ICF.

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Assignment # 2.

Question 1

a) $\Sigma\Pi = (\bar{A}\bar{B}\bar{C}\bar{D}) + (\bar{A}\bar{B}\bar{C}D) + (\bar{A}\bar{B}C\bar{D}) + (\bar{A}B\bar{C}D) + (A\bar{B}\bar{C}\bar{D}) + (A\bar{B}\bar{C}D) + (A\bar{B}C\bar{D}) +$
$(AB\bar{C}D)$

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

b)

X AB \ CD	00	01	11	10
00	1	1	0	1
01	0	1	0	0
11	0	1	0	0
10	1	1	0	1

$$\boxed{\Sigma\Pi = (\bar{B}\bar{D}) + (\bar{C}D)}$$

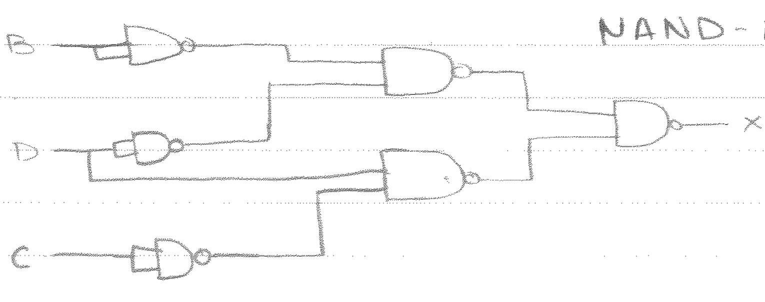
$$\boxed{\Pi\Sigma = (\bar{B}+D)\cdot(\bar{C}+\bar{D})}$$

d) $\Sigma\Pi : x = (\bar{B}\bar{D}) + (\bar{C}D)$

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

$$\boxed{x = \overline{\overline{(\bar{B}\bar{D})}\cdot\overline{(\bar{C}D)}}}$$

NAND-NAND implementation:



e) let $\Sigma\Pi = x$

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

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

$$\bar{x} = \overline{(\bar{B}\bar{D})} \cdot \overline{(\bar{C}D)}$$

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

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

$$\bar{x} = BC + B\bar{D} + DC + D\bar{D}$$

$$\bar{\bar{x}} = \overline{BC + B\bar{D} + DC}$$

$$x = \overline{BC} \cdot \overline{B\bar{D}} \cdot \overline{DC}$$

$$\boxed{x = (\bar{B} + \bar{C}) \cdot (\bar{B} + D) \cdot (\bar{D} + \bar{C})}$$

~~Question 2~~

Extra part since the 0's can be grouped together in more than 2 ways.

Question 2

a)

	X_1	X_0	Y_1	Y_0	Output
*	0	0	0	0	1
	0	0	0	1	0
	0	0	1	0	0
	0	0	1	1	0
	0	1	0	0	0
*	0	1	0	1	1
	0	1	1	0	0
	0	1	1	1	0
	1	0	0	0	0
	1	0	0	1	0
*	1	0	1	0	1
	1	0	1	1	0
	1	1	0	0	0
	1	1	0	1	0
	1	1	1	0	0
*	1	1	1	1	1

b) $\Sigma\Pi = (\bar{X}_1 \bar{X}_0 \bar{Y}_1 \bar{Y}_0) + (\bar{X}_1 X_0 \bar{Y}_1 Y_0) + (X_1 \bar{X}_0 Y_1 \bar{Y}_0) + (X_1 X_0 Y_1 Y_0)$

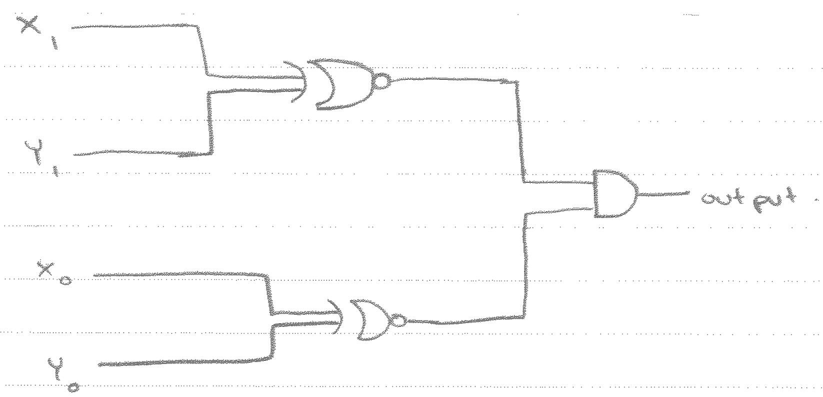
c)

output, X $(X_1 X_0)$ \ Y $(Y_1 Y_0)$	00	01	11	10
00	1	0	0	0
01	0	1	0	0
11	0	0	1	0
10	0	0	0	1

