Name KEY CM _____ Section _____

ME430 - Mechatronics
Examination I – Written Portion
December 15, 2011

Problem			Score	
5:14 - 5:19	1	5	/ ##	12
5:24 - 5:25	2	1	/ ##	3
5:26 - 5:27	3	1	/ ##	10
5:30 - 5:32	4	2	/ ##	10
5:32 - 5:33	5	1	/ ##	5
	Total	10 min	/ ##	40

For the written portion of the exam, you may use only:

- 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.
- A pencil/pen.
- A calculator (optional).

For the computer portion of the exam, you may use only:

- Your computer
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- 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).
- ANGEL 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, Variable Types, and Operators

What are the decimal values of `result1` and `result2` in the following code segment? Show all your work for full credit.

```
signed char a = 3;
signed char b = 0x40;
signed char c = 0x07;
signed char d = 0b00100000;
signed char result1, result2;

result1 = a*b;
result2 = c/a*d;
```

2 pts a = 3 b = 4 * 16 = 64 a * b = 192

2 pts 192 = 1100,0000 binary

this will be negative −01000000 = −64

2 pts 2 pts

c = 7

a = 3

2 pts d = $10_{32}\,0000_{8\,4\,2\,1}$ = 32_{10}

2 pts 7/3 * 32 = 2 * 32 = 64

result1 = −64

result2 = 64

Problem 2 – Special Function Registers

Match the functional description to each Special Function Register (SFR).

3 pts

b ADCON1
c TRISA
a PORTD

a. set or read pin value
b. set pins to analog or digital
c. set pins as inputs or outputs

Problem 3 – Clock Frequency and Instruction Cycles

Write the delay command(s) required to create a 15 millisecond delay when the clock frequency is set to 1 MHz. Show all your work for full credit.

6 pts

Clock frequency 1 MHz

Inst Cycle Frequency 250 kHz 2 pts

4×10^{-6} s/cycle } 4 pts (may not need to find period explicitly)

15 ms ⇒ 3750 Inst Cycles

4 pts

```
Delay10TCYx(50);
Delay100TCYx(37);
```

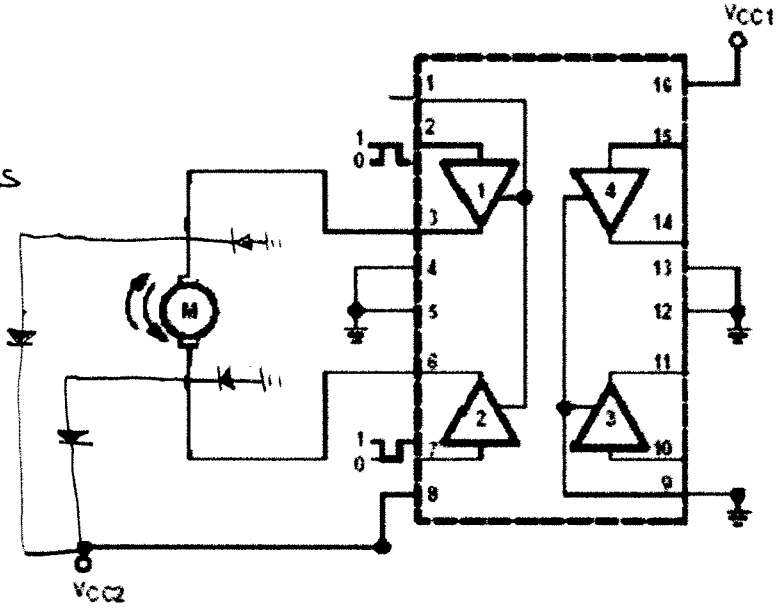
-2 if use # > 255

-3 if use a decimal (i.e. 37.5)

Problem 4 – Snubbers

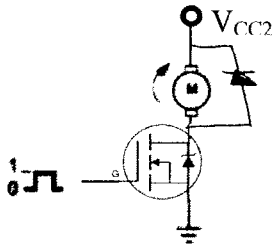
6 pts (a) Add snubber diode(s) to the motor circuit shown in the schematic below:

2 directions
2 connections
2 four diodes



4 pts (b) Add snubber diode(s) to the motor circuit shown in the schematic below:

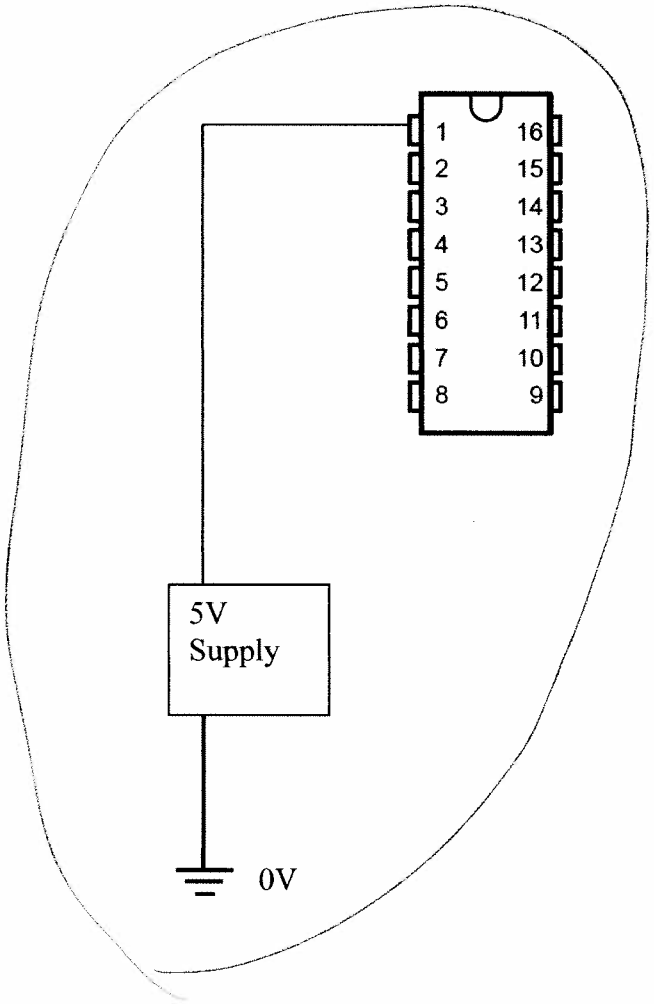
1 direction
1 connection 1
1 connection 2
1 just one diode

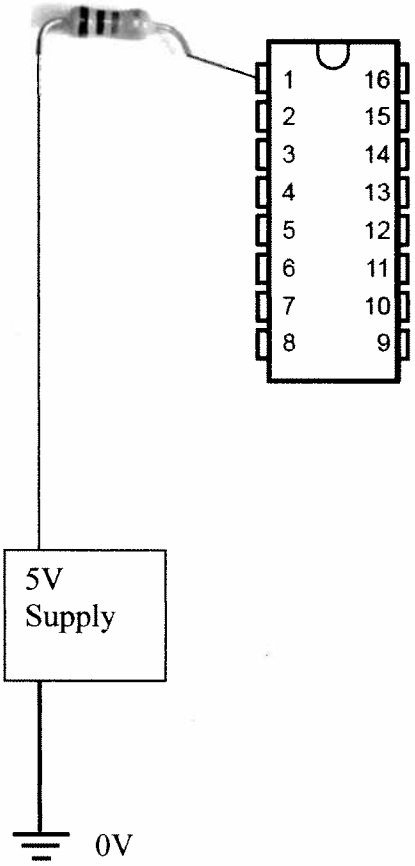


Problem 5 – Logical High and Power

One of the diagrams below shows a chip with a pin held at +5V for logic (the proper procedure for an enable line). The other diagram shows a chip with a power pin at +5V.

Circle the diagram that shows a power pin.





5 pts (all or nothing)

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ME430 - Mechatronics
Examination I – Computer Portion
December 15, 2011

Problem			Score
5:35 - 5:37	6	2	14 / ##
5:39 - 5:42	7	3	9 / ##
5:43 - 5:45	8	2	11 / ##
5:46 - 5:50	9	4	26 / ##
Total		11 min	60 / ##

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14 **Problem 6 – Printing**

Suppose that we want to print the numbers 1 through 3 to the UART window using a for loop. We want each number on a separate line, and we want each number to appear in the window only once. Insert the appropriate lines of code into the template file below (don't worry about the comments):

```
/*********************************************************************
* Prints the numbers 1 through 3 to the UART window
*********************************************************************/

/** Header Files ******************************************************/
#include <p18f4520.h>
```

