

EE2000 Assignment 1

Question 1

Simplify the following logic function $Z = (A + \bar{B} + \bar{C})(A + \bar{B}C)$ with Boolean algebra.

Question 2

Find the POS form for logic function $f(a,b,c,d) = \sum m(0,1,2,5,8,9) + \sum dc(4,11,12)$. Implement the circuit with NAND gate only.

Question 3

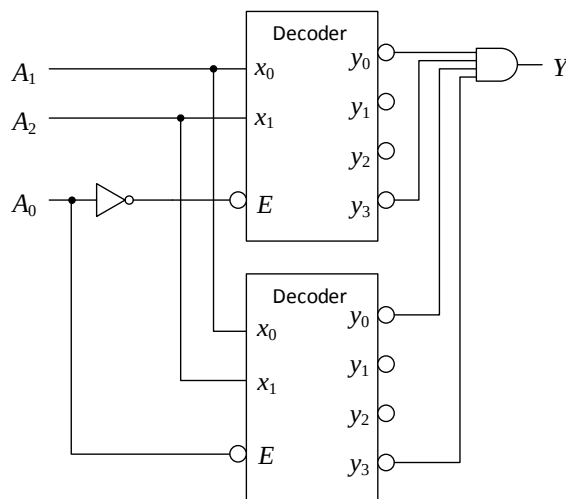
Use Q-M method to minimize function $F : F(A, B, C, D) = \sum m(0,1,2,3,5,7,8,10,12,13,15)$.

Question 4

Use 74LS138 to design the circuit for $f(a,b,c) = a'b + ab' + ac$.

Question 5

Determine the logic function of the following circuit: $F(A_2, A_1, A_0)$

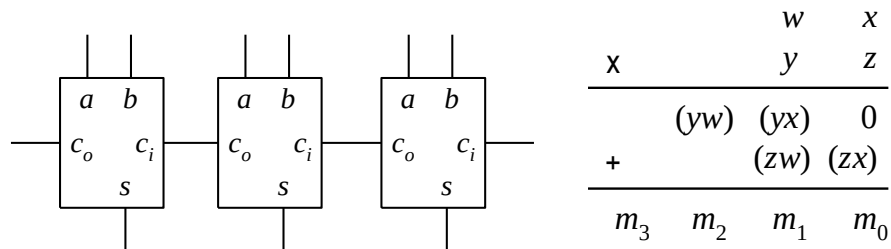


Question 6

Given a logic function $f(a,b,c,d) = \sum m(0,1,2,3,6,7,8,9,14,15)$. Design the circuit using (i) 74LS138 3-to-8 decoder(s), (ii) 74LS153 (MUXs), and (iii) 74LS158 (MUXs).

Question 7

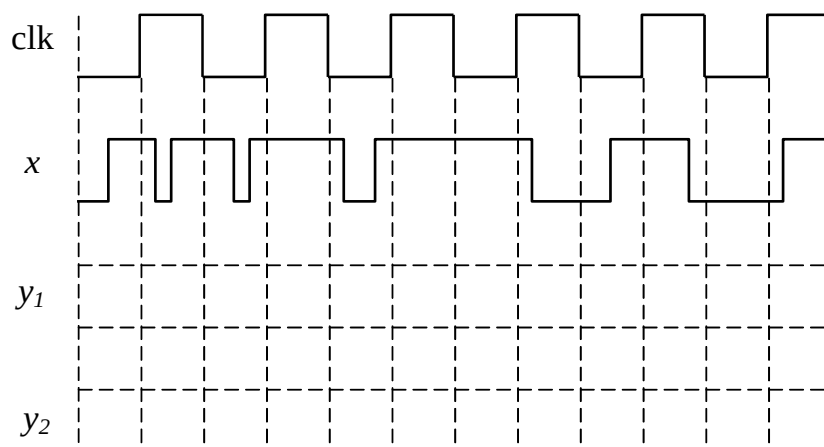
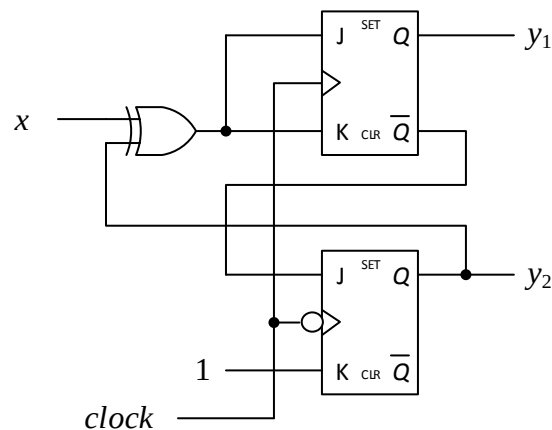
A 3-bit full-adder circuit shown below is used to multiply two 2-bit numbers. The computation of the product is as follow:



