Instruction

- Separate into groups of no more than three people.
- Each group uses a sheet of A4 paper.
- Write the name and ID of all group members on the top of the sheet.
- You have 10 minutes to do this quiz.
- **Show your work**! Write down what you have done to obtain your answer.

Questions

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

1. Write down the canonical sums for Σ and c_{out} defined in the given truth table.
2. Find the corresponding K-maps of your answers in Q1.
3. Find the minimal sums using the K-maps from Q2.
4. Implement what you got from Q3 with inverters and AND-OR logic.
5. Construct equivalent circuits using NAND gates.

ECS371 Quiz 2 Solution

Monday, July 13, 2009
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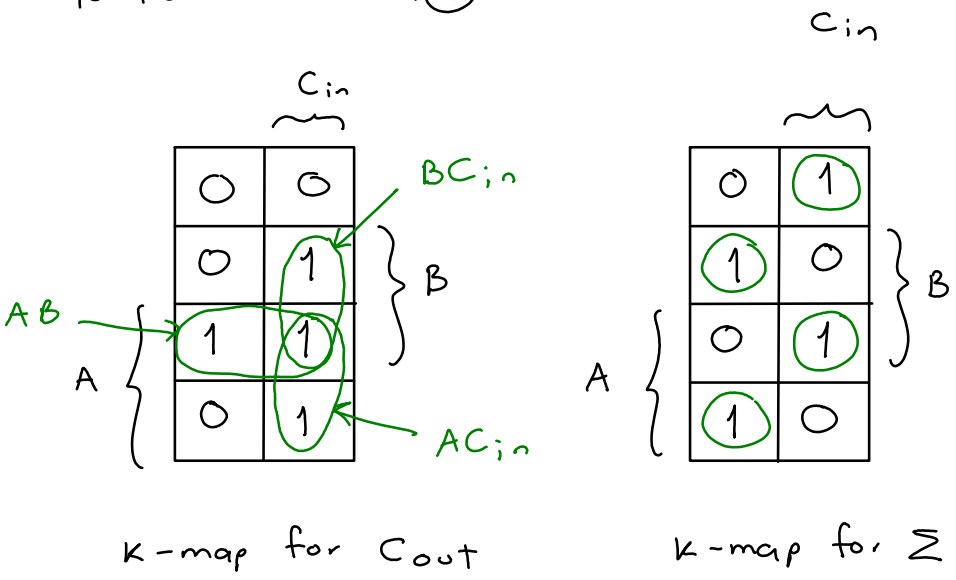
(1) For each of the outputs in the truth table, find the rows where the outputs are 1, then add all the minterms corresponding to those rows.

$$C_{out} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$$

$$\Sigma = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

(2) Put 1s in the K-maps where each 1 corresponds to the minterm in (1).



K-map for C_{out} K-map for Σ

(3) When the 1s are mapped in the K-maps, we then find all prime implicants.

It turns out that we need every prime implicants (for both cases).

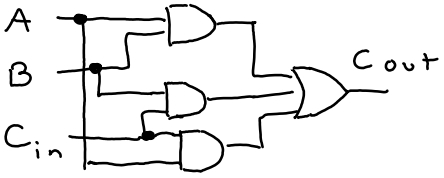
Minimal sums are found by summing the product terms corresponding to the "surviving" prime implicants.

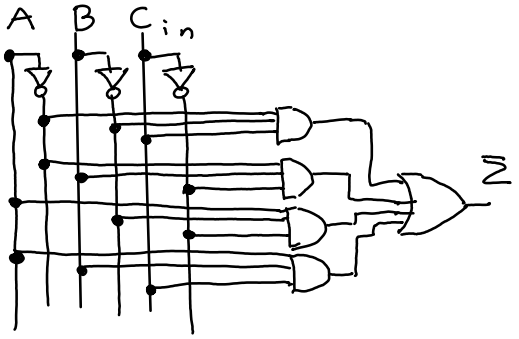
$$C_{out} = AB + BC_{in} + AC_{in}$$

$$\Sigma = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

(4) Any SOP expression can be directly turned into circuit with inverters and AND-OR

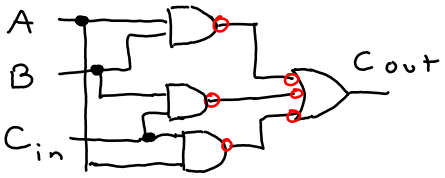
logic.

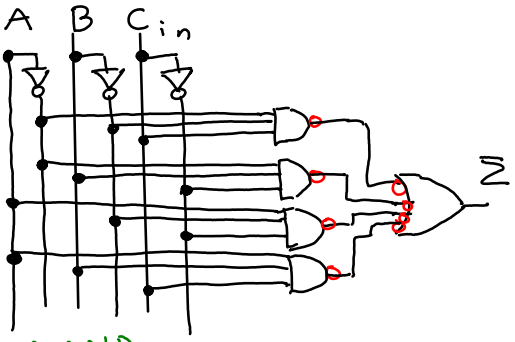




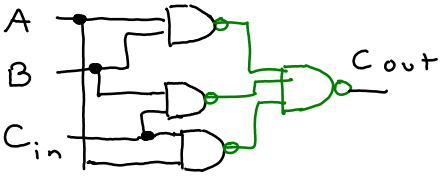
(5) When circuits are already in the AND-OR config., it is straight-forward to turn them into circuits which use only NAND gates.

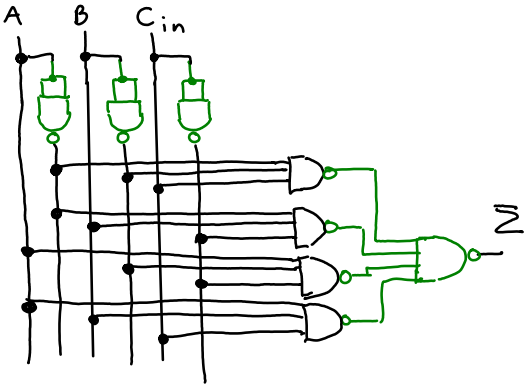
First, we add the bubbles ...



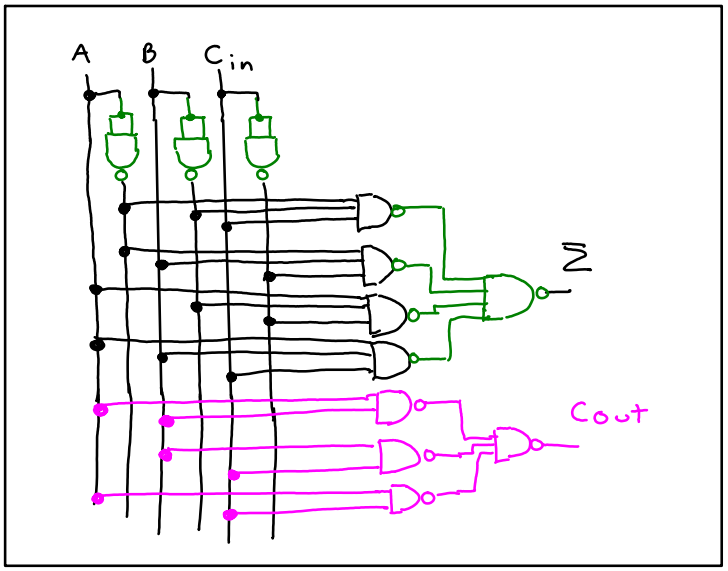


Then, we convert Negative-OR to NAND and replace ⊸ with ⊸.





In fact, I can combine the two circuits into one picture below:


A
B
Cin
Σ
Cout