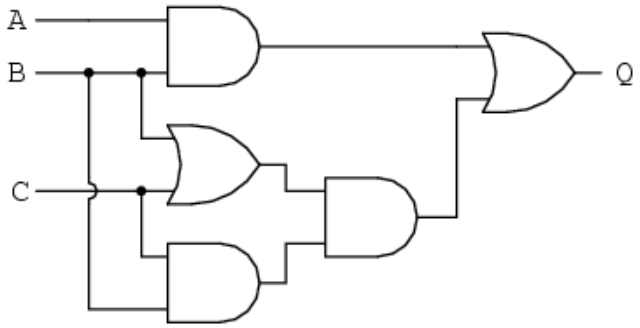
Name: (as it would appear on official course roster)	
UCSB email address: **@ucsb.edu**	**Perm ID Number:**
Lab Section Time:	
Optional: name you wish to be called if different from above	
Optional: name of "homework buddy" (leaving this blank signifies "I worked alone")	

Lab 07: Combinatorial and Sequential Logic

Assigned: *Wednesday, November 20th, 2019*
Due: *Wednesday, November 27th, 2019*
Points: *100*

- You may collaborate on this homework with AT MOST one person, an optional "homework buddy".
- MAY ONLY BE TURNED ON **GRADESCOPE as a PDF file**.
- There is NO MAKEUP for missed assignments.
- We are strict about enforcing the LATE POLICY for all assignments (see syllabus).

1. Given the following digital circuit:



a) (5 pts) Draw the Karnaugh map for this circuit. Show optimal groupings.

b) (5 pts) Write the ***optimized*** logic function that describes the diagram in the form of "sum-of-product".

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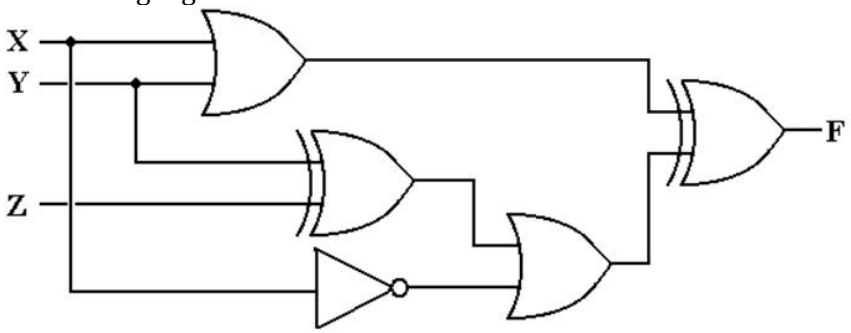
c) (10 pts) Re-draw the circuit based on your answers in part (b). Bad drawings will lose points!

2. Given the following digital circuit:



a) (10 pts) Construct the truth table for this circuit.

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b) (10 pts) Using your answer from part (a), write the ***optimized*** logic function that describes the diagram in the form of "sum-of-product". You can use Karnaugh maps (if so, show optimal groupings!) or other techniques, if you like.

c) (10 pts) Go to the logic simulation webpage that I demonstrated in lecture (https://logic.ly/demo) and recreate/assemble this circuit on there. Use the *toggle switches* for the 3 inputs and the *light bulb* for the output F. Go through all the entries in the truth table from part (a) and verify that they are correct, according to the *logic.ly* simulation. Take a screenshot of the design you set up on the website (let your setup show X, Y, Z be 0, 0, 1, respectively) and paste it on the next page of this homework sheet.

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PASTE THE SCREENSHOT HERE FROM PART (c)

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3. Consider the following C++ function where all variables are single bits:

```
boolean FunctionZ(boolean a, boolean b, boolean c)
{
      boolean x = a & b | c;
      boolean y = ~(x ^ a);
      return y;
}
```

a) (10 pts) Draw the circuit that is a direct representation of this function (without simplifying). Bad drawings will lose points!

b) (10 pts) Use algebraic simplification to simplify this function and write it as a "sum-of-products" format. Start off with:

$$y = \overline{(x \oplus a)}$$

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c) (10 pts) Given your answer in (b), draw the Karnaugh map for this function output and find an optimal simplification for the function output, **y**. Then, using this, further simplify the function output and prove that: `y = (a & b) + ~(a ^ c)`.

4. (10 pts) Design and draw an 8:1 3-bit multiplexer using just 2:1 3-bit multiplexers.

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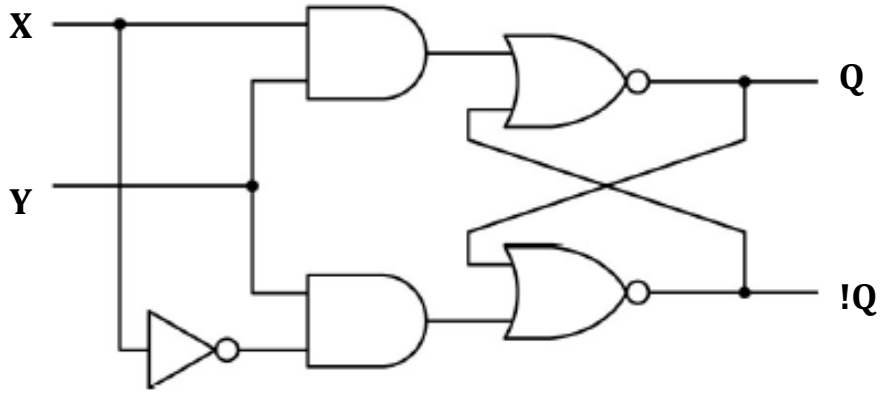
5. Consider this digital circuit:



a) (2 pts) What is the name of the sequential logic circuit that is "driving" the output stage?

b) (5 pts) Write out the truth table for the full circuit.

c) (3 pts) Describe (using words! ☺) what this circuit does.