Name Key CM _____ Section _____

ME430 - Mechatronics
Examination I
September 23, 2014

Problem	Score
1	/ 18
2	/ 16
3	/ 6
4	/ 30
5	/ 10
6	/ 20
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 – Number systems

0 1 1 0 0 0 0 1

Assume you have the following ones and zeros stored in your PICs memory:

a								b								c							
1	0	0	1	1	1	1	1	0	1	0	1	1	0	0	0	1	0	1	0	1	0	1	1

0 1 1 0 0 0 0 0 0 1 0 1 0 1 0 0 0

Pretend that there are **char** variables stored in positions **a**, **b**, and **c**. What is the decimal value for each char?

	Decimal value
Assume char **a** is **signed**	-97
Assume char **b** is **signed**	88
Assume char **c** is **unsigned**	171

Pretend that char b is storing a char that that represents an ASCII character.

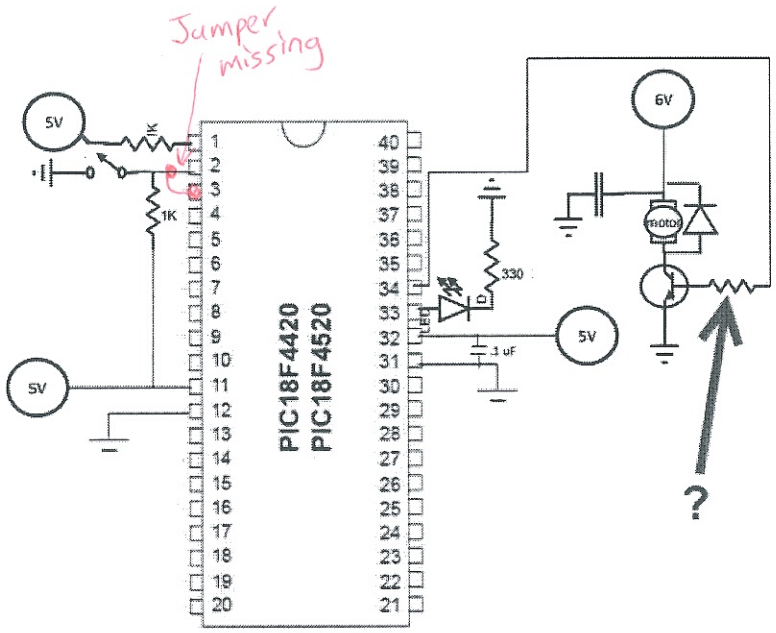
	ASCII value
What ASCII character is **b**?	'X'

Pretend that there is an int variable stored in position **a**. What is the decimal value? (Hint: the int starts at position **a** and runs to the right until it has enough digits. The int does not care whether we think a different variable starts at location **b**.)

	Decimal value
Assume int **a** is **signed**	-24,744
Assume int **a** is **unsigned**	40,792

Problem 2 – BJTs (Note that there are two parts to this problem)

Students working Lab 2 Part A (BJT) built this circuit, but haven't done a calculation yet. *(You may assume that the voltage regulator is set up correctly, even though it is not shown.)*



(a) Assuming they measured the motor's resistance as 80 ohms what size resistor should they use for the resistor with the question mark? Show your work, using 6.0 volts for the motor power, and state both the exact resistor size and the real resistor size you'd use. (Select a size from the E6 or E12 series. Hint: we covered this on day 2.)

Motor
$V = iR$
$6 = i(80)$
$i = 0.075\,A$

Want
$\frac{i}{10} \Rightarrow \frac{0.075A}{10} \Rightarrow .0075A$

PIC
$V = iR$
$5 = (.0075)R$
$R = 666.7\,\Omega$

Exact resistor size wanted: 667 Ω

Real resistor size used: 680 Ω

(b) The circuit <u>did not work</u> for that student! The LED turned on with the switch but the motor turned on at random times, sometimes with the switch and sometimes without the switch. Find their mistake and fix it on the circuit above (Hint: Use your notes from Lab 2 to help you).

