Solution

ELEC 2607 ('17)

Assignment 2

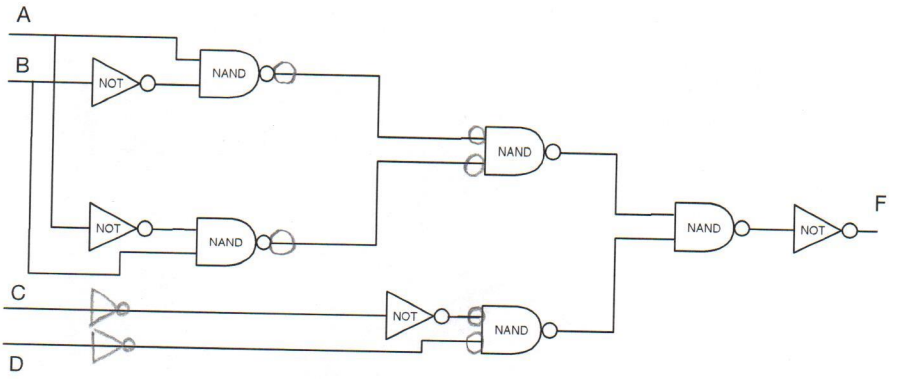
15 Marks

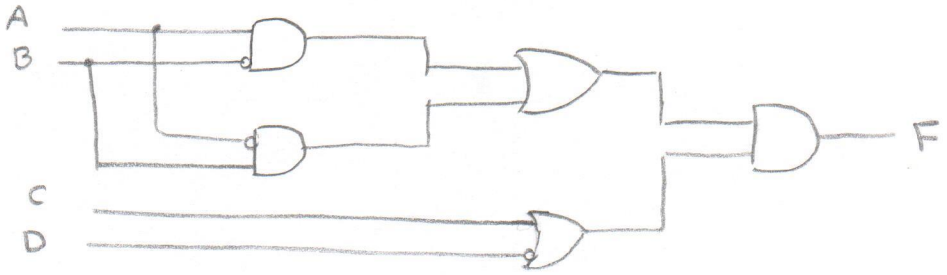
1. Prove or disprove that the function $Z = ab + c(a + b)$ is self-dual. Note that self-dual functions satisfy the property $\overline{f(a, b, c)} = f(\bar{a}, \bar{b}, \bar{c})$. 2 marks

$\bar{Z} = \overline{[ab] + [c(a+b)]} = [\bar{a}+\bar{b}] \cdot [\bar{c} + (\bar{a}\bar{b})] = \bar{a}\bar{c} + \bar{c}\bar{b} + \bar{a}\bar{b} + \bar{a}\bar{b}$

$= \bar{a}\bar{b} + \bar{c}(\bar{a}+\bar{b}) \Rightarrow$ it is self dual

2. Convert the following NAND-NOR circuit to an AND-OR circuit (bubbles i.e. inverters allowed). 3 marks





3. Perform the following conversions by showing your work. 4 marks

(a) $(11001.001)_2 = (?)_{10}$ (1/2)

$= 1\times2^4 + 1\times2^3 + 1 + 1\times2^{-3} = 16 + 8 + 1 + 1/8 = (25.125)_{10}$

(b) $(1001110.11)_2 = (?)_8$ (1/2)

$= 001\ 001\ 110.110 = (116.6)_8$

(c) $(1001110.11)_2 = (?)_{16}$ (1/2)

$= 0100\ 1110.1100 = (4E.C)_{16}$

(d) AE72.B = $(?)_2$ (1/2)

$= 1010\ 1110\ 0111\ 0010.1011$

(e) $(125.86)_{10} = (?)_2$ upto 3 fractional digits (1 1/2)

$= (1111101.110)_2$

125	R
62	1
31	0
15	1
7	1
3	1
1	1
0	1

0.86	1.72
0.72	1.44
0.44	0.88

(f) 9F82.E = $(?)_{10}$

$= 9\times16^{3} + 15\times16^{2} + 8\times16 + 2 + 14\times16^{-1} = (40834.875)_{10}$

