

AME 3623 Real-Time Embedded Systems  
Midterm  
March 12, 2015

General instructions:

- Please wait to open this exam booklet until you are told to do so.
- This examination booklet has 8 pages. You also have been issued a bubble sheet.
- Write your name, university ID number and date, and sign your name below. Also, write your name and ID number on your bubble sheet, and fill in the bubbles for your ID.
- The exam is closed book, notes and electronic devices. The exception is that you may have one page of personal notes (double sided).
- The exam is worth a total of 100 points (and 10% of your final grade).
- 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.
- Use your bubble sheet to answer all multiple-choice questions. Make sure that the question number and the bubble row number match when you are answering each question. <sup>A</sup>

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

**Signature:** \_\_\_\_\_

**Name:** \_\_\_\_\_

**ID Number:** \_\_\_\_\_

**Date:** \_\_\_\_\_

Question	Points	Score
Binary Representations and Operators	30	
Circuits	20	
Digital/Analog Systems	15	
Motor Control	15	
Digital I/O	20	
Total:	100	

Part I. Binary Representations and Operators

1. (5 points) What is the decimal value of  $c$  after the following code is executed? Assume a “6.2” fixed-point representation.

```
uint8_t a = 7;
uint8_t b = 10;
uint8_t c = fixed_point_mul(a, b);
```

A. 17   B. 70   C. 2   D. 3   E. Answer not shown

2. (5 points) What is the binary representation of  $a$  after the following code is executed?

```
uint8_t a = 52;
```

A. 0010 1100   B. **0011 0100**   C. 0100 0100   D. 0010 1110  
E. Answer not shown

3. (5 points) What is the binary representation of  $b$  after the following code is executed?

```
uint8_t a = 0x3F;
uint8_t b = a >> 3;
```

A. **0000 0111**   B. 0000 1110   C. 0001 1111   D. 0011 1111  
E. Answer not shown

4. (5 points) What is the binary representation for -78? Assume a signed, 8-bit integer.

A. 0010 1010   B. 0010 1011   C. 1101 0111   D. **1011 0010**  
E. Answer not shown

5. (5 points) What is the decimal representation of  $b$  after the following code is executed?

```
uint8_t a = 4;
uint8_t b = 99 * (a/5);
```

A. **0**   B. 79   C. 79.2   D. 80   E. Answer not shown

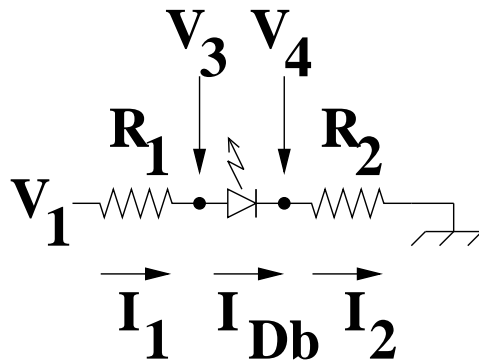
6. (5 points) What is the hexadecimal representation of  $c$  after the following code is executed?

```
uint8_t a = 0xA5;  
uint8_t b = 0xC3;  
uint8_t c = a & b;
```

- A. 0xE7    **B. 0x81**    C. 0x1    D. 0x69    E. Answer not shown

Part II. Circuits

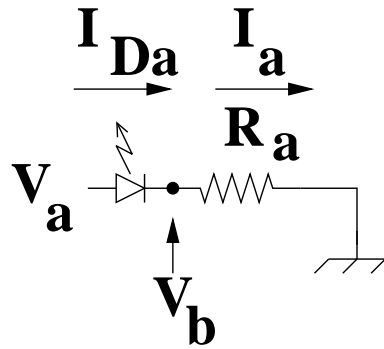
Consider the following circuit:



Assume  $R_1 = 100\Omega$ ,  $R_2 = 300\Omega$  and  $V_{fb} = 2V$ .

