

COMP311 WA3 Name: _____

Use the notation from class for all boolean algebra expressions, including $\overline{A}$ for NOT A , $A + B$ for A OR B , and $A \cdot B$ for A AND B .

Question 1: Boolean Algebra Simplify each expression as much as possible using Boolean algebra. Show intermediate steps and name the laws you use.

1.1. $F = AB + A\overline{B} + \overline{A}B$

1.2. $G = (A + B)(A + \overline{B}) + AC$

Question 2: De Morgan's Laws Rewrite each expression so that NOT applies only to individual input variables. Show your steps; your answer may contain both AND and OR.

2.1. $H = \overline{(A + B)C}$ (The bar covers the entire product.)

2.2. $J = \overline{A + \overline{BC}}$

Question 3: Karnaugh Maps For each of the following questions, find the most simplified Boolean expression.

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

3.1.

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

3.4.

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

3.2.

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

3.5.

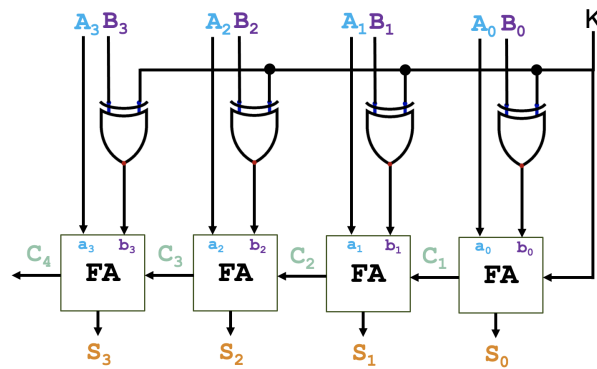
AB \ CD				
	00	01	11	10
00	1	0	X	1
01	0	1	X	1
11	1	1	X	X
10	1	1	X	X

3.3.

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

3.6.

Question 4: Ripple Carry Adder/Subtractor Use the circuit below for both operations. Treat the operands as 4-bit two's-complement numbers.



Complete the table. Write each group of four signals as a four-bit value. The b signals are the inputs to the full adders **after the XOR gates**; C_4 is the final carry-out.

Operation	K	$b_3b_2b_1b_0$	$C_4C_3C_2C_1$	$S_3S_2S_1S_0$	Signed overflow? (Yes/No)
$4 + 5$					
$3 - 1$					

Question 5: Design with a Multiplexer Implement the function below using **one 4:1 mux** and at most one NOT gate. Use A and B as the select bits, with A as the most significant bit. Constant 0 and 1 inputs are allowed.

A	B	Output F
0	0	C
0	1	1
1	0	0
1	1	$\overline{C}$

5.1. Draw a mux block diagram showing the input connections and output F .

5.2. Using your circuit, what is F when $A = 1$, $B = 1$, and $C = 0$?