Determine the logic functions for all inputs and outputs. Draw the circuit based on the above adder circuit.

Question 8

Draw the timing diagram of the following circuit. Assuming that the initial conditions for $y_1 y_2$ are “00” and both SET and CLR are tied to LOW. Draw the output for y_1 and y_2 .



Answers

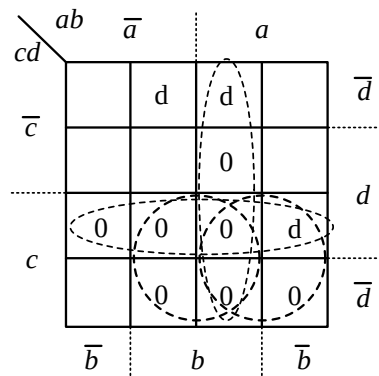
Q1.

$$\begin{aligned}
 Z &= (A + \bar{B} + \bar{C})(A + \bar{B}C) \\
 &= AA + A\bar{B}C + A\bar{B} + \bar{B}\bar{B}C + A\bar{C} + \bar{B}C\bar{C} \\
 &= A(1 + \bar{B}C + \bar{B} + \bar{C}) + \bar{B}C \\
 &= A + \bar{B}C
 \end{aligned}$$

[6 marks]

Q2.

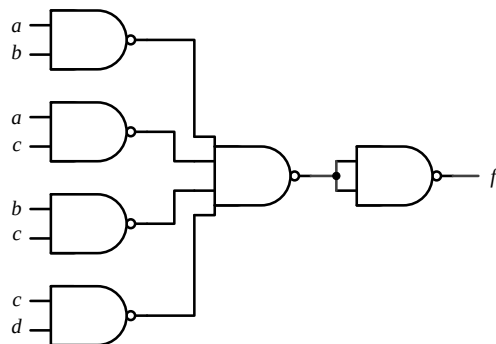
$$f(a,b,c,d) = \prod M(3,6,7,10,13,14,15) + \sum dc(4,11,12)$$



[4 marks]

$$\begin{aligned}
 f(a,b,c,d) &= (\bar{a} + \bar{b})(\bar{c} + \bar{d})(\bar{a} + \bar{c})(\bar{b} + \bar{c}) \\
 &= \bar{a}\bar{b} \cdot \bar{a}\bar{c} \cdot \bar{b}\bar{c} \cdot \bar{c}\bar{d} \\
 &= \overline{\overline{\bar{a}\bar{b} \cdot \bar{a}\bar{c} \cdot \bar{b}\bar{c} \cdot \bar{c}\bar{d}}} \\
 &= \overline{ab \cdot ac \cdot bc \cdot cd}
 \end{aligned}$$

[4 marks]



[2 marks]

Q3.

