Ass 2 – Solutions

1. Let $f(a,b,c) = ab + c(a+b) = z$

$$\overline{f(a,b,c)} = \overline{ab + c(a+b)} = (\bar{a}+\bar{b})\cdot\{\bar{c} + \bar{a}\bar{b}\}$$

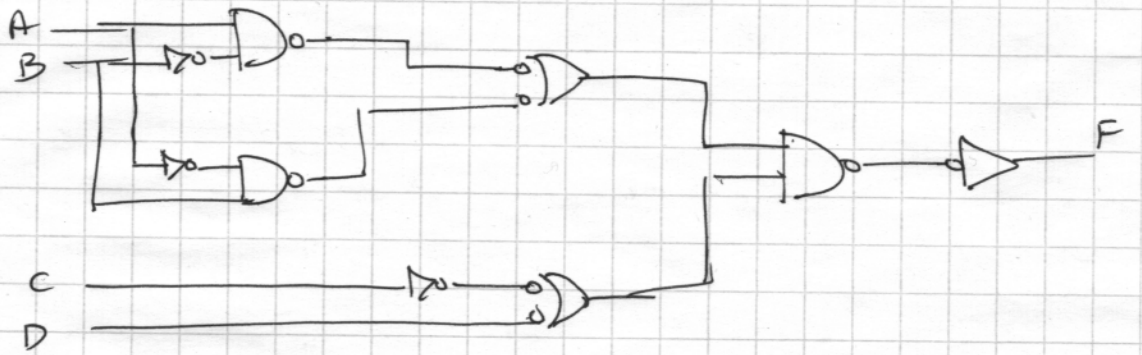
$$= \bar{a}\bar{c} + \bar{a}\bar{b} + \bar{b}\bar{c} = \bar{a}\bar{b} + \bar{c}(\bar{a}+\bar{b})$$

$$= f(\bar{a},\bar{b},\bar{c})$$

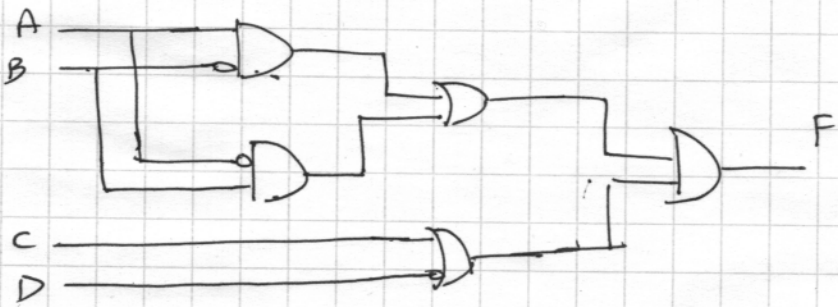
$\therefore$ z satisfies $\overline{f(a,b,c)} = f(\bar{a},\bar{b},\bar{c})$

$\Rightarrow$ z is a self-dual function.

2. Selecting the second and fourth layer and changing the ~~nand~~ gates to unconventional ones, we have



which can be redrawn as



1. $z = ab + c(a+b)$

$z(\bar{a}, \bar{b}, \bar{c}) = \bar{a}\bar{b} + \bar{c}(\bar{a}+\bar{b})$

$\bar{z} = \overline{ab + c(a+b)}$

$= (\overline{ab})(\bar{c} + \overline{(a+b)})$ $\quad \overline{A+B} = \bar{A}\bar{B}$, $\overline{A+B} = \overline{AB}$

$= (\bar{a}+\bar{b})(\bar{c} + \bar{a}\bar{b})$

$= \bar{a}\bar{c} + \bar{a}\bar{a}\bar{b} + \bar{b}\bar{c} + \bar{a}\bar{b}\bar{b} = \bar{a}\bar{b} + \bar{c}(\bar{a}+\bar{b})$

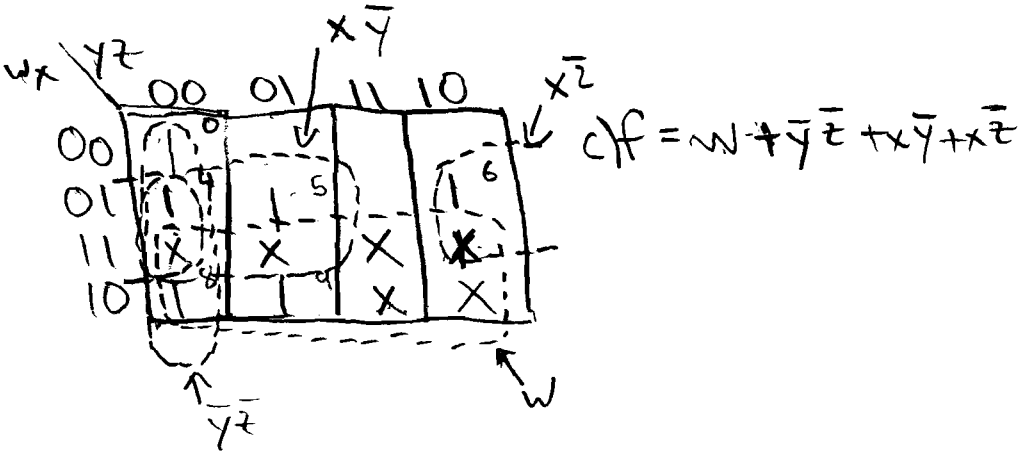
$\overline{z(a,b,c)} = z(\bar{a}, \bar{b}, \bar{c})$