7. (5 points) Given that  $V_1 = 3V$ . What is  $I_{Db}$ ?  
A. 10 mA    B. 0 mA    C. 7.5 mA    **D. 2.5 mA**    E. Answer not shown
8. (5 points) Given the same choices as above, what is  $V_3$ ?  
**A. 2.75 V**    B. 2.25 V    C. 0 V    D. 3 V    E. Answer not shown

Consider the following circuit:



Assume  $R_a = 500\Omega$  and  $V_{fa} = 3V$ .

9. (5 points) Given that  $V_a = 7V$  What is  $I_{Da}$ ?  
A. 0 mA    B. 6 mA    **C. 8 mA**    D. 14 mA    E. Answer not shown
  
10. (5 points) Given that  $V_a = 2V$  What is  $V_b$ ?  
A.  $-1 V$     **B. 0 V**    C. 2 V    D. 3 V    E. Answer not shown

Part III. Digital/Analog Systems

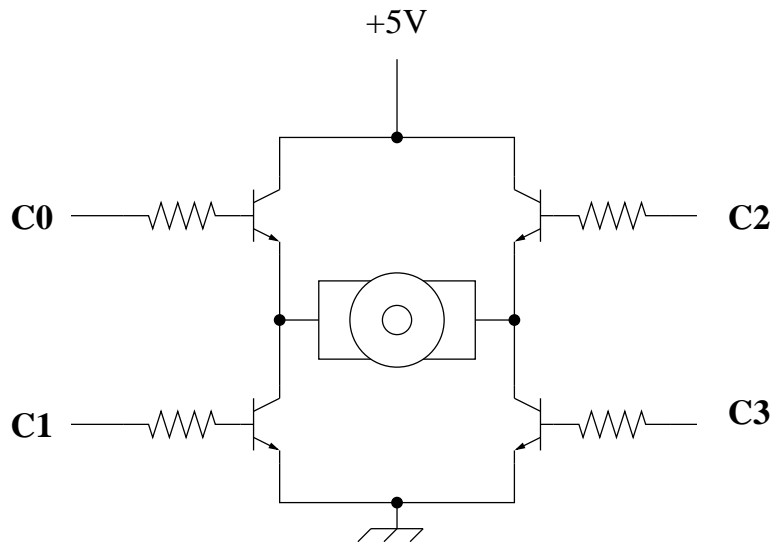
11. (5 points) Assume an 6-bit analog-to-digital converter that uses the successive approximation algorithm, and has a range of 0 to 10 volts. What is the binary value that corresponds to  $V_{in} = 8V$ ?
- A. 1111 1111   B. 0011 1111   **C. 0011 0010**   D. 0011 1000  
E. Answer not shown
12. (5 points) Assume an 8-bit analog-to-digital converter that uses the successive approximation algorithm, and has a range of 0 to 5 volts. What is the digital representation of  $V_{in} = 1.5V$  in binary?
- A. 0101 1000   B. 0100 1101   C. 0100 0110   D. 0100 1010  
**E. Answer not shown**

<b>Solution:</b> 0100 1100
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13. (5 points) Assume an 8-bit analog-to-digital converter that uses the successive approximation algorithm, and has a range of 0 to 5 volts. If  $V_{in} = 4V$  and the first guess by successive approximation is 1000 0000, what is the fifth guess?
- A. 1100 0000   B. 1100 1100   **C. 1100 1000**   D. 0110 1000  
E. Answer not shown

Part IV. Motor Control

Consider the following circuit:



