0. Name (2 pts):

AME 3623: Embedded Real-Time Systems

Midterm Exam

March 13, 2008

General instructions:

- This examination booklet has 10 pages.
- Do not forget to write your name at the top of the page and to sign your name below.
- The exam is closed book, closed notes, and closed electronic device. The exception is that you may have one page of your own notes.
- The exam is worth a total of 100 points (and 10% of your final grade).
- Explain your answers clearly and concisely. Do not write long essays (even if there is a lot of open space on the page). A question worth 5 points is only worth an answer that is at most 2 sentences.
- You have 1.25 hours to complete the exam. Be a smart test taker: if you get stuck on one problem go on to the next. Don't waste your time giving details that the question does not request. Points will be taken off for answers containing excessive or extraneous information.
- Show your work. Partial credit is possible, but only if you show intermediate steps.

Problem	Topic	Max	Grade
0	Name	2	
1	Digital Logic	27	
2	Sequential Logic	17	
3	Memory	20	
4	Microcontrollers	20	
5	Timers	16	
Total			

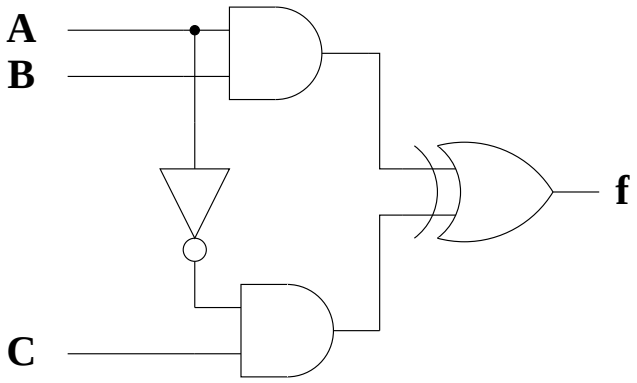
On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this exam.

Signature: _____

Date: _____

1. **Digital Logic** (27 pts)

Given the following circuit:



(a) (8 pts) Show the corresponding truth table.

A	B	C	f
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Given the following truth table:

A	B	C	f
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

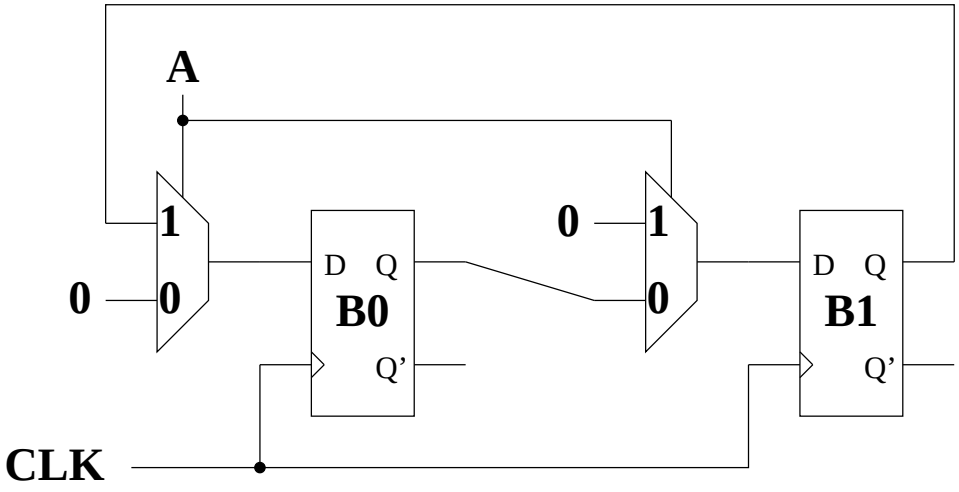
(b) (5 pts) Give the "minterm" form of the corresponding algebraic expression.

(c) (9 pts) Derive a simplified algebraic description for f. Justify each step (provide the name of the rule that you are using).

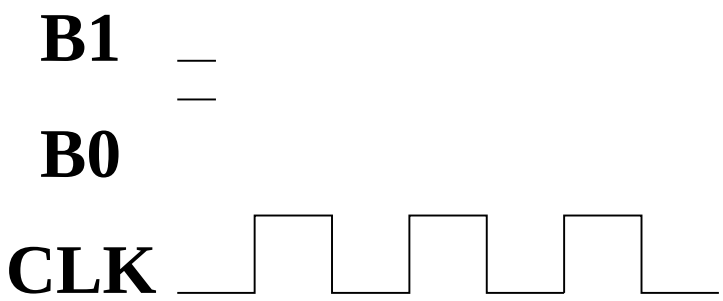
(d) (5 pts) Draw the corresponding circuit.

