Question 1 D

Saturday, 7 March 2020 6:20 pm

a) i)

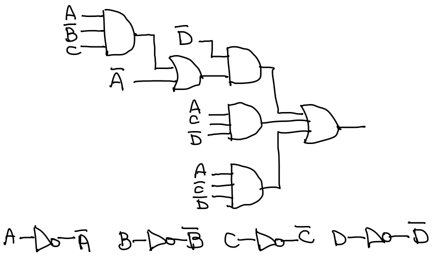
Literals = 11

Terms = 5

Complements = 4

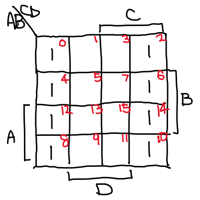
GIC = 20

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



Students may draw logic diagram to determine GIC

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



$F = \Sigma m(0,2,4,6,8,10,12,14)$

OR

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

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

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

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

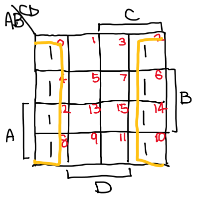
$= \bar{D}(A\bar{B}C+1)$

$= \bar{D}$

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	0	m_5
0	1	1	0	1	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	0	m_{11}
1	1	0	0	1	m_{12}
1	1	0	1	0	m_{13}
1	1	1	0	1	m_{14}
1	1	1	1	0	m_{15}

iv)

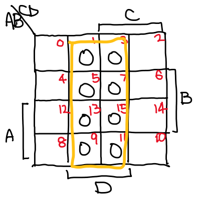


$F = \bar{D}$ ← SOP

$PI : \bar{D}$

$EPI : \bar{D}$

v)



$F = \bar{D}$ ← POS

$PI : \bar{D}$

$EPI : \bar{D}$

vi) literals = 1

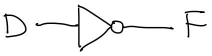
terms = 0

complements = 1

GIC = 2

Reduction of 18 GIC after optimisation

vii)



b)

binary	hexadecimal	octal
110011100.101	19C.A	634.5

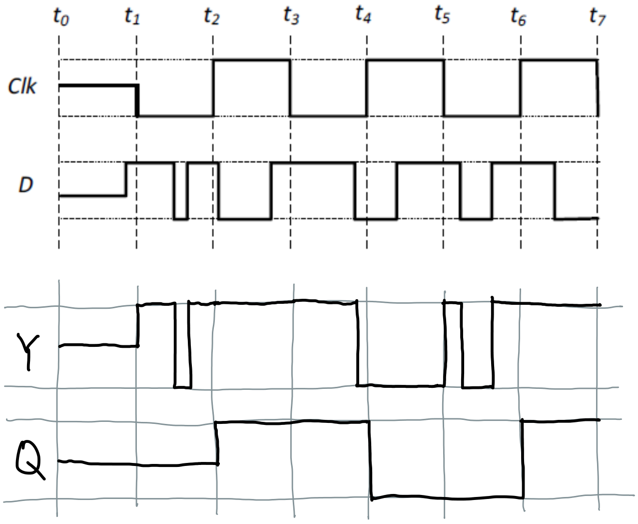
Octal → binary

$\underbrace{110}_{6}\underbrace{011}_{3}\underbrace{100}_{4}\cdot\underbrace{101}_{5}$ ← octal

$\underbrace{0001}_{1}\,\underbrace{1001}_{9}\,\underbrace{1100}_{\substack{12\\ \equiv\\ C}}\cdot\underbrace{1010}_{\substack{10\\ \equiv\\ A}}$ ← Hex

c) A - D latch

B - Positive edge-triggered D flip-flops



Question 2 D

Saturday, 7 March 2020 8:31 pm

a) i)

$A+B= A\oplus B + AB$

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

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

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

$= A+B$

ii)

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

$= \underbrace{X\oplus Y}_{A} + \underbrace{XY\overline{Z}}_{B}$

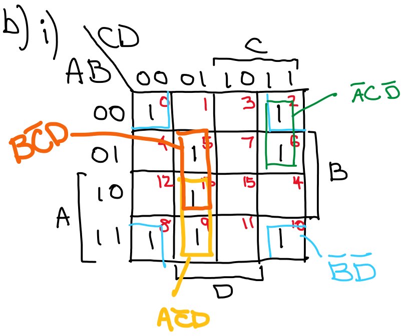
$\boxed{A+B = A\oplus B + AB}$

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

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

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

b) i)



