0. Name (2 pts):

AME 3623: Embedded Real-Time Systems

Midterm Exam

March 15, 2007

General instructions:

- This examination booklet has 9 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, 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	28	
2	Number Systems	10	
3	Sequential Logic	15	
4	Memory	20	
5	Microcontrollers	27	
Total			

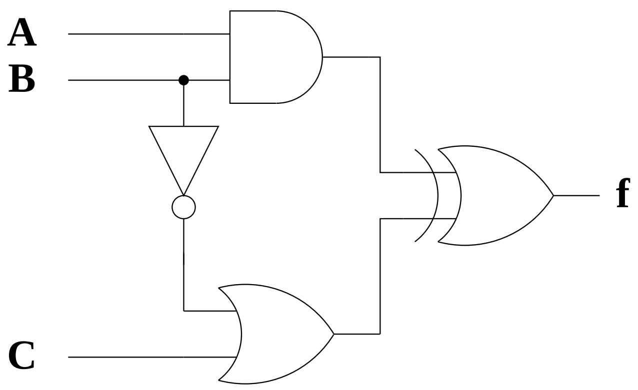
On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this exam.

Signature: ____________________

Date: ____________________

1. **Digital Logic** (28 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	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

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

(c) (10 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.

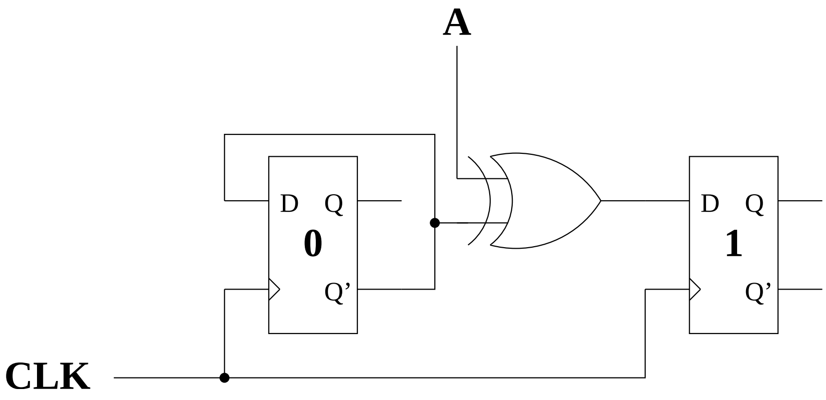
2. **Number Systems** (10 pts)

(a) (5 pts) What is the decimal equivalent of $3E$? Show your work.

(b) (5 pts) What is the binary equivalent of decimal number 35? Show your work.

3. **Sequential Logic** (15 pts)

Given the following circuit:

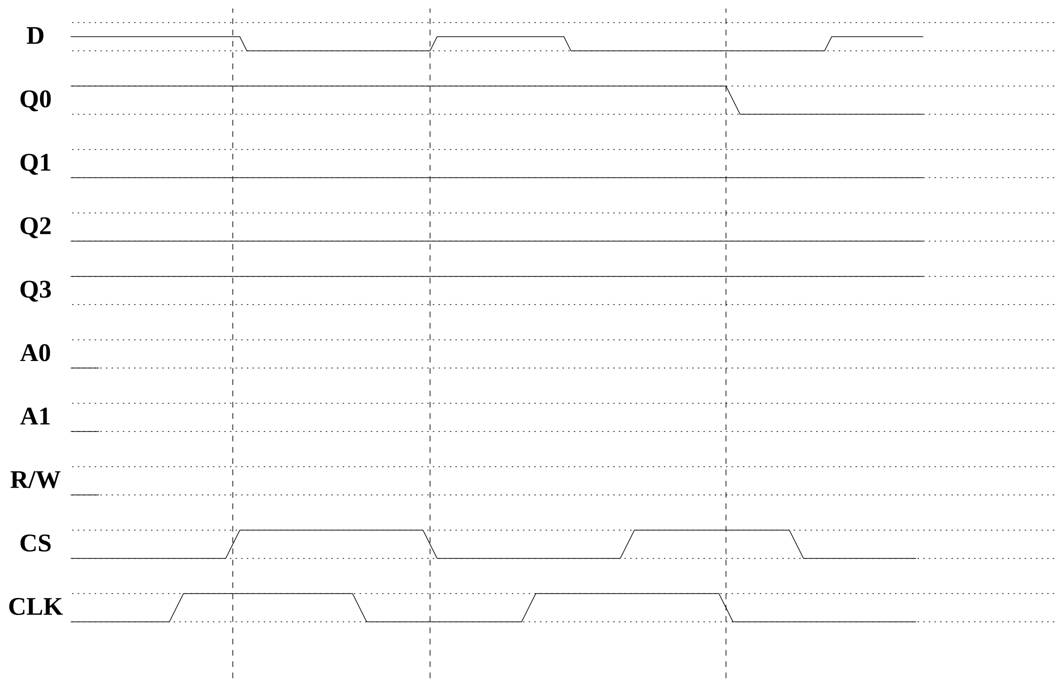


(a) (5 pts) What are the possible states (list all of them)? (by *state* we are referring to the stored information only)

(b) (10 pts) Assume an initial state of $Q1 = 0$ and $Q0 = 1$, and that $A = 1$. What is the sequence of states over 5 clock cycles?

