1) $\overline{\bar{A}C + B(A+\bar{C})} = \bar{Z}$, if $\overline{f(a,b,c)} = f(\bar{a},\bar{b},\bar{c})$

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

$= (\bar{A}+\bar{C}) \cdot \left(\bar{B} + \overline{(A+\bar{C})}\right)$

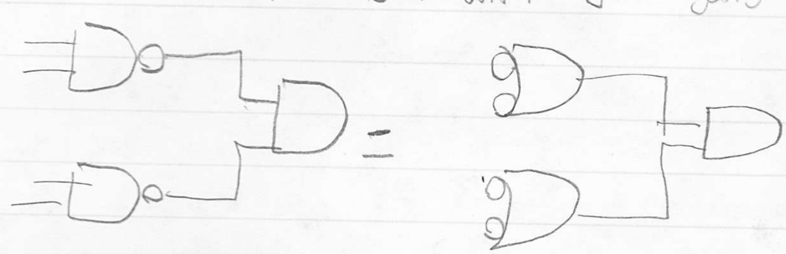
$= (\bar{A}+\bar{C}) \cdot \left(\bar{B} + (\bar{A} \cdot C)\right) \rightarrow \bar{A}\bar{B} + \bar{A}\bar{A}C + \bar{B}\bar{C} + \cancel{\bar{C}\bar{A}C}$ 0

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

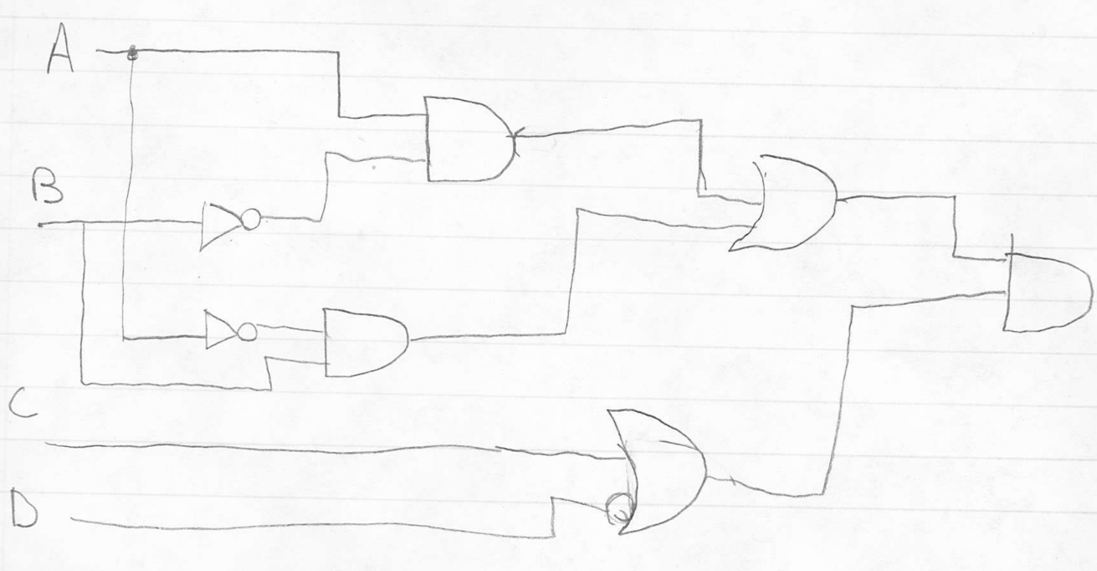
$\therefore \overline{f(a,b,c)} \neq f(\bar{a},\bar{b},\bar{c})$ $\therefore$ Z is not a self dual

2) Step 1) Convert Nand with invert to AND

Step 2) convert NAND to OR with Demorgan's law



Step 3) Take inverters and cancel each other finally we have:



$A_1 \; A_0 \; A_3 \; A_2$

$A_2 \; A_3 . \; A_0 \; A_1$

3.