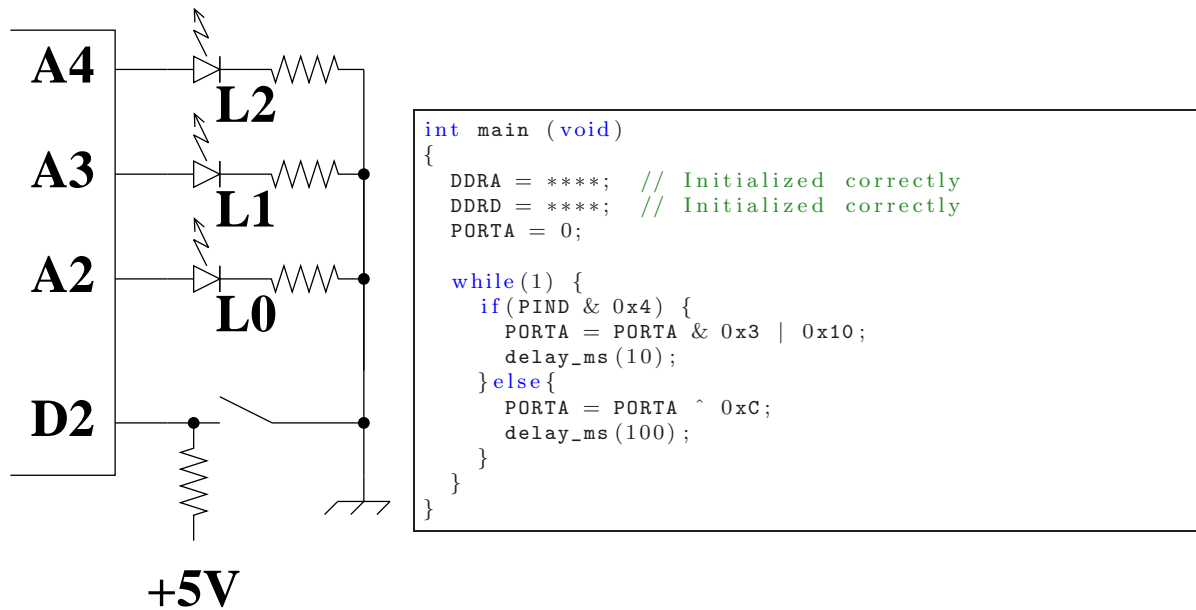
14. (5 points) What configuration of C signals would result in a dynamic braking of the motor?  
 A.  $C[3210] = 1100$     B.  $C[3210] = 1001$     C.  $C[3210] = 0000$   
 D.  $C[3210] = 1010$     E. Answer not shown

**Solution:** The above correct answer is correct. However, the lecture slides only covered the case where C0 and C2 were turned on. So, I will accept “Answer not shown” as well.

15. (5 points) Assume  $C0 = 1$  always. Which pin(s) would have to be pulsed at 50% duty cycle to achieve an average of half the maximum torque?  
 A. C1    B. C2    C. C3    D. C2 and C3    E. Answer not shown
16. (5 points) What configuration of C signals would result in imposing a torque about the motor?  
 A.  $C[3210] = 1100$     B.  $C[3210] = 1001$     C.  $C[3210] = 0000$   
 D.  $C[3210] = 1010$     E. Answer not shown

Part V. Digital I/O

Consider the following circuit and code:



17. (5 points) What is the correct initialization for DDRD given the circuit?  
 A.  $0xFF$    B.  $0x38$    C.  $0x3C$    D.  $0x1C$    E. Answer not shown

**Solution:** DDRD = 0x0 (no pins of D should be configured as an output)

18. (5 points) When the switch is closed, at what frequencies do  $L_2$  and  $L_1$  pulse? Only consider sustained pulsing.  
 A. 10 Hz and 10 Hz   B. 10 Hz and 0 Hz   C. 0 Hz and 10 Hz  
 D. 10 Hz and 10 Hz (don't choose)   E. Answer not shown
19. (5 points) When the switch is open, at what frequencies do  $L_2$  and  $L_1$  pulse? Only consider sustained pulsing.  
 A. 100 Hz and 0 Hz   B. 0 Hz and 100 Hz   C. 0 Hz and 0 Hz  
 D. 100 Hz and 100 Hz   E. Answer not shown
20. (5 points) What is the correct initialization for DDRA given the circuit?  
 A.  $0xFF$    B.  $0x38$    C.  $0x3C$    D.  $0x1C$    E. Answer not shown