CS 240 SI Worksheet Solutions
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Session #4
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Combinational Logic + Logic for Arithmetics (Part 1)

1. For the following truth table, derive a simplified boolean expression using Karnaugh maps:

ABCD	M
0000	1
0001	0
0010	1
0011	0
0100	0
0101	0
0110	0
0111	1
1000	1
1001	0
1010	1
1011	0
1100	1
1101	1
1110	0
1111	0

(Each box is highlighted in a unique color.)

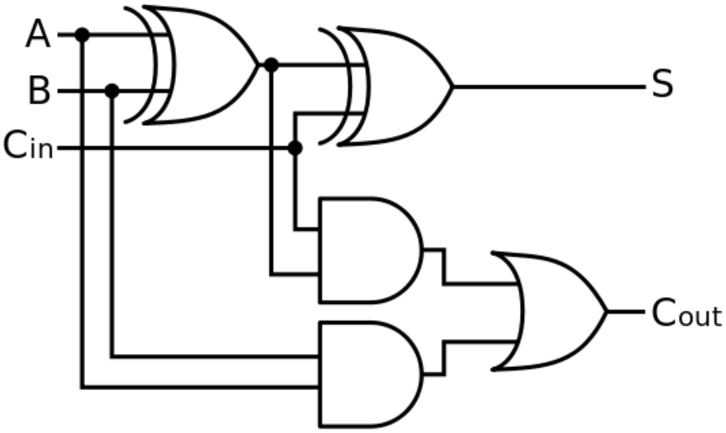
	CD				
AB		**00**	**01**	**11**	**10**
	00	1	0	0	1
	01	0	0	1	0
	11	1	1	0	0
	10	1	0	0	1

M = B'D' + ABC' + A'BCD

a. What makes Karnaugh maps useful for generating expressions in minimal sum-of-products form?

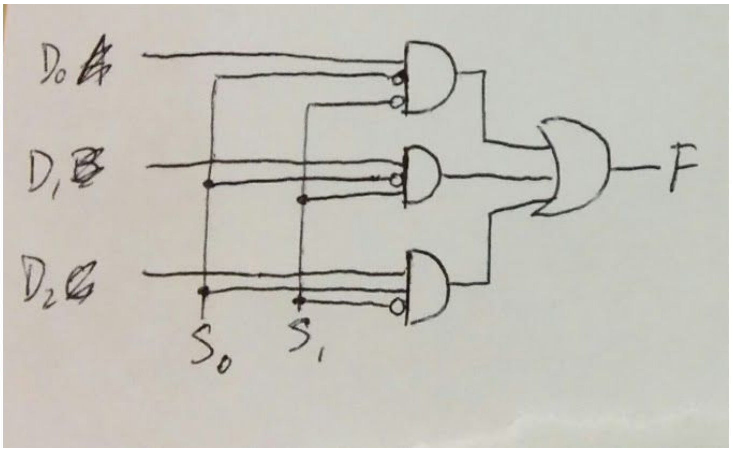
The Gray Codes: adjacent inputs differ in only one bit (and can also wrap around)

2. Implement a 1-bit full adder.



3. Implement a 3-to-1 MUX with 3-input gates: input line = D, output line = F, select line = S

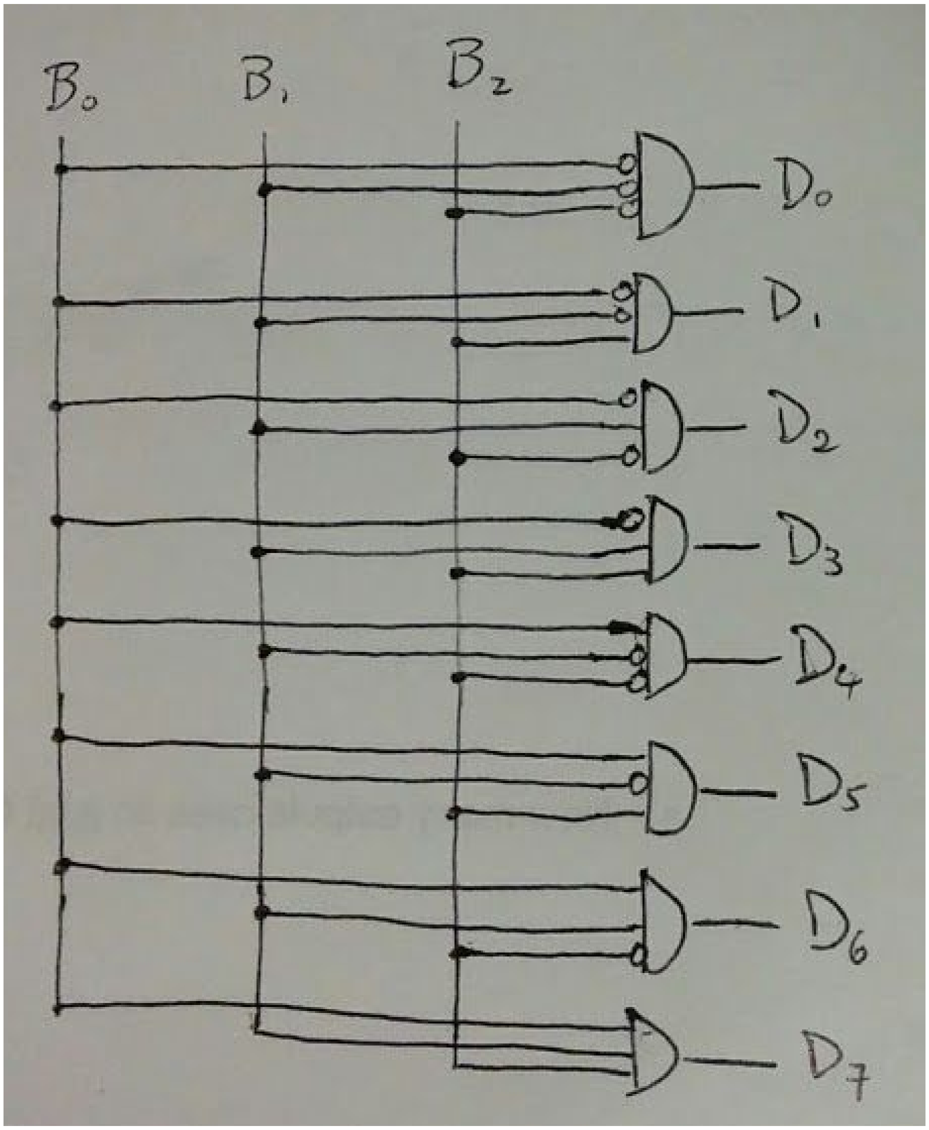
An n-to-1 MUX needs $\log_2 n$ select lines (the collective input of the select lines act as binary code for the input line to be outputted).



a. What is its high-level behavior? (Or what is its purpose?)
   It selects one of the inputs as output.

4. Implement a 3-bit decoder: input line = B, output line = D

(This solution uses only code detectors.)



a. How many outputs does an n-bit decoder have?
2^n (the inputs indicate the binary number of the output line to output 1).