Name Key CM _____ Section _____

ME430 - Mechatronics
Examination I
December 17, 2013

Problem	Score
1	/ 8
2	/ 12
3	/ 12
4	/ 10
5	/ 24
6	/ 9
7	/ 25
Total	/100

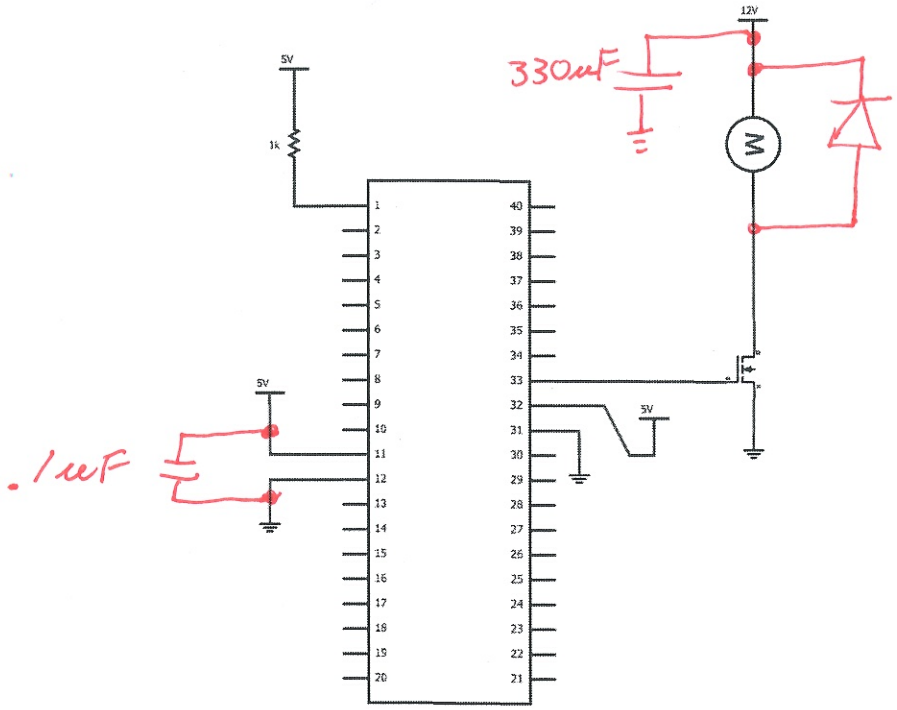
You may use only:

- 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.

Problem 1 – Inductive kick protection

Add snubber diodes and decoupling capacitors to this MOSFET circuit. Label capacitor values.



Problem 2 – Number Systems:

What is stored in **signed char X** in each of the following cases?

Write your answer in **binary**. (show all 8 bits)

10 = 00001010

-10 ⇒ 11110110

Calculation	X value
X = -10;	1111 0110
X = 20;	0001 0100
X = 0x20;	0010 0000

Problem 3 – Stepper motor drive

Assume you have a stepper motor controlled by an H-bridge chip (754410 chip, just like we used in lab). Assume that pins 2 and 7 are connected to one coil of the stepper motor and pins 10 and 12 are connected to the other coil. (Once again, as we did in lab.)

Show 8 steps of Full Step drive. Show a 0 for a low voltage going to the pin or a 1 for a high voltage.

