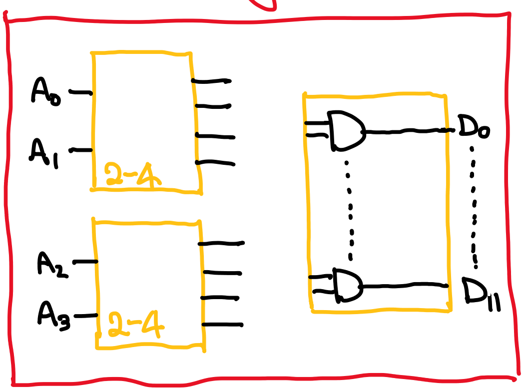


GIC = 4 + 4x2 + 4x2 + 12x2 = 44



12 AND gates

Block diagram



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.