

Name \_\_\_\_\_

Section \_\_\_\_\_

## **ME430 - Mechatronics Laboratory Exam**

October 29, 2008

Problem	Score
1 - LED Lights	/20
2 - Piezo Buzzer	/30
3 - LCD and ADC	/20
4 - Pushbutton	/20
Code Submitted	/10
Total	/100

Put all four parts into the same .c file. When you are finished, all four parts will be running at the same time. If you feel confident about your coding skills, you can finish all four parts and get them checked off together.

You can use your computer, the class website, any class notes,  
and any lab code written by your team.

You may **not** use your neighbor or **any work that was not done by you.**

You CAN ask for help from the instructor. This will come at a price!  
Each time you ask for help with a part, you will lose 5 points.

**ME430 Mechatronic Systems:  
Lab Exam: PIC programming on the PICDEM 2 Board**

**Part 1: LED Lights**

\_\_\_\_\_ Hint: \_\_\_ Part A) Light pattern RB3->RB2->RB1->RB0-> (repeat)

\_\_\_\_\_ Hint: \_\_\_ Part B) Light changing every 1.2 seconds

**Part 2: Piezo Buzzer**

\_\_\_\_\_ Hint: \_\_\_ Part A) Buzzer making noise at low frequency

\_\_\_\_\_ Hint: \_\_\_ Part B) Buzzer heartbeat

\_\_\_\_\_ Hint: \_\_\_ Part C) Frequency changing, buzzer heartbeat

**Part 3: LCD Display and the ADC**

\_\_\_\_\_ Hint: \_\_\_ Part A) Display an arrow pointer on the LCD

\_\_\_\_\_ Hint: \_\_\_ Part B) Using the ADC to move the arrow up and down

**Part 4: Pushbutton Fires the Cannon**

\_\_\_\_\_ Hint: \_\_\_ Part A) Pressing RA4 Fires the Cannon

\_\_\_\_\_ Hint: \_\_\_ Part B) Everything working together

**Part 5: Code submission**

Upload your code to Angel (only the .c file)

## **Part 1: LED Lights**

### **Part 1A) Light Pattern RB3->RB2->RB1->RB0-> (repeat)**

Use the 4 LEDs on the PICDEM 2 board, make the LEDs flash in the sequence:

**RB3->RB2->RB1->RB0-> (repeating)**

Each light state can be displayed for any length of time that is visible to the human eye.

When you finish with this part you can have it checked off, or you can continue working on the problem. The program continues to build upon this part so checking off a later part counts as a check-off for all the earlier parts.

### **Part 1B) Light changing every 1.2 seconds**

Make each LED stay on for exactly 1.2 seconds.

For the rest of this exam the lights should continue to use a 1.2 second delay. I would highly recommend setting up a timer interrupt that happens every 1.2 seconds. Then I'd put the code to swap the LED within the Interrupt Service Routine. Using an interrupt will free up the while(1) loop for later parts.

Keep the #pragma config OCS = EC line set to the external (4 MHz) clock. You will need this later.

When you have finished part 1B, you have finished all of part 1. The program continues to build upon this part so you can get it checked off along with later parts.

## Part 2: Piezo Buzzer

### Part 2A) Buzzer making noise at low frequency

Have the buzzer make a steady low frequency noise at 300 Hz. Again keep the clock on the EC source. So in your PWM Period equation  $T_{osc} = 1/4\ 000\ 000$ .

You can call over an instructor to check off this part or continue working on the next part.

### Part 2B) Buzzer heartbeat

At the moment when the lights switch, have the buzzer create a 0.1 second beep (or beat). For example, when RB3 comes on make a 0.1 second beat. When RB2 comes on, make another beat. Use the 300 Hz buzzer noise (for now).

I would recommend also putting this code into the Interrupt Service Routine (ISR). The ISR will take 0.1 seconds to complete, but the while(1) loop in main is still totally empty.

You can get this checked off or move on to the next part.

### Part 2C) Frequency changing, buzzer heartbeat

Instead of always using 300 Hz for the heartbeat, have the frequency change according to which RBx light is on. Use the following system:

	RB3	RB2	RB1	RB0
300 Hz beat	<b>On</b>	Off	Off	Off
450 Hz beat	Off	<b>On</b>	Off	Off
600 Hz beat	Off	Off	<b>On</b>	Off
750 Hz beat	Off	Off	Off	<b>On</b>

Continue to use the 0.1 second beat. You should hear the frequency get higher.

When you have finished part 2C, you have finished all of part 2. The program continues to build upon this part so you can get it checked off along with later parts.

Special Note: When you get the buzzer checked off feel free to remove the little jumper above the piezo buzzer to stop it from annoying those around you. :). It's really pretty annoying. However, the buzzer code should always continue running for all later parts (just making no sound). For the last part, 4B, you will prove it's still working.

Please put back the jumper when done with the test for next hour.

## **Part 3: LCD Display and the ADC**

### **Part 3A) Display an arrow pointer on the LCD**

Display two ASCII characters on the LCD display at the top left. Display an arrow “->” (dash/minus sign then a greater than symbol)

As always, either get this part checked off or move on to the next part.

### **Part 3B) Using the ADC to move the arrow up and down**

Use the potentiometer to move the arrow up and down. If the potentiometer knob is right of center, display the arrow on Line 2 of the LCD. If the potentiometer is left of center, display the arrow on Line 1. Note: The arrow pointer is only displayed on one line at a time.

When you have finished part 3B, you have finished all of part 3. The program continues to build upon this part so you can get it checked off along with later parts.

## **Part 4: Pushbutton to Fire!**

### **Part 4A) Pressing RA4 Fires the Cannon**

For part 4A you need to use pushbutton RA4. When you press the button it should put a space and three dashes to the right of the arrow pointer “-> ---”. The three dashes should be displayed whenever the RA4 button is being pressed on the line where the arrow is displayed. (This is the cannon “firing”.)

The instructor will test your program by putting the arrow on Line 1 using the ADC then pressing RA4. Then the instructor will move the knob so that the cannon is on Line 2 and press the button to fire the cannon.

When you are finished with this part, read the next part and see if you can get them checked off together.

### **Part 4B) Everything working together**

If your earlier code has been made using interrupts as requested this should be the easiest part. Simply put back in the jumper for the piezo buzzer and demonstrate all the code requested in this exam happening harmoniously together.

Have your program checked off!

## **Part 5: Code submission**

### **Upload your code to Angel (only .c file)**

Go on Angel, under the Lessons tab, find the dropbox for your section and submit your file. You do not need to submit the LCD helper files. If you used multiple files like Supporting.c and Supporting.h, submit those (I'm guessing most people did not use helper files).

Make sure you add obvious things like your name and a brief description of what the program does before submitting the files.

Your commented title block and minimal comments within the project are important. You can also lose points for extremely inefficient or overly complex, brute force solutions. It is also possible to lose points for abundant worthless code that represents a lack of understanding. So if you copied code in from another lab make sure to remove things you don't need (like extra #include lines).

Submit your code on Angel before leaving the room.