4. Let $A = 10101101$, $B = 01100110$ be two numbers encoded using the 2's complement system with 8 bits. Perform the following operations and indicate if there is an overflow. 2 marks

(a) $A+B$

$$\begin{array}{r} \overset{1}{1}\ \overset{1}{0}\ 1\ \overset{1}{0}\ 1\ 1\ 0\ 1 \\ +\ 0\ 1\ 1\ 0\ 0\ 1\ 1\ 0 \\ \hline 1\ 0\ 0\ 0\ 1\ 0\ 0\ 1\ 1 \end{array}$$

discard ← 1 00010011 = 19 ✓

$A = -(01010011) = -83$

$B = 01100110 = 102$

no overflow

(b) $A-B$

$-B = 10011010$

$A-B = A+(-B)$

$$\begin{array}{r} \overset{1}{1}\ \overset{1}{0}\ \overset{1}{1}\ 0\ 1\ 1\ 0\ 1 \\ +\ 1\ 0\ 0\ 1\ 1\ 0\ 1\ 0 \\ \hline 1\ 0\ 1\ 0\ 0\ 0\ 1\ 1\ 1 \end{array}$$

Answer is not valid because of overflow

↳ since sign bit is different than sign of the operands, there is overflow

(c) $B-A$

$-A = 01010011$

$B-A = B+(-A)$

$$\begin{array}{r} 0\ 1\ 1\ 0\ 0\ 1\ 1\ 0 \\ +\ 0\ 1\ 0\ 1\ 0\ 0\ 1\ 1 \\ \hline 1\ 0\ 1\ 1\ 1\ 0\ 0\ 1 \end{array}$$

Answer is not valid because of overflow. An extra bit is needed.

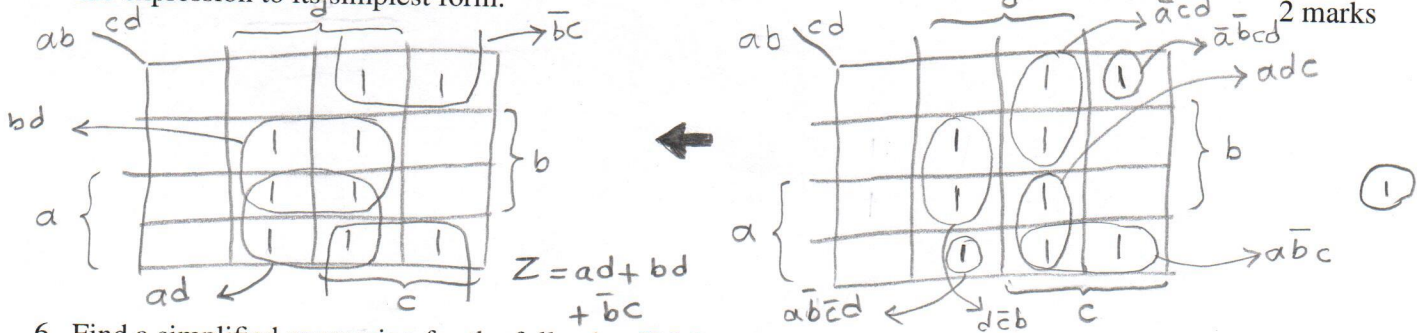
(d) $-A-B = -A+(-B)$

$$\begin{array}{r} 0\ 1\ 0\ 1\ 0\ 0\ 1\ 1 \\ +\ 1\ 0\ 0\ 1\ 1\ 0\ 1\ 0 \\ \hline 1\ 1\ 1\ 0\ 1\ 1\ 0\ 1 \end{array}$$

$\begin{array}{r} 83 \\ -102 \\ \hline -19 \end{array}$ ✓

no overflow. overflow cannot happen if operands have different signs.

5. Draw the K-Map for the expression $Z = a\bar{b}c + d\bar{c}b + adc + \bar{a}cd + a\bar{b}\bar{c}d + \bar{a}\bar{b}cd$. Using the K-Map reduce the expression to its simplest form. 2 marks



6. Find a simplified expression for the following K-Map. 2 mark

$Z = bd + \bar{b}\bar{d}$

$= \overline{b \oplus d}$