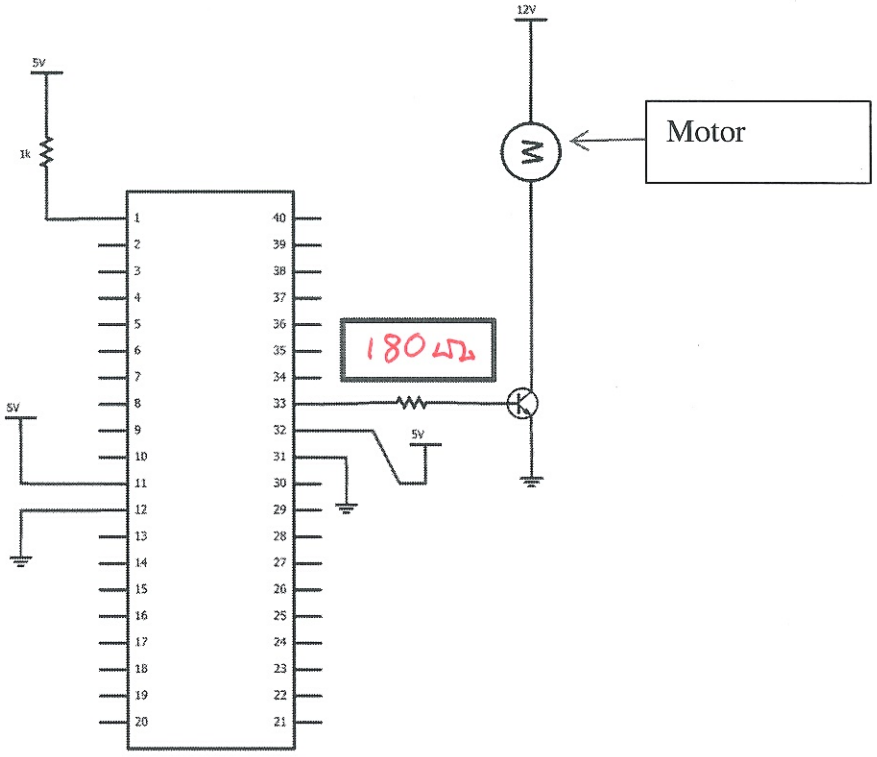
H-Bridge pin 2	H-Bridge pin 7	H-Bridge pin 10	H-Bridge pin 15
0	1	0	1
0	1	1	0
1	0	1	0
1	0	0	1
0	1	0	1
0	1	1	0
1	0	1	0
1	0	0	1

After these 8 steps how many degrees would our stepper motors from lab move?

$1.8° * 8 = \boxed{14.4°}$

Problem 4 – BJT Transistor:

Assume you have a 45 ohm motor that you are driving at 12 volts. What size resistor do we need going to the base of the BJT? Use a real resistor size from the E12 series and place your answer in the box above the resistor. *Note, snubber diodes and decoupling capacitors are not shown, but you don't need to add them.*



