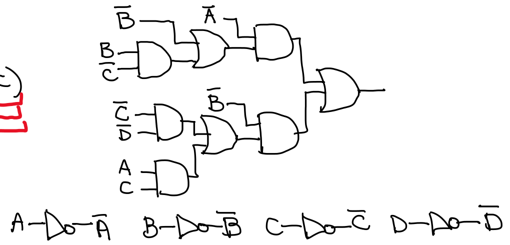
Question 1 C

Saturday, 7 March 2020   6:20 pm

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

GIC = 20

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



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	00	01	11	10
00	1 (0)	1 (1)	1 (3)	1 (2)
01	1 (4)	1 (5)	(7)	(6)
11	(12)	(13)	(15)	(14)
10	1 (8)	(9)	1 (11)	1 (10)

OR

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

$= \bar{A}\bar{B}+\bar{A}B\bar{C}+\bar{B}\bar{C}\bar{D}+A\bar{B}C$

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

$F=\sum m(0,1,2,3,4,5,8,10,11)$

iii)

A	B	C	D	F	m_i
0	0	0	0	1	m_0
0	0	0	1	1	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	1	m_5
0	1	1	0	0	m_6
0	1	1	1	0	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	0	m_{13}
1	1	1	0	0	m_{14}
1	1	1	1	0	m_{15}

iv)

AB \ CD	00	01	11	10
00	1 (0)	1 (1)	1 (3)	1 (2)
01	1 (4)	1 (5)	(7)	(6)
11	(12)	(13)	(15)	(14)
10	1 (8)	(9)	1 (11)	1 (10)

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

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

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

v)

AB \ CD	00	01	11	10
00	(0)	(1)	(3)	(2)
01	(4)	(5)	0 (7)	0 (6)
11	0 (12)	0 (13)	0 (15)	0 (14)
10	(8)	0 (9)	(11)	(10)

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

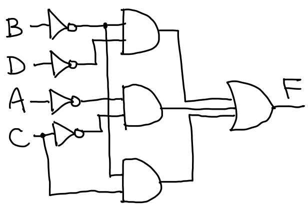
PI: $\bar{B}+\bar{C}$, $\bar{A}+\bar{B}$, $\bar{A}+C+\bar{D}$

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

vi) literals = 6
terms = 3
complements = 4
GIC = 13

Reduction of 7 GIC after optimisation

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



b) binary | hexadecimal | octal
110011100.101 | 19C.A | 634.5

Hex → Binary

8 4 2 1

$\underbrace{000}_{}\ \underbrace{1100 1}_{}\ \underbrace{1100}_{}.\underbrace{1010}_{}$ ← binary

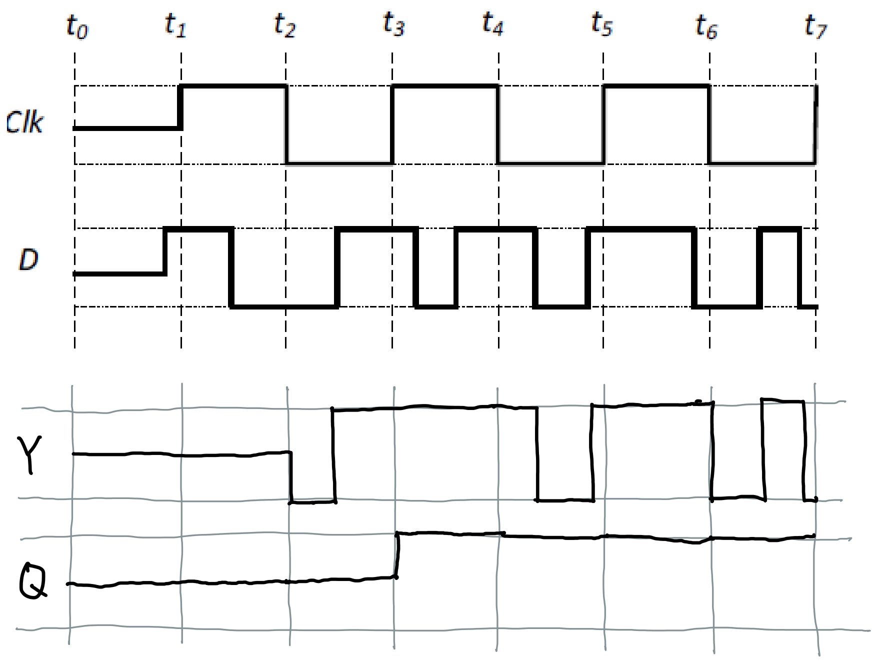
12 ≡ C, 10 ≡ A

1 9 C . A ← Hex

Binary → Octal

$\underbrace{110}_{6}\ \underbrace{011}_{3}\ \underbrace{100}_{4}.\underbrace{101}_{5}$ ← Octal

c) A – D latch
B – Positive edge triggered D flipflop



Question 2 C

Saturday, 7 March 2020 8:31 pm

a) i) $A+B = A\oplus B + AB$

$A\oplus B + AB = A\bar{B} + \bar{A}B + AB$

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

$= A(\bar{A}+B) + B(A+\bar{A})$

$= A+B$

ii)

$H(X,Y,Z) = X\bar{Y} + XY\bar{Z} + \bar{X}Y$

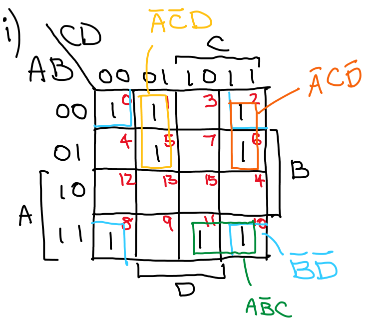
$= \underbrace{X\oplus Y}_{A} + \underbrace{XY\bar{Z}}_{B}$ $\boxed{A+B = A\oplus B + AB}$

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

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

$= X\oplus Y\oplus XY\bar{Z}$

b) i)



$G = \prod M(3,4,7,9,12,13,14,15)$

$= \sum m(0,1,2,5,6,8,10,11)$

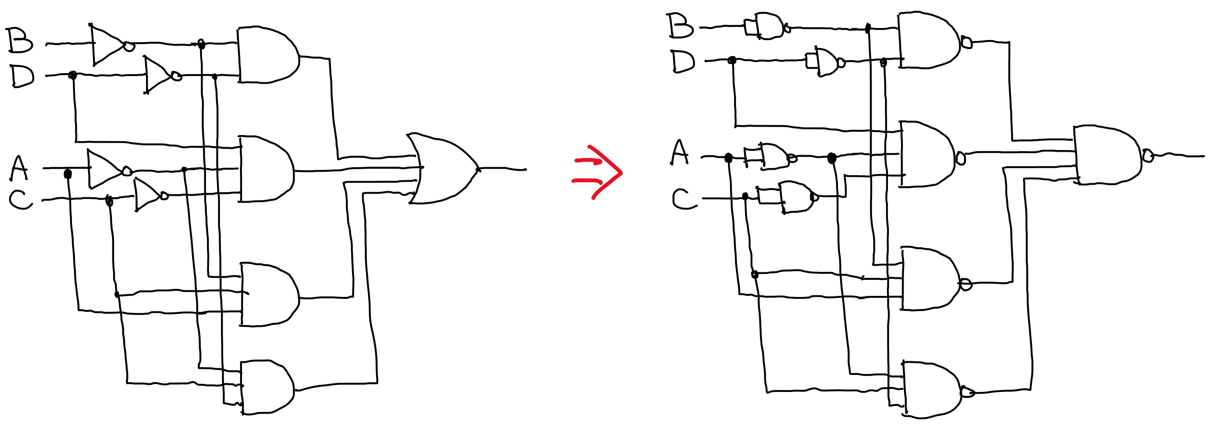
$= \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + A\bar{B}C\,D$

$+ A\bar{B}C\bar{D} + \bar{A}\bar{B}C\bar{D}$

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

$= \bar{B}\bar{D} + \bar{A}\bar{C}\bar{D} + A\bar{B}C + \bar{A}C\bar{D}$

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



c) i)

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

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

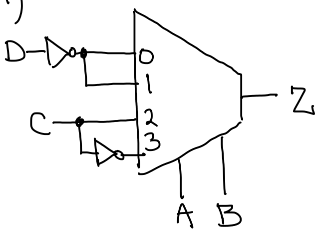
CD select

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

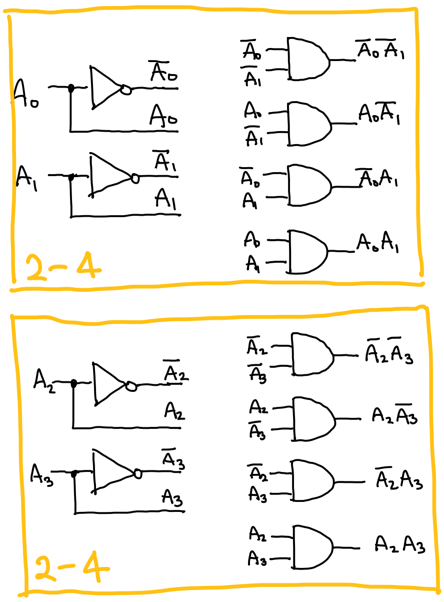
Note: Using CD as select would not give the simplest design.

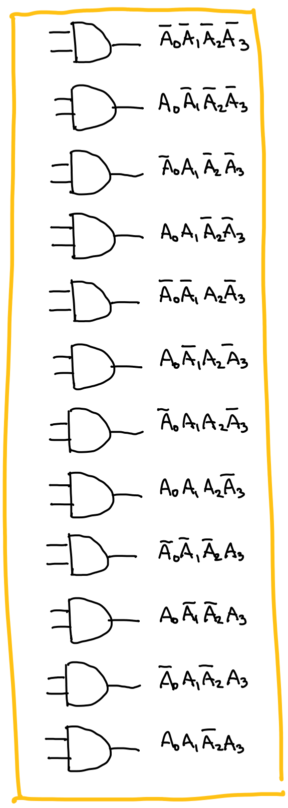
ii) $Z=\sum m(0,2,4,6,10,11,12,13)$

iii)



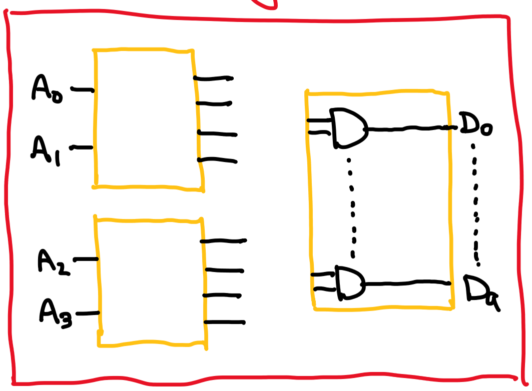
d) Not required!





10 AND gates

Block diagram



GIC = 4 + 4x2 + 4x2 + 10x2 = 40

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.