2. **Sequential Logic** (17 pts)

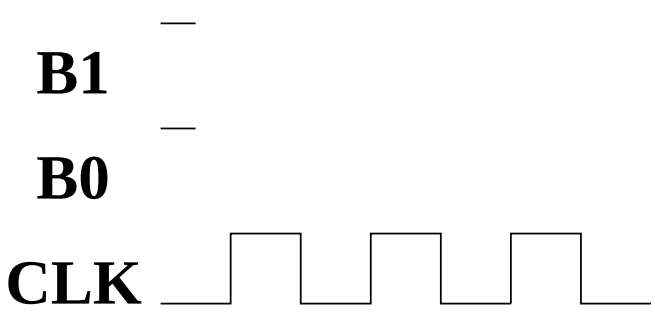
Given the following circuit:



(a) (6 pts) Assume that the initial state is $B1 = 0$ and $B0 = 1$, and that $A = 0$. Fill in the following timing diagram:



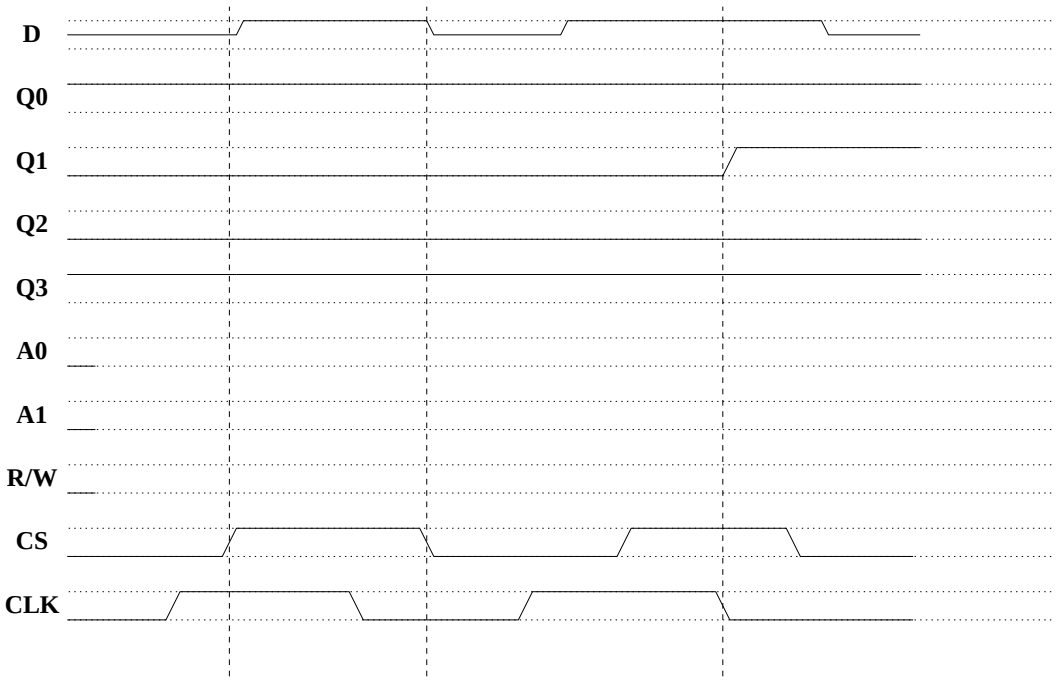
(b) (6 pts) Assume that the initial state is $B1 = 1$ and $B0 = 1$, and that $A = 1$. Fill in the following timing diagram:



(c) (5 pts) If you interpret $B1, B0$ as a 2-bit number, what mathematical operation(s) does this device perform on each clock cycle?