Motor

$V = iR$

$12 = i\ 45$

$i = \frac{12}{45}$

$i = 0.267\ A$

$i\ \frac{1}{10} = 0.0267A$

Pin to Base

$V = iR$

$5 = .0267\ R$

$R = \frac{5}{.0267}$

$R = 187.5\ \Omega$

Real value from R12

180 Ω

Also ok

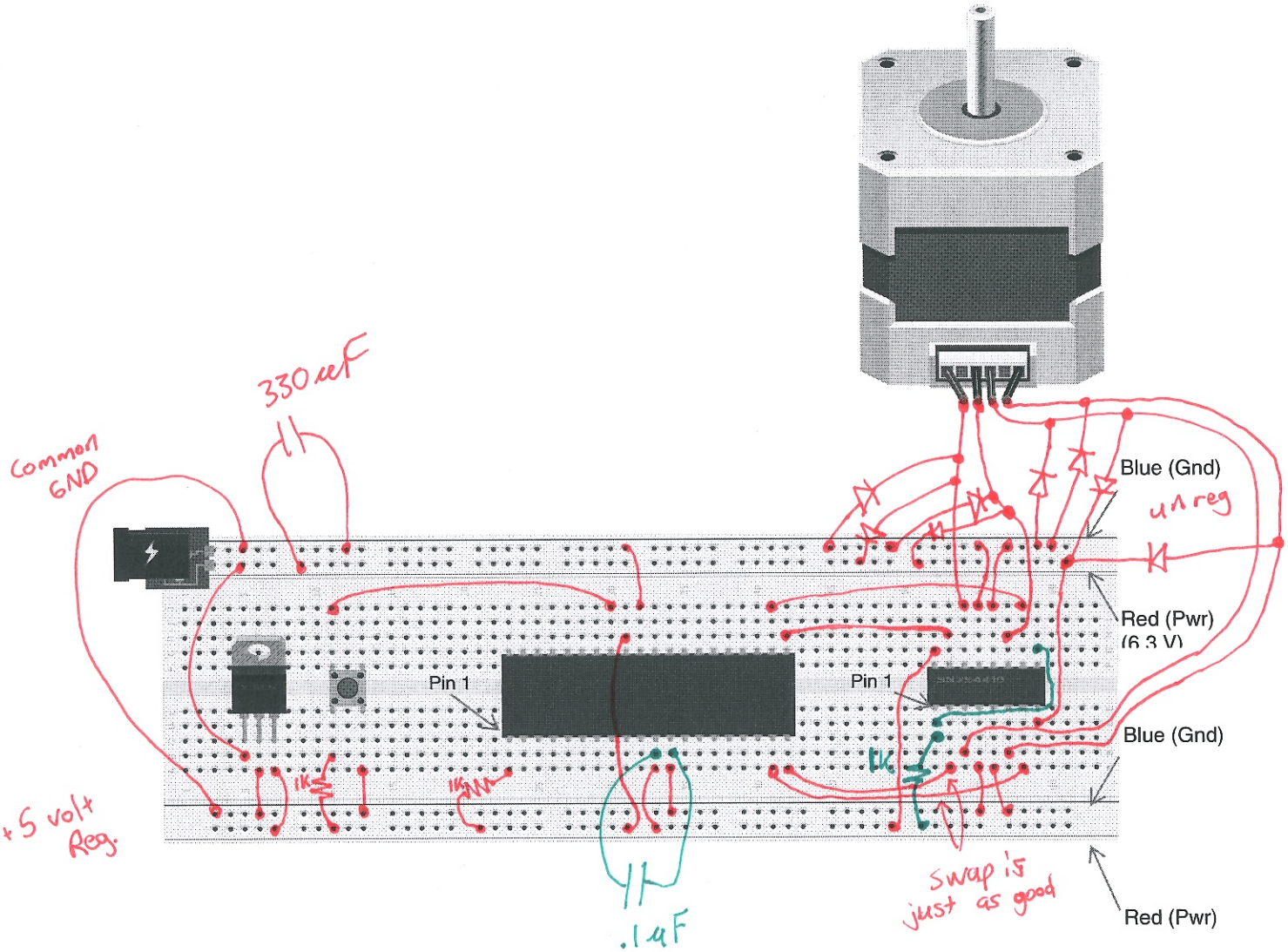
150, 220

Problem 5 – H-Bridge:

Below you will find a 6.3 volt power source connected on the top rail, a voltage regulator, a pushbutton, an 18F4520 PIC , an H-Bridge chip, and a stepper motor.

- Connect the voltage regulator (making a 5 volt power and ground rail on bottom)
- Set up a basic switch circuit with the pushbutton, and connect the signal line to RB0.
- Connect the PIC as needed (assume it is already programmed) to run the H-bridge:
  - RD0 and RD1 to one side of the H-bridge
  - RD2 and RD3 to the other side of the H-bridge
  - Power and ground on the PIC
  - MCLR on the PIC
- Connect all of the other H-Bridge pins as appropriate **in order to drive the stepper motor.**
- Add snubber diodes, decoupling capacitors, and size all resistors for the circuit.

You will need to draw the resistors, caps, and snubbers, but don't redraw any other components: connect to the ones shown. For wire connections on the board draw solid circles at the connection points. For example:



Problem 6 – C debugging

a. Consider the code scrap shown below. The red ! symbols indicate an error in the code. Mark the correction on the code. (Hint: #include <stdio.h> is already in the code—so it's not that.)

```
34  #pragma code
35  void main(void) {
        int n
        printf("The integer is %d \n",n);
38      while (1) {
39          // This area loops forever
40      }
41  }
```

missing ;

Note that n will have whatever value is in that memory location which might be 0 or any other value.

b. Now consider this code scrap. (Once again, it's not the #include <stdio.h>.) Mark the correction on the code.

```
34  #pragma code
35  void main(void) {
36      int n=2;
        for (i=0; i < 10; i++) {
38          n=n*2;
39      }
40      printf("n=%d",n);
41      while (1) {
42          // This area loops forever
43      }
44  }
```

int i;

Missing declaration of the variable i (char i; also good)

c. This one really has us stumped. There aren't any red symbols but nothing prints at all. Mark the correction on the code. (Hint: the print statement and the #includes are fine.)

```
34  #pragma code
35  void main(void) {
36      int n=2;
37      while (n < 2000);
38          n=n*2;
39      printf("n=%d",n);
40      while (1) {
41          // This area loops forever
42      }
43  }
```

Remove ; ; ends while statement. Probably meant ... while (n < 2000) { n = n * 2; }

Currently an infinite loop as n wouldn't change

Problem 7 – Simple C

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 code to sum all of the integers from 1 to 50 and print the answer to the UART 1 Output window. The answer should be printed as shown below:

```
The sum of all the integers from 1 to 50 is 1275
```

The answer must only print to the window one time. In order to get full credit for this problem you must use a loop to calculate the answer.

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

```
void main() {
    int sum = 0;
    int i;
    for( i = 0 ; i <= 50 ; i++) {
        sum += i;
    }
    printf("The sum of all the integers from 1 to 50 is
            sum );

    while(1) {
    }
}
```