Name _____ Class hours _____

ME430 - Mechatronics
Examination I
Dec 15th, 2016

Problem	Score	
1	/ 24	
2	/ 14	
3	/ 18	
4	/ 14	
5	code	check off
	/ 28	/2
Total	/100	

You may use only:

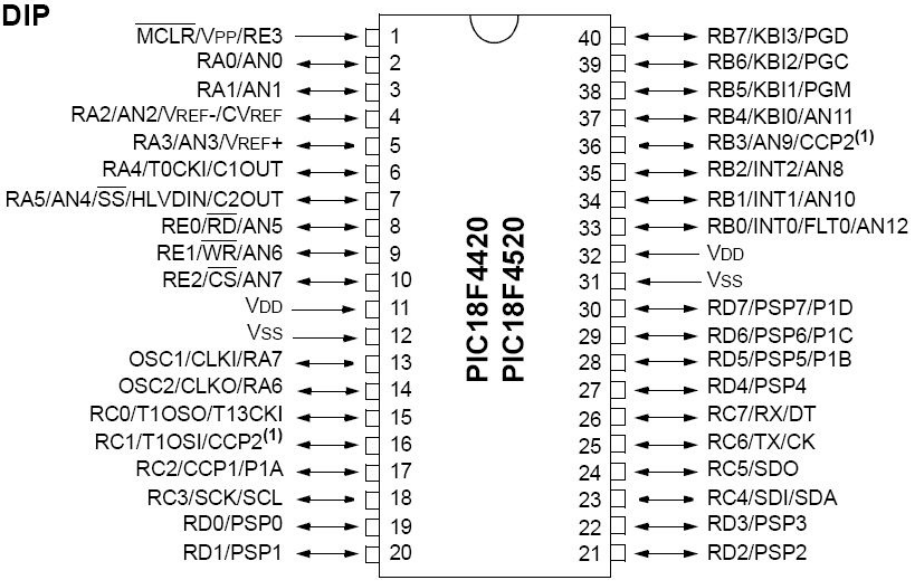
- Your computer
- Any paper notes (such as notes on the videos) you brought to the exam, so long as those notes were written by you or your lab partner.
- Any electronic notes or code residing on your local (C:) hard drive, so long as those notes/code were written by you or your lab partner.
- The course website. (This is the only approved use of the internet for this exam.)
- A calculator (optional).
- Moodle for code submission.

Anything not specifically allowed is prohibited. In particular, you may not use notes or code written by someone outside your lab group.

Reference

This diagram can also be found on the course website. It is copied here as a reference.

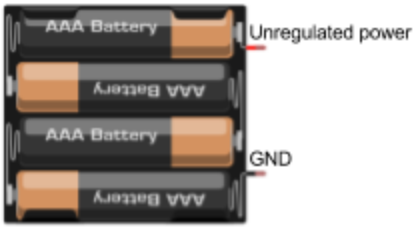
40-pin PDIP

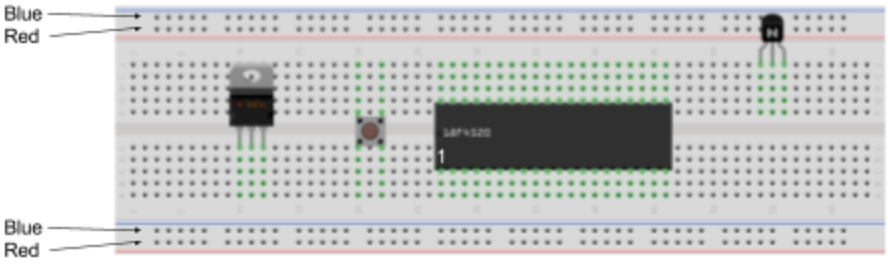


Problem 1 – DC Motor

For this problem you have a battery pack as your unregulated voltage, a voltage regulator, a switch, PIC, NPN BJT, and a small DC motor. Assume the DC motor has 60 ohm resistance and the unregulated power from the battery supply is exactly 6.0 volts. Show the wiring connections below to do the following:

- Make the blue rails be GND, top red rail be unregulated power, and the bottom red rail be 5.0 volt regulated power
- Setup the switch to control RA4, show the value on any resistor used
- Draw all necessary wiring connections on the PIC - pwr/ground, capacitors, etc.
- Connect the motor using a standard BJT circuit using the parts shown controlled by pin RC3 on the PIC. If you need to add resistors, capacitors, or diodes simply draw them. Only size resistors, putting your answers into the boxes below. Choose a **real resistor** from the E12 series of resistors. (*Hint: Day 2, in class*.) Show all work for your calculations.