3. **Memory** (20 pts)

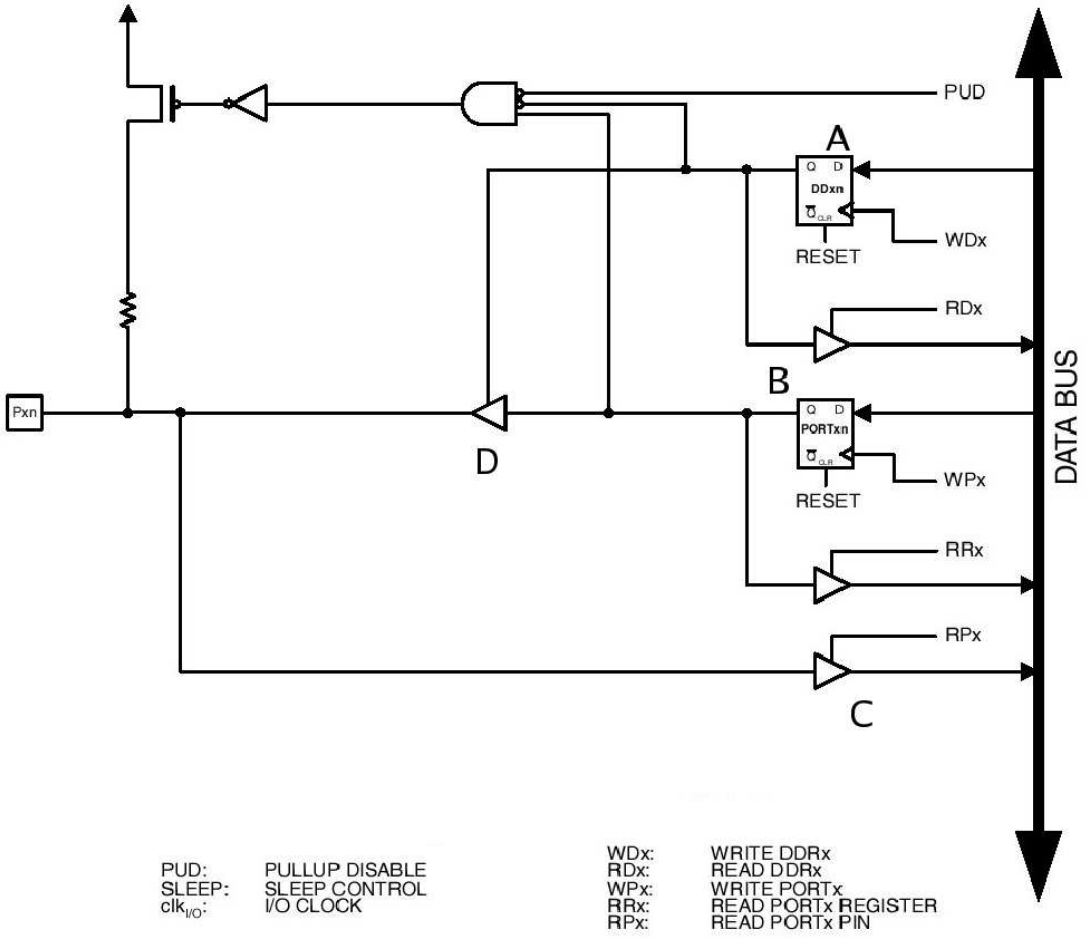
(a) (10 pts) For the timing diagram below, fill in the missing control signals. Specifically, we wish to read from $Q3$, and then write a 1 to $Q1$.



(b) (5 pts) True/False and explain: The chip select is an output from the memory chip.

(c) (5 pts) True/False and explain: The data bus is an input to the memory chip.

4. **Microcontrollers** (20 pts)



(a) (5 pts) Identify component "C". Briefly explain the function of this component in this circuit.

Assume an initial state of:
$DDRB = 0x36$
$PORTB = 0xA5$

(b) (5 pts) What effect does the following code have on $DDRB$ and on the above circuit (in terms of components A, B, C, and D)?

```
DDRB = DDRB & ~0x2;
```

(c) (5 pts) What effect does the following code have on the state of this circuit (in terms of components A, B, C, and D)?

```
PORTB = PORTB | 0x30;
```

(d) (5 pts) What is the function of the program counter? (be brief)

5. **Timers** (16 pts)

(a) (8 pts) Given a system clock of $16MHz$ and a prescaler of 8. How long does it take for timer 0 to count from 0 to 200?

(b) (8 pts) Given a system clock of $16MHz$ and a prescaler of 64. How long does it take for timer 2 to count from 0 to 400?