3. 7 seg display

f | _ |
  | | |
  | _ |

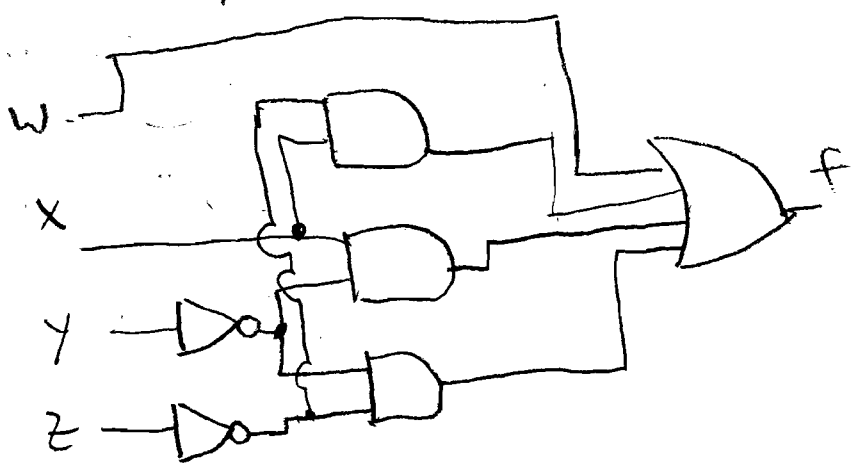
a) f = 0, 4, 5, 6, 8, 9

b)



$f = w + \bar{y}\bar{z} + x\bar{y} + x\bar{z}$

3d) $f = w + \bar{y}\bar{z} + x\bar{y} + x\bar{z}$



4.

8b 2's compliment range $= -2^{n-1}$ to $2^{n-1} - 1$
$= -128$ to $+127$

a) A+B
$$\begin{array}{r} 11100100 \quad (-28) \\ +\ 11000110 \quad (-58) \\ \hline 10101010 \quad (-86) \end{array}$$
↑ no overflow

b) B+(-A)

A = 11100100
-A = 00011100

$$\begin{array}{r} 11000110 \quad (-58) \\ +\ 00011100 \quad (+28) \\ \hline 11100010 \quad (-30) \end{array}$$
no overflow

c) -A + (-B)

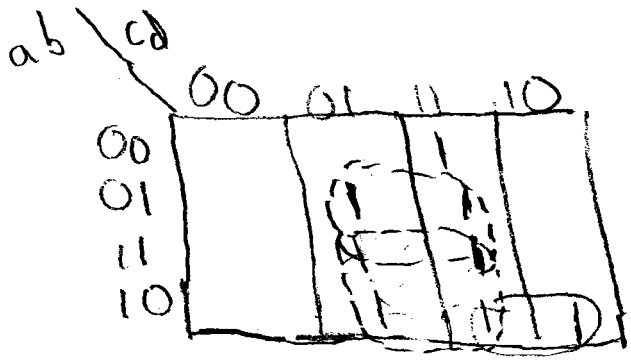
-A = 00011100
-B = 11000110
-B = 00111010

$$\begin{array}{r} 00011100 \quad (+28) \\ +\ 00111010 \quad (+58) \\ \hline 01010110 \quad (+86) \end{array}$$
no overflow

5. $a\bar{b}c + b\bar{c}d + acd + \bar{a}cd + a\bar{b}\bar{c}d$

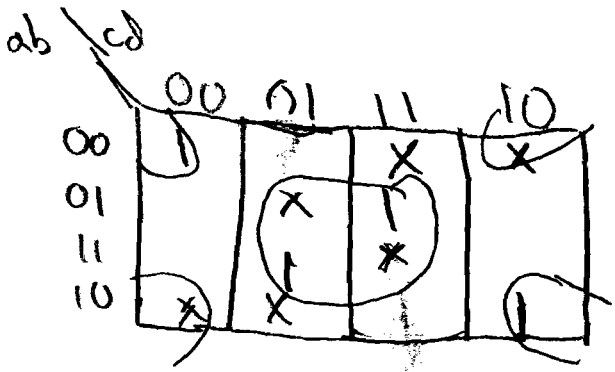
1010 0101 1011 0011 1001

1101 1111 0111



$F = ad + b\bar{d} + cd + a\bar{b}c$

6.



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