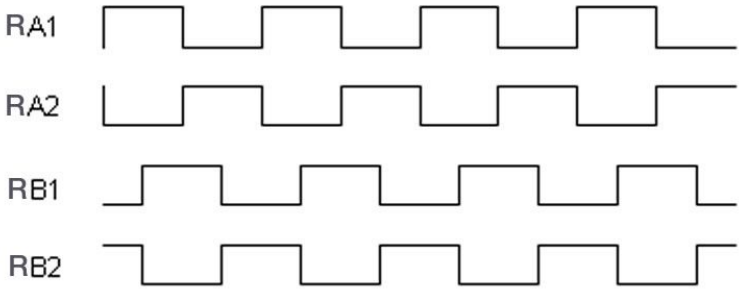


Exact BJT resistor value calculated

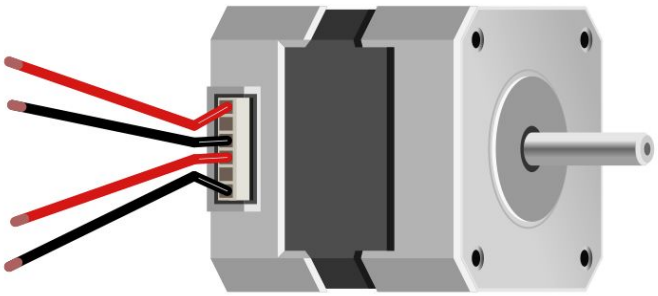
Real BJT resistor value

Problem 2 – Stepper

Assume that you have a stepper motor which is designed to run on 12 volts and a PIC that is programmed such that it has no inputs, but is continuously outputting high (5v) and low (0v) signals using this pattern on the pins shown:



Show every wiring connection that is necessary **on the H-bridge** to run the stepper motor. For the H-bridge, make the enable lines always enabled. On the PIC, only show the connections to the H-bridge. For the stepper motor, assume the top two wires are a pair and bottom two wires are a pair. For power draw a power supply symbol and clearly label it as regulated 5 volts (write **Reg 5v**), unregulated 6.3 volts (write **6.3v**), or unregulated 12 volts (write **12v**). For locations connected to ground draw a ground symbol. You may draw as many power and ground symbols as needed to avoid lots of messy crossing lines. Label any resistor sizes used. However to keep your drawing neater **DO NOT draw any snubber diodes or capacitors (gets too messy)**.



Problem 3 – Number systems and operators

Determine the output of each expression. Write the value stored as both an 8 bit binary number and as a signed char decimal number.

char x = 10 * 10;

Value stored in binary ☐☐☐☐☐☐☐☐ ☐ Decimal value if printed

char x = -100;

Value stored in binary ☐☐☐☐☐☐☐☐ ☐ Decimal value if printed

char x = 30 % 7;

Value stored in binary ☐☐☐☐☐☐☐☐ ☐ Decimal value if printed

char x = 30 / 7;

Value stored in binary ☐☐☐☐☐☐☐☐ ☐ Decimal value if printed

char x = 30 ^ 7;

Value stored in binary ☐☐☐☐☐☐☐☐ ☐ Decimal value if printed

char x = 30 * 7;

Value stored in binary ☐☐☐☐☐☐☐☐ ☐ Decimal value if printed

Problem 4 – C debugging

Consider the code scrap shown below.

```
#include <stdio.h>

void main(void) {
    int x = 5;

    for (i = 10; i < 13; i++) {
        x = x + i;
        if x > 25 {
            printf("Getting big ")
        }
        printf("x = %d\n", x)
    }

    while (1) {
    }
}
```

a. This code contains syntax errors and won't compile. Mark each mistake with an arrow and indicate how it should be fixed. Modify only issues that will cause the code not to run-- do not change the functionality.

b. If the errors were fixed what would the code print? Show your work to the side.

Output:

Problem 5 – C Programming

Create a new project in MPLABx that uses the Simulator. Starting from template.c, create a file called "lastname_firstname.c".

In that file, write a program that determines the total number of positive values in the array, the smallest value in the array, and the sum of all values in the array. **You will demonstrate your code for check-off using the following array:**

```
#define NUM_VALUES 10
int values[NUM_VALUES] = {0, 1, 20, 20, -5, -6, 20, 19, 18, 0};
```

The total number of positive values is 6. The smallest value is -6. The sum of all values is 87. Your program should print to the UART1 window, exactly as shown below, for your demo.

```
Num positive = 6
Smallest = -6
Sum = 87
```

Recall: You learned to **enable the UART1 window** in the day 4 lecture "Intro to MPLABx", "Hello World Program". (http://www.rosebotics.org/me430/unit?unit=4&lesson=2)

You are required to use a for loop to solve this problem and will receive no credit for hard-coded solutions. Your program must work for any array size (2 or larger) and any int values. Hint, be careful about checking for the smallest value if all values are positive. You can assume that the constant NUM_VALUES will match the size of the array. For example, here is another possible array.

```
#define NUM_VALUES 4
int values[NUM_VALUES] = {20, 30, 20, 30};
```

The output of that array would be:

```
Num positive = 4
Smallest = 20
Sum = 100
```

Assume that we will later test your code with other arrays. It must work for any array values. Try both of the arrays shown plus more, but demo with the first example. **When you complete this problem and have it running, call your instructor over to check it off on the front sheet.**

Regardless of whether you finish or not, submit your code into the Moodle dropbox (just the lastname_firstname.c file).