Connect RA0 & RA1

Problem 3 – Stepper

A student was working Lab 2 part D. Is their circuit shown below correct? Circle the best answer below: *(You may assume that the voltage regulator is set up correctly, even though it is not shown.)*

A. It is correct.

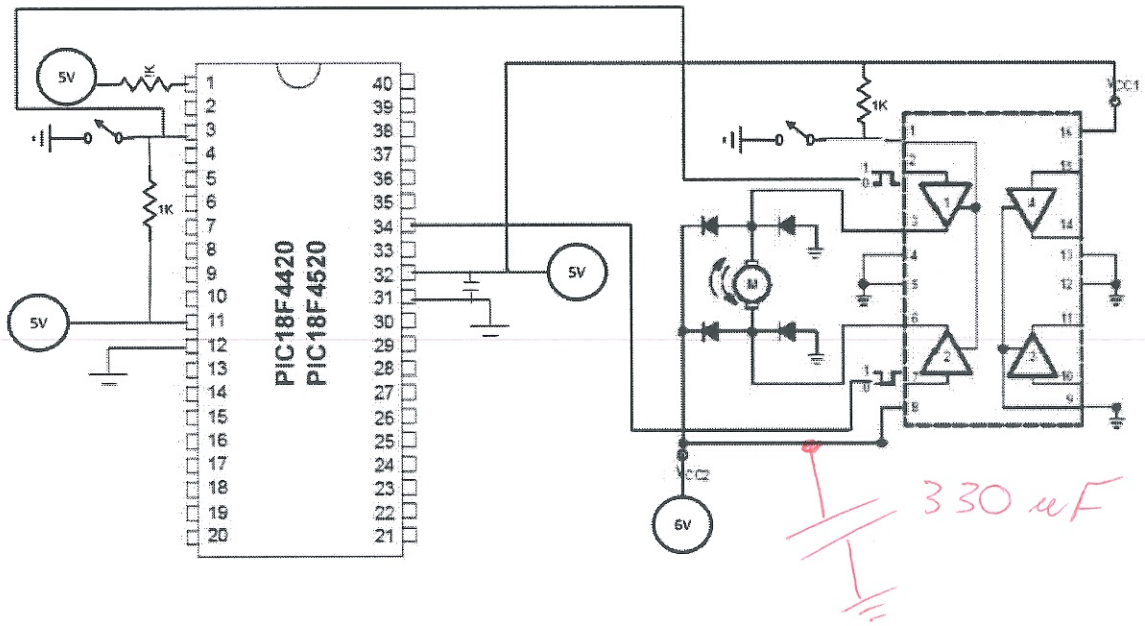
B. The basic switches are incorrect. The student should remove the 1K resistors between the high side of the switches and the 5V supply.

C. The snubber diodes near the motor are all in backwards. They should point the other way.

D. It is correct, but ideally I would add a decoupling capacitor between the 6V supply and ground.

E. It is correct, but ideally I would add another snubber diode between the 6V supply and ground.

F. None of the previous answers are appropriate. The circuit is **NOT** correct, and I have drawn the correction on the circuit.

