(2 pts) Name:

AME 3623: Embedded Real-Time Systems

Midterm Exam

March 9, 2006

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 be concise. 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 1.5 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	-	2	
1	Digital Logic	37	
2	Number Systems	15	
3	Sequential Logic and Finite State Machines	20	
4	Memory	10	
5	Microcontroller I/O	18	
Total			

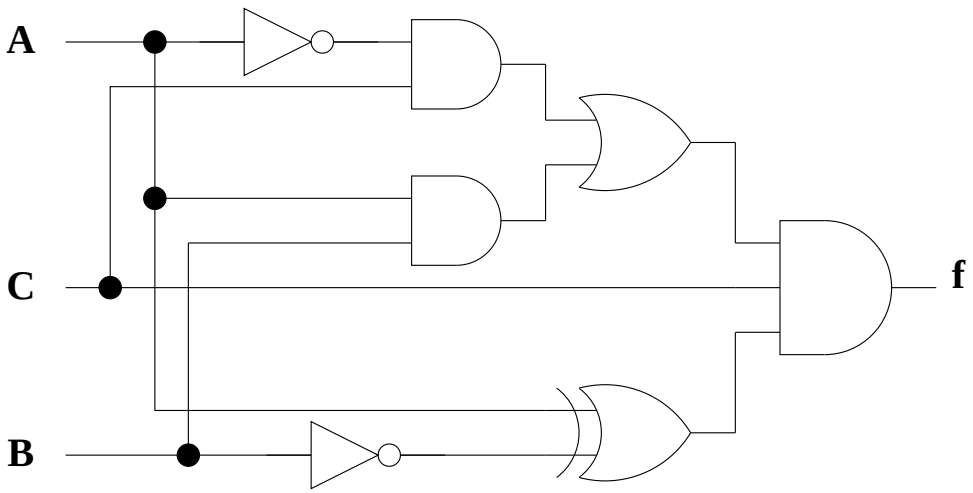
On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this exam.

Signature: _____

Date: _____

1. **Digital Logic** (37 pts)

Given the following circuit:



(a) (10 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	D	f
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

(b) (7 pts) Give the Karnaugh map and show the clusters.

(c) (5 pts) What is the corresponding algebraic description for f (that comes directly from the clusters)?

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

(e) (10 pts) Prove that $A \oplus \overline{B} = \overline{A \oplus B}$

2. **Number Systems** (15 pts)

Given the following number in hexadecimal: $2E$.

(a) (5 pts) What is the binary equivalent of this number?

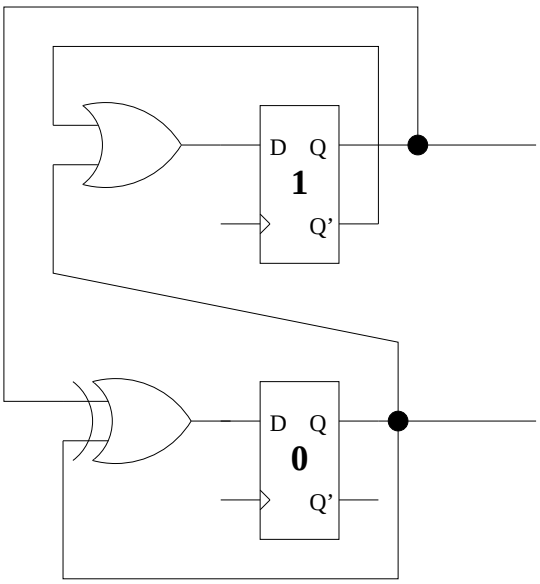
(b) (5 pts) What is the decimal equivalent of this number?

(separate question) Given the decimal number 178:

(c) (5 pts) What is the binary equivalent of this number? (show your work)

3. **Sequential Logic** (20 pts)

Given the following circuit:



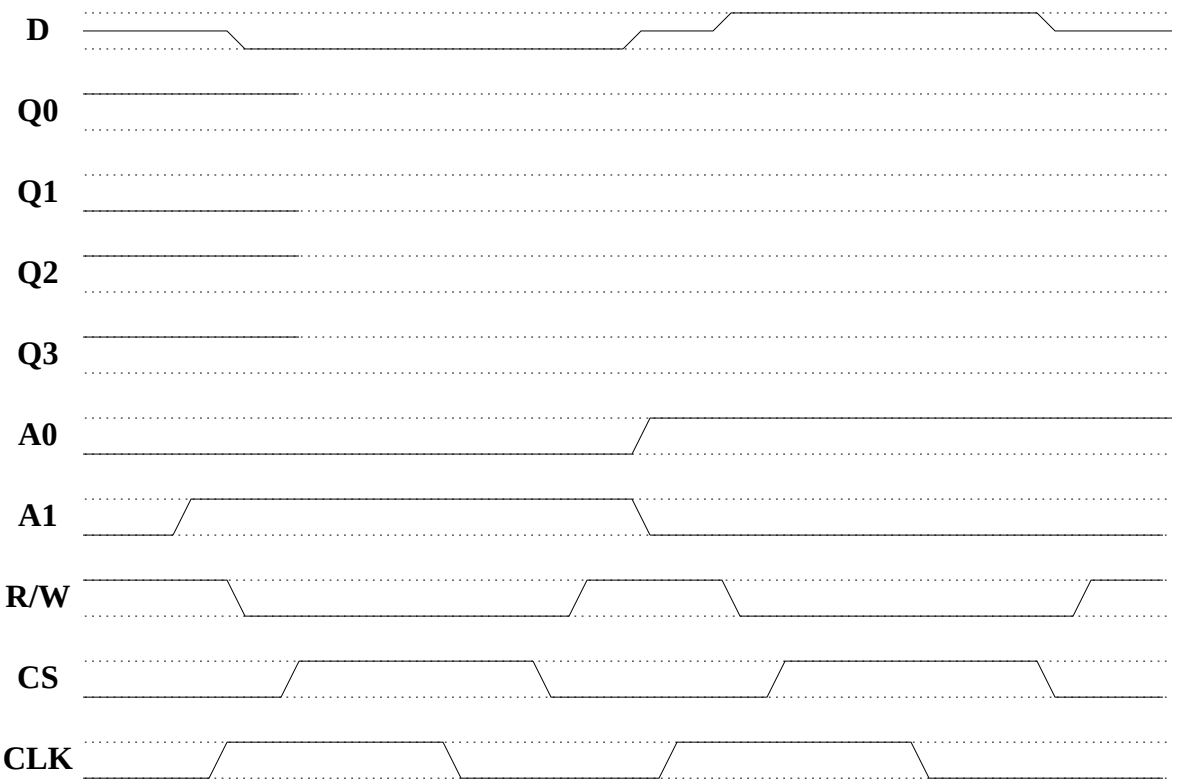
(a) (5 pts) What are the possible states (list all of them)?

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

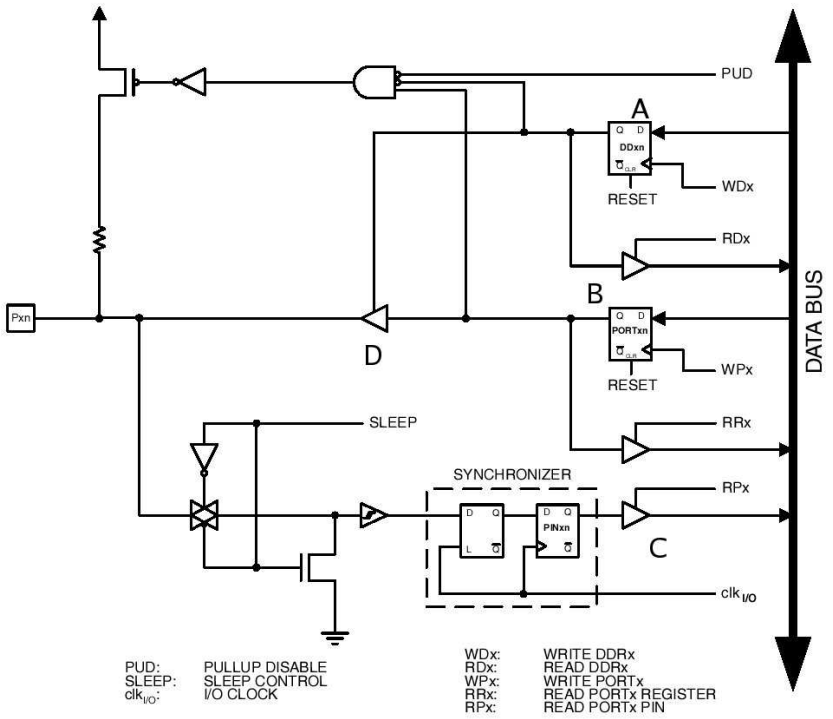
(c) (5 pts) Draw the finite state machine representation of this circuit.

4. **Memory** (10 pts)

(a) (10 pts) For the timing diagram below, fill in the missing traces.



5. **Microcontroller I/O** (18 pts)



(a) (8 pts) Identify component "C". Explain in brief the function of this type of component (in general, not in this circuit).

(b) (10 pts) What effect does the following code have on the state of this circuit (in terms of components A, B, C, and D)? State any assumptions that you must make.

```
PORTB = PORTB | 0x10;
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