First List	Second List	Third List
A B C D	A B C D	A B C D $\bar{A} \bar{B}$
<u>0 0 0 0 0 ✓</u>	0,1 0 0 0 ✓	0,1 2 3 0 0 - - $\bar{A} \bar{B}$
1 0 0 0 1 ✓	0,2 0 0 - 0 ✓	0,2 1 3 0 0 - -
2 0 0 1 0 ✓	<u>0,8 - 0 0 0 ✓</u>	0,2,8,10 - 0 - 0 $\bar{B} \bar{D}$
<u>8 1 0 0 0 ✓</u>	1,3 0 0 - 1 ✓	<u>0,8,2,10 - 0 - 0</u>
3 0 0 1 1 ✓	1,5 0 - 0 1 ✓	1,3,5,7 0 - - 1 $\bar{A} \bar{D}$
5 0 1 0 1 ✓	2,3 0 0 1 - ✓	<u>1,5,3,7 0 - - 1</u>
10 1 0 1 0 ✓	2,10 - 0 1 0 ✓	5,7,13,15 - 1 - 1 B D
<u>12 1 1 0 0 ✓</u>	8,10 1 0 - 0 ✓	<u>5,13,7,15 - 1 - 1</u>
7 0 1 1 1 ✓	<u>8,12 1 - 0 0 A $\bar{C} \bar{D}$</u>	
<u>13 1 1 1 1 ✓</u>	3,7 0 - 1 1 ✓	
<u>15 1 1 1 1 ✓</u>	5,7 0 1 - 1 ✓	
	5,13 - 1 0 1 ✓	
	<u>12,13 1 1 0 - A B $\bar{C}$</u>	
	7,15 - 1 1 1 ✓	
	<u>13,15 1 1 - 1 ✓</u>	

[5 marks]

PI chart:

PI	Numeric	0	1	2	3	5	7	8	10	12	13	15
$A'B'$	00--	X	X	X	X							
$B'D'$	-0-0	X		X				X	X			
$A'D$	0--1		X		X	X	X					
$-B-D$	-1-1					X	X				X	X
$AC'D'$	1-00							X		X		
ABC'	110-									X	X	

Essential PI = $\bar{B}\bar{D} + BD$

[5 marks]

Reduced PI chart

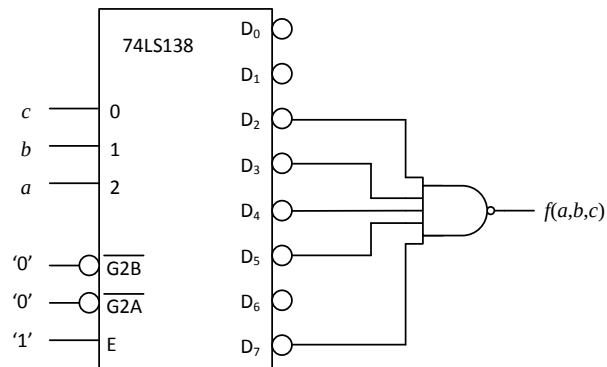
PI	Numeric	1	3	12
$A'B'$	00--	X	X	
$A'D$	0--1	X	X	
$AC'D'$	1-00			X
ABC'	110-			X

[2 marks]

Many choices, $Z = \bar{B}\bar{D} + BD + \begin{cases} \bar{A}\bar{B} + A\bar{C}\bar{D} \\ \bar{A}\bar{D} + A\bar{C}\bar{D} \\ \bar{A}\bar{B} + AB\bar{C} \\ \bar{A}\bar{D} + AB\bar{C} \end{cases}$

[4 marks]

Q4 $f(a,b,c) = a'b + ab' + ac = a'bc' + a'bc + ab'c' + ab'c + abc' + abc$
 $= \sum m(2,3,4,5,7) = \overline{\overline{D_2} + \overline{D_3} + \overline{D_4} + \overline{D_5} + \overline{D_7}} = \overline{\overline{D_2} \cdot \overline{D_3} \cdot \overline{D_4} \cdot \overline{D_5} \cdot \overline{D_7}}$