a) Karnaugh maps

A)

A_0A_1 \ A_2A_3	00	01	11	10
00	1	0	1	1
01	0	1	1	1
11	X	X	X	X
10	1	1	X	X

$\boxed{A_0 + A_1A_3 + A_2 + \bar{A}_1\bar{A}_3}$

B)

A_0A_1 \ A_2A_3	00	01	11	10
00	1	1	1	1
01	1	0	1	0
11	X	X	X	X
10	1	1	X	X

$\Rightarrow \boxed{\bar{A}_1 + \bar{A}_2\bar{A}_3 + A_2A_3}$

C)

A_0A_1 \ A_2A_3	00	01	11	10
00	1	1	1	0
01	1	1	1	1
11	X	X	X	X
10	1	1	X	X

$\boxed{A_1 + \bar{A}_2 + A_3}$

D)

A_0A_1 \ A_2A_3	00	01	11	10
00	1	0	1	1
01	0	1	0	1
11	X	X	X	X
10	1	1	X	X

$\boxed{\bar{A}_1\bar{A}_3 + \bar{A}_1A_2 + A_2\bar{A}_3 + A_1\bar{A}_2A_3 + A_0}$

E)

A_0A_1 \ A_2A_3	00	01	11	10
00	1	0	0	1
01	0	0	0	1
11	X	X	X	X
10	1	0	X	X

$\boxed{\bar{A}_1\bar{A}_3 + A_2\bar{A}_3}$

F)

A_0A_1 \ A_2A_3	00	01	11	10
00	1	0	0	0
01	1	1	0	1
11	X	X	X	X
10	1	1	X	X

$\boxed{\bar{A}_2\bar{A}_3 + A_1\bar{A}_2 + A_1\bar{A}_3 + A_0}$

G)

A_0A_1 \ A_2A_3	00	01	11	10
00	0	0	1	1
01	1	1	0	1
11	X	X	X	X
10	1	1	X	X

$\boxed{\bar{A}_1A_2 + A_2\bar{A}_3 + A_1\bar{A}_2 + A_0}$

Sum of Products where 4 input $A_0A_1A_2A_3$

$A = A_0 + A_1A_3 + A_2 + \bar{A}_1\bar{A}_3$

$B = \bar{A}_1 + \bar{A}_2\bar{A}_3 + A_2A_3$

$C = A_1 + \bar{A}_2 + A_3$

$D = \bar{A}_1\bar{A}_3 + \bar{A}_1A_2 + A_2\bar{A}_3 + A_1\bar{A}_2A_3 + A_0$

$E = \bar{A}_1\bar{A}_3 + A_2\bar{A}_3$

$F = \bar{A}_2\bar{A}_3 + A_1\bar{A}_2 + A_1\bar{A}_3 + A_0$

$G = \bar{A}_1A_2 + A_2\bar{A}_3 + A_1\bar{A}_2 + A_0$

4)

a) $-2^{(n-1)}$ to $2^{(n-1)}-1$

So: -128 to 127

b) A = 11111 00100 B = 001000110] With sign extesion

-A = 000011100 -B = 110111010

b) A+B

```
  11   1
  111100100
+ 001000110
-----------
~~1~~ 000101010
```

∴ because first 2 digits are the same no overflow.

c) B-A

B+(-A)

```
    111
  001000110
+ 000011100
-----------
  001100000
```

∴ no overflow

d) -A+-B

```
    111
  000011100
  110111010
-----------
  111010110
```

∴ no overflow.

5)

ab \ cd	00	01	11	10
00	1	0	1	1
01	0	0	0	0
11	0	0	1	1
10	1	0	0	1

6)

ab \ cd	00	01	11	10
00	0	0	X	0
01	1	1	1	1
11	0	X	0	X
10	X	0	0	1

$= \bar{a}b + aD\bar{c}$