2 `#include <stdio.h>`

```
/** Configuration Bits ************************************************/
#pragma config OSC = EC  // EC = External 4MHz Crystal for PICDEM board only
#pragma config WDT = OFF
#pragma config LVP = OFF
#pragma config BOREN = OFF
#pragma config XINST = OFF

/** Define Constants Here *********************************************/
#define SAMPLE 100

/** Global Variables **************************************************/
int sampleVariable = 0;



/*********************************************************************
* Function:        void main(void)
*********************************************************************/
#pragma code
void main (void)
{
      // This area happens once
      // Good for initializing and things that need to happen once
      int a;
      for (a=1; a<=3; a++)
      { printf ("%d\n", a); }
      while (1)
   {
         // This area loops forever


   }
}
```

2 4 6

-1 if used a=3

= more space

= more space

printf line: { } 2 for brackets

some format 2

correct format including \n 2

9 **Problem 7 – Using Special Function Registers**

Specify the Special Function Registers (SFRs) in the code segment below according to the following specifications. Assume all other variables are appropriately defined before getting to `void main (void)`.

- Make five analog inputs. (the ~~first~~ 5)
- Set pins RA4, RA6, and RA7 to be outputs and pins RA0 – RA3 and RA5 to be inputs
- Set pins RB0 – RB7 to be outputs.
- Set RA4 and RA7 high. Set RA6 low.

```
void main (void)
{
      ADCON1 = 0b00001010 ;    or  0x0A
      TRISA = 0b00101111 ;     or  0x4F
      TRISB = 0b00000000 ;     or  0x00
      PORTAbits.RA4 = 1 ;
      PORTAbits.RA7 = 1 ;
      PORTAbits.RA6 = 0 ;

      PORTB = 0x00;

      idx = 1;
      result = 0;
      while( idx <= 5 )  {
            result = result + idx;
            printf("result = %d \n", result);
            PORTB = result;
            idx = idx + 1;
         }
      while(1) {
      }
}
```

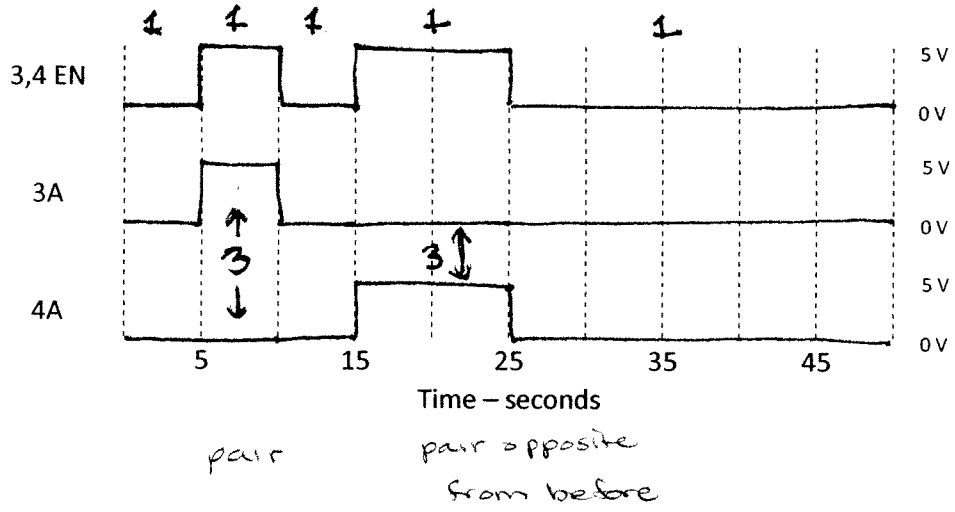
11 **Problem 8 – H-bridges**

Sketch the enable signal and two motor control input signals needed to drive a 24V bi-directional DC motor according to the specifications below. Use the grid provided for sketching your signals. Assume the DC motor is connected to the right-hand side of an h-bridge, which is the same as the one in your kits. The control sequence for the motor is:

1. Disabled for 5 seconds.
2. Enabled one direction for 5 seconds.
3. Disabled for 5 seconds.
4. Enabled in the opposite direction for 10 seconds.
5. Disabled for remaining time.

5 pts

6 pts



pair

pair opposite from before

Problem 9 (26 pts) – Wiring

Connect the components shown