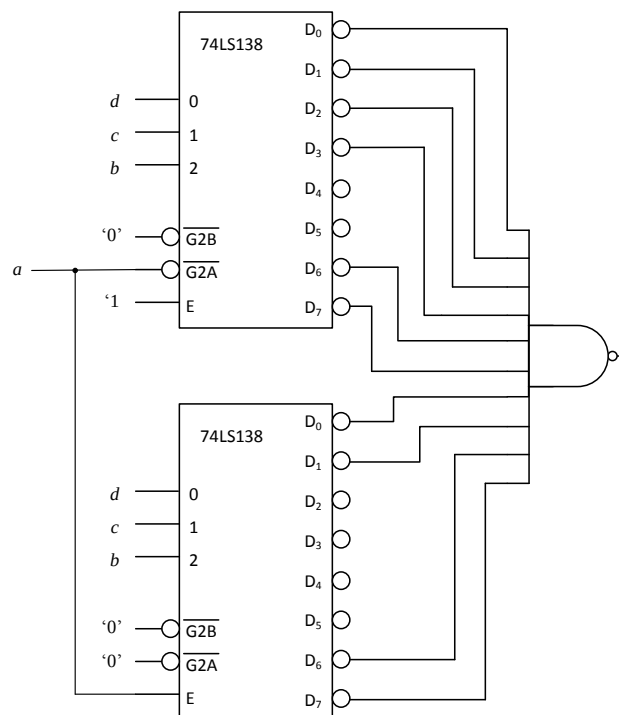


[6 marks]

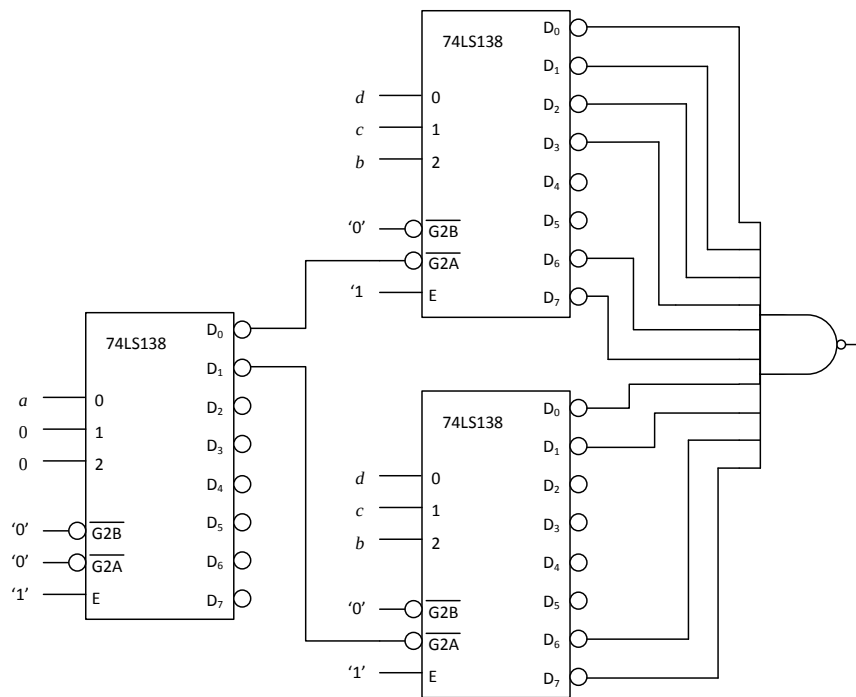
Q5. $(A_2'A_1'A_0)' \cdot (A_2A_1A_0)' \cdot (A_2'A_1'A_0')' \cdot (A_2A_1A_0')'$
 $= [(A_2'A_1'A_0) + (A_2A_1A_0) + (A_2'A_1'A_0') + (A_2A_1A_0')]'$
 $= [(A_2'A_1') + (A_2A_1)]'$
 $= A_1 \oplus A_2$

[6 marks]

Q6. (i)