4. **Memory** (20 pts)

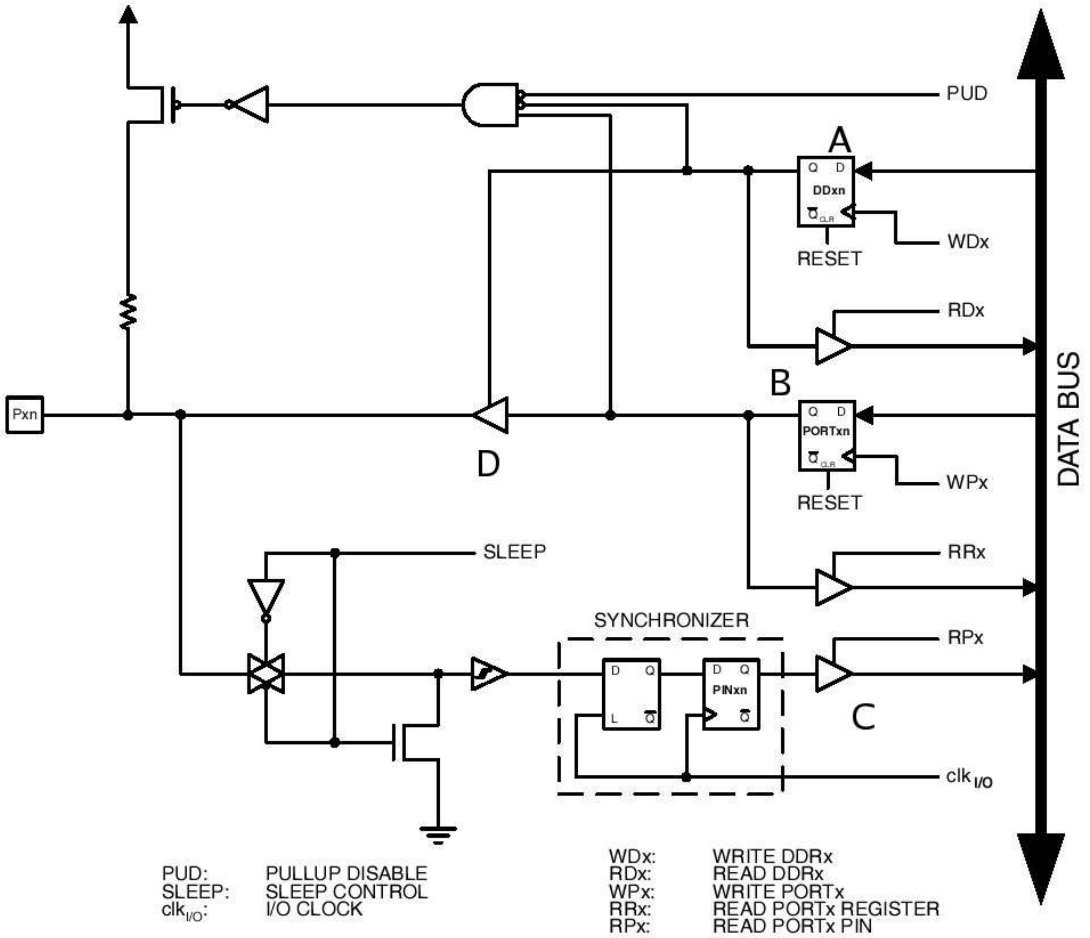
(a) (10 pts) For the timing diagram below, fill in the missing control signals. Specifically, we wish to read from $Q2$, and then write a 0 to $Q0$.



(b) (5 pts) Briefly explain the function of the chip select signal (in general, not for part a).

(c) (5 pts) Briefly explain the difference between the types of memory that we call RAM and ROM.

5. **Microcontrollers** (27 pts)



(a) (5 pts) Identify component "D". Explain in brief the function of this type of component.

Assume an initial state of:
$DDRB = 0x34$
$PORTB = 0xA5$

(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 | 0x40;
```

(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 & ~0x40;
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(d) (5 pts) What is the function of a general purpose register? (be brief)

(e) (7 pts) List two properties of all buses (be brief).