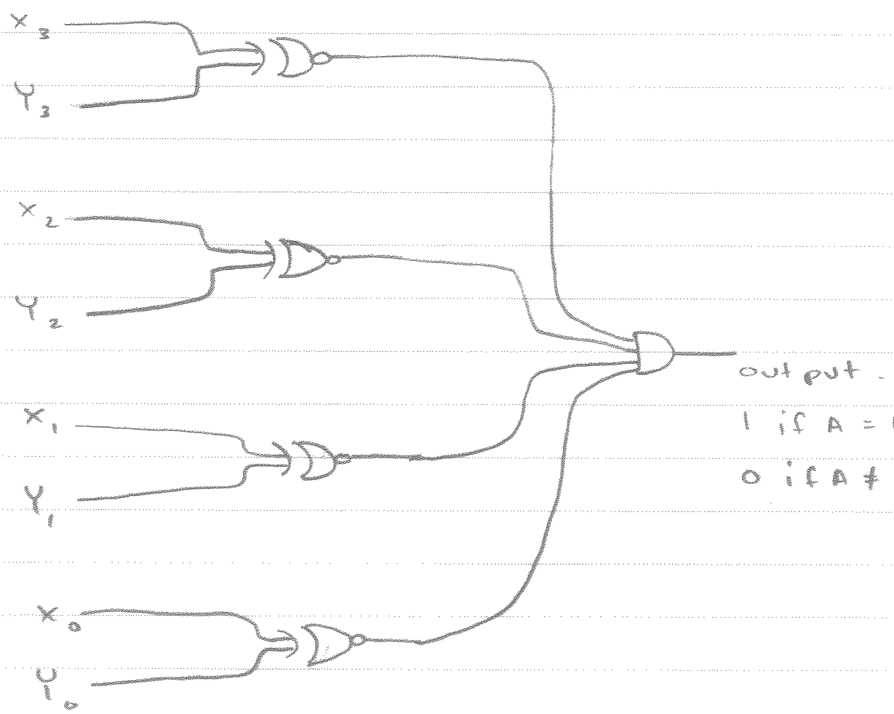
Cannot be minimized Answer same as (b)

$\Sigma\Pi = (\bar{X}_1 \bar{X}_0 \bar{Y}_1 \bar{Y}_0) + (\bar{X}_1 X_0 \bar{Y}_1 Y_0) + (X_1 \bar{X}_0 Y_1 \bar{Y}_0) + (X_1 X_0 Y_1 Y_0)$

e)



f) for a 4 bit comparator, all we will have is inputs X_0 X_1 X_2 X_3 & Y_0 Y_1 Y_2 Y_3.
So the circuit will just be:

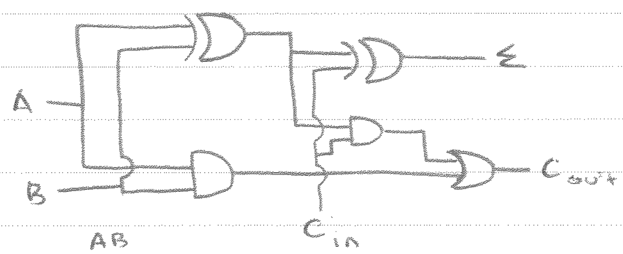


1 if A = B
0 if A ≠ B.

Question 3

Full adder :

C_{in}	A	B	Σ	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1



Σ

C_{in} \ AB	00	01	11	10
0	0	1	0	1
1	1	0	1	0

ΣΠ: $\Sigma = C_{in}\bar{A}\bar{B} + C_{in}AB + \bar{C}_{in}\bar{A}B + \bar{C}_{in}A\bar{B}$

ΠΣ: $\Sigma = (C_{in}+A+B)(C_{in}+\bar{A}+\bar{B})(\bar{C}_{in}+A+\bar{B})$
$(\bar{C}_{in}+\bar{A}+B)$

C_{out}

C_{in} \ AB	00	01	11	10
0	0	0	1	0
1	0	1	1	1

ΣΠ: $C_{out} = AB + C_{in}B + C_{in}A$

ΠΣ: $C_{out} = (A+B)(C_{in}+B)(C_{in}+A)$