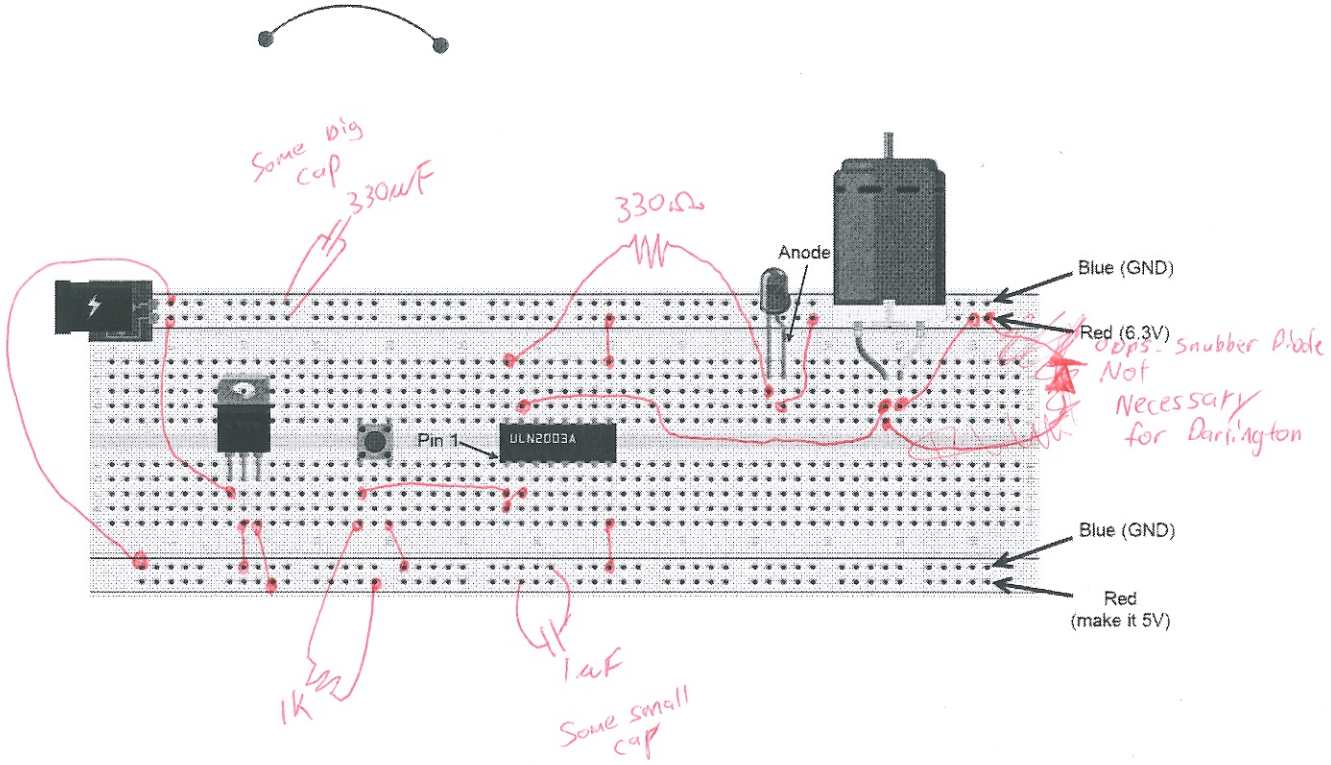


Problem 4 –Darlington:

Below you will find a 6.3 volt power source connected on the top rail, a voltage regulator, a pushbutton, a ULN2003 Darlington, an LED, and a DC 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 two Darlington inputs.
- Connect all of the other Darlington pins as appropriate **in order to drive the LED from one output and the motor from a different output. The switch should change the state of the LED and the state of the motor at the same time.**
- 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 5 – C debugging

a. Consider the code scrap shown below. It won't print "The value of i =5". It won't even compile. Mark the correction on the code. (Hint: #include <stdio.h> is already in the code—so it's not that or any other setup code that came earlier, assume that is all right just not shown.)

```
#pragma code
void main(void) {
    // Set the clock to 4 MHz
    OSCCONbits.IRCF2 = 1;
    OSCCONbits.IRCF1 = 1;
    OSCCONbits.IRCF0 = 0;

    // Pin IO Setup
    OpenADC(ADC_FOSC_8 & ADC_RIGHT_JUST & ADC_12_TAD,
            ADC_CH0 & ADC_INT_OFF & ADC_REF_VDD_VSS,
            0x0B); // Four analog pins
    TRISA = 0xFF; // All of PORTA input
    TRISB = 0xFF; // All of PORTB input
    TRISC = 0x00; // All of PORTC output
    TRISD = 0x00; // All of PORTD output
    PORTC = 0x00; // Turn off all 8 Port C outputs

    int i = 5;
    printf("The value of i = %d\n", i);

    while (1) {
    }
}
```

Variable declarations must be at the top of the function.

b. The goal this time is to toggle the RC0 and RC7 LEDs on the green board, but it isn't working. Mark the correction on the code.

b (x is for hex)

```
while (1) {
    PORTC = 0x10000000;
    Delay10KTCYx(100);
    PORTC = 0x00000001;
    Delay10KTCYx(100);
}
```

Problem 6 – 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 create a char array called **roseHulman** that is loaded with the character string "Rose-Hulman" then sum up all the ASCII values. Print the answer to the UART 1 Output window. (answer hidden here by XXXX)

```
The sum of the characters in Rose-Hulman = XXXX
```

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. You may hardcode the length of the loop to go from 0 to 10. To be clear your *code* must do all the math, it is pointless to manually do the calculation, we want to see that you can write *code* to do the job.

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

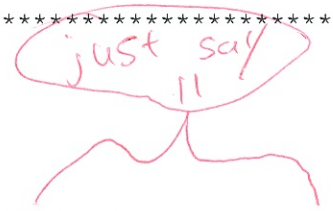
Next page.

```c
#include <stdio.h>

/** Global Variables ************************************************/
char roseHulman[] = "Rose-Hulman";

/*********************************************************************
 * Function:        void main(void)
 ********************************************************************/
#pragma code
void main(void) {
    int i;
    int sum = 0;
    for (i = 0; i < sizeof(roseHulman); i++) {
        sum += roseHulman[i];
    }
    printf("The sum of the characters in Rose-Hulman = %d\n", sum);

    while (1) {
    }
}
```



OR $i <= 10$

sizeof is a function that you don't know it