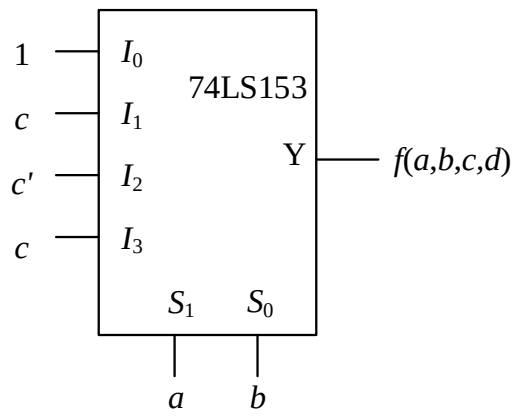
OR



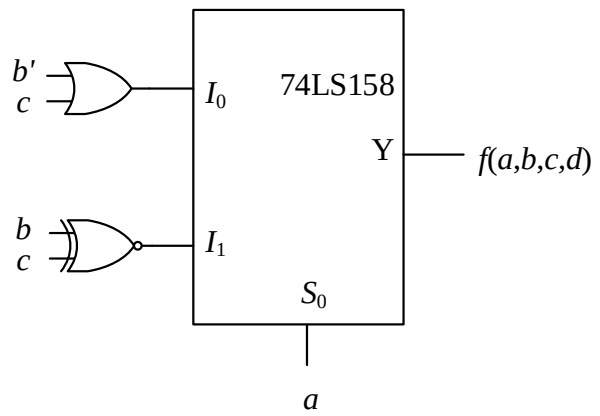
[6 marks]

(ii) & (iii) 74LS158: 2-to-1 MUX, 74LS153 : 4-to-1 MUX

$abcd$	F	Use 74LS 158 : $S_0=a$	Use 74LS 153 : $S_1=a, S_0=b$
0000	1		$I_0 = 1$
0001	1		
0010	1		
0011	1		
0100	0		
0101	0	$I_0 = b' + c$	$I_1 = c$
0110	1		
0111	1		
1000	1		
1001	1		
1010	0	$I_1 = (b \oplus c)'$	$I_2 = c'$
1011	0		
1100	0		
1101	0		
1110	1		
1111	1		$I_3 = c$

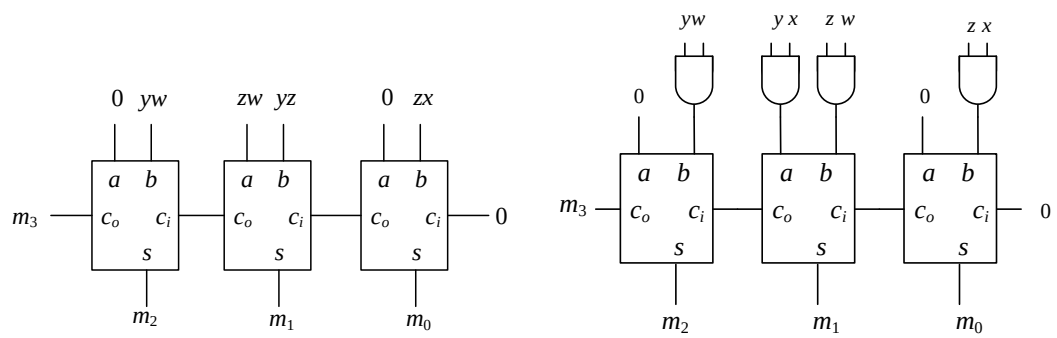


[6 marks]



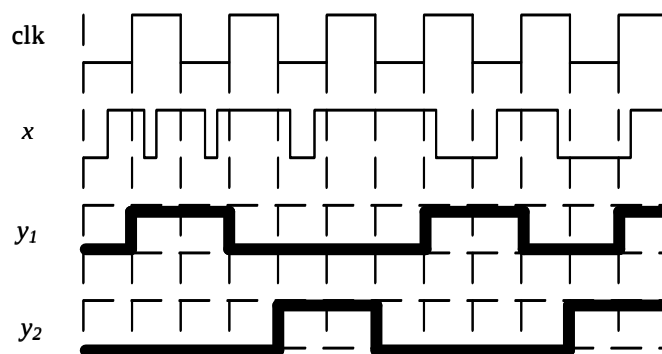
[8 marks]

Q7.



[8 marks]

Q8.



[8 marks]