Name:

Instructions

This is a closed-book, closed-notes quiz. I want to see what you remember about the prerequsite material in digital design. It should help you determine if you have the right background for this course, and it will also help me decide what to do with students on the waiting list.

Work independently. Show your work! Answers with no justification will not be given credit. *Don't Panic!*

Put your name at the top of each sheet of the exam before you start!

1	20 points	
2	20 points	
3	20 points	
4	20 points	
5	20 points	
Total	100 points	

1 Basic Electronics

1.1 RC Circuits: 10 Points

Consider a switch that connects a 120v source, a 23 MΩ resistor, and a $5\mu F$ capacitor. How long should you leave the switch closed in order to charge the capacitor to 12v? Draw the circuit and set up the equation. You don't have to solve the equation and get the answer in seconds, but you should set up the equation and define the terms.

1.2 Power: 10 Points

What is the maximum voltage that can be connected across a series combination of a 180Ω 2-watt resistor and a 120Ω 1-watt resistor with exceeding either resistor's power rating. Again, you can set up the equations without solving them if you like.

2 Arithmetic: 20 Points

Compute the following additions assuming the numbers are 2's complement numbers. Show the result, and indicate which, if any, cause overflow.

```
A)  10111001        B)  01011101        C)  00100110
  + 11010110          + 00100001          + 01011110
  ----------          ----------          ----------
```

```
D)  01001010        E)   10010110
  + 11110110          + 01001101
  ----------          ----------
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3 Combinational Logic: 20 Points

Convert the following circuit to an equivalent circuit that uses only NAND gates. Do NOT minimize the circuit, just change the gate types. Remember that using deMorgan's theorem $\overline{A \wedge B} = \overline{A} \vee \overline{B}$ which means that you can draw a NAND as an AND with inverted output or as an OR with inverted inputs.
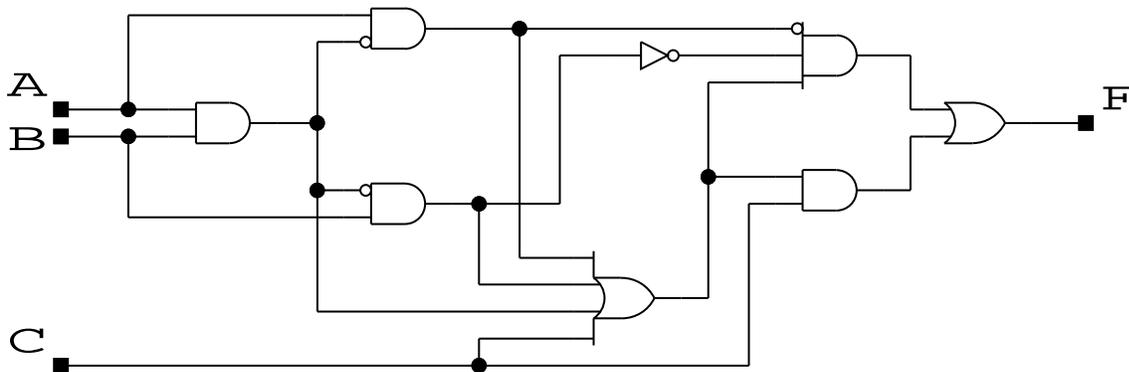
4   Circuit Timing: 20 Points

Consider the counter circuit in the following figure (This is a synchronous counter with parallel load).
Assume that T_{su} (setup time) is 3ns and T_h (hold time) is 1ns for the flip flops.
Assume that T_{pd} (propogation delay) through each gate (AND, XOR, and MUX) is 1ns.
What is the maximum clock frequency for which the counter will operate correctly? Why?
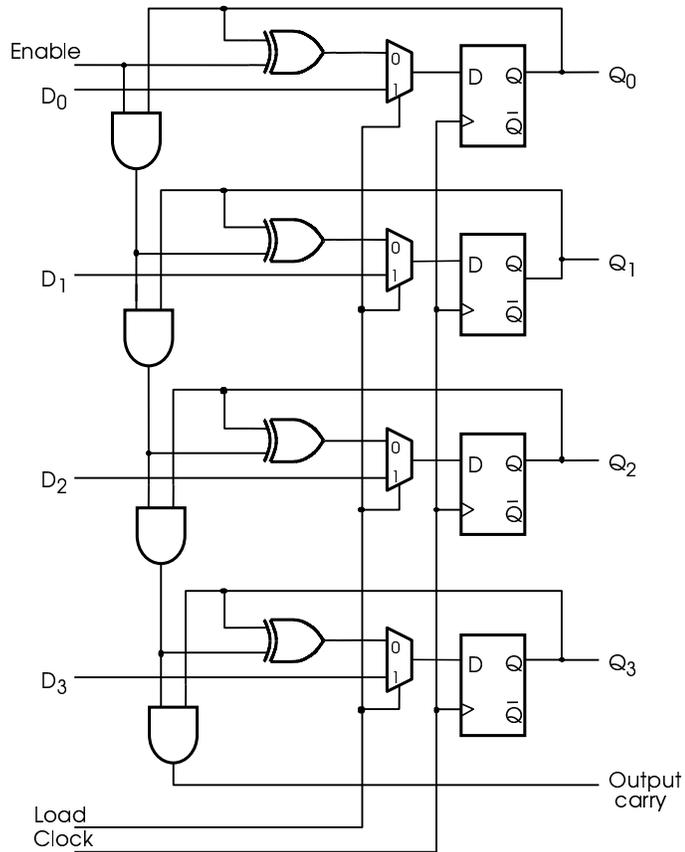
5   Finite State Machine Design: 20 Points

Design a finite state machine with one input I, and two outputs Z and E. The machine should produce a Z output whenever it has seen a 110 pattern on the input stream, except that if it ever sees a 001 pattern on the input stream, it should assert the E output, and keep that E output asserted until the machine is reset. Note that Z should never be asserted again once E is asserted. Design a state machine to implement this function. Don't implement the circuit, just draw the state diagram.

I've given you a framework for a Moore-style state machine (i.e. outputs are determinied only by which state you're in). All you need to do is fill in the remaining transitions and output values.