$G = \prod M(1,3,4,7,11,12,14,15)$

$= \sum m(0,2,5,6,8,9,10,13)$

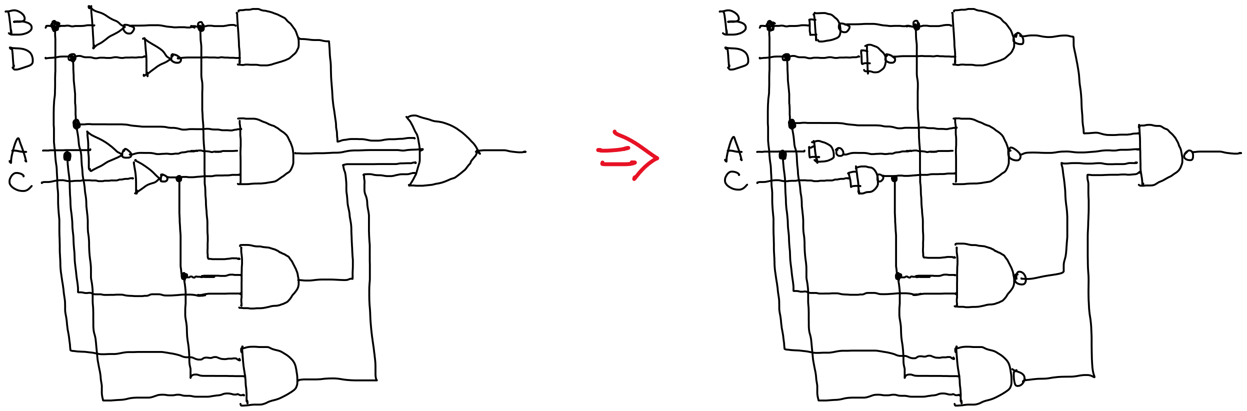
$= \underbrace{\overline{A}\overline{B}\overline{C}\overline{D}} + \underbrace{\overline{A}\overline{B}C\overline{D}} + \underbrace{\overline{A}B\overline{C}D} + \underbrace{\overline{A}BC\overline{D}} + \underbrace{A\overline{B}\overline{C}\overline{D}} + \underbrace{A\overline{B}\overline{C}D} + \underbrace{A\overline{B}C\overline{D}} + \underbrace{AB\overline{C}D}$

$+ \overline{A}\overline{B}C\overline{D} + AB\overline{C}D$

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

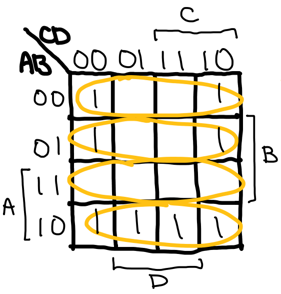
$= \overline{B}\overline{D} + B\overline{C}D + \overline{A}C\overline{D} + A\overline{C}D$

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



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	1	$Z = 1$
1	0	0	1	1	
1	0	1	0	1	
1	0	1	1	1	
1	1	0	0	0	$Z = 0$
1	1	0	1	0	
1	1	1	0	0	
1	1	1	1	0	



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

AB select

$I_0 = \bar{D}$
$I_1 = \bar{D}$
$I_3 = 0$
$I_2 = 1$

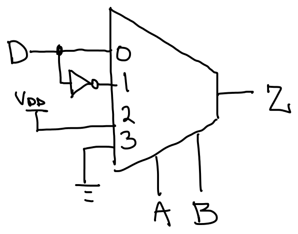
CD select

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

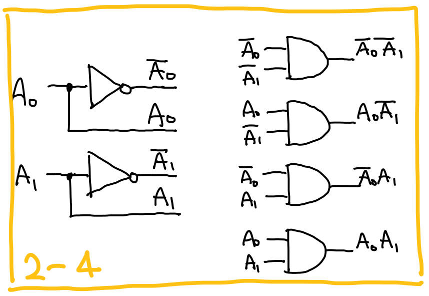
Note: Using CD as select would not give the simplest design.

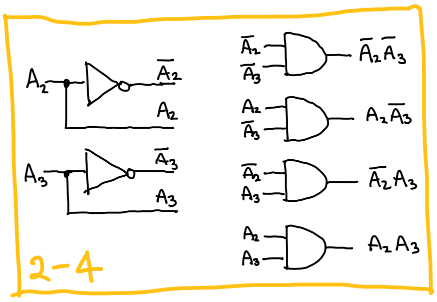
ii) $Z = \Sigma m(0, 2, 4, 6, 8, 9, 10, 11)$

iii)

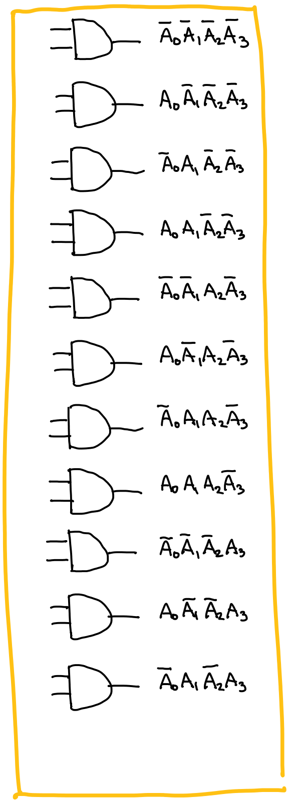


d) Not required!



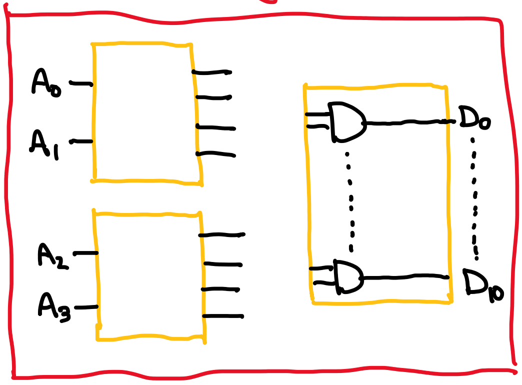


GIC = 4 + 4×2 + 4×2
+ 11×2
= 42



11 AND gates

Block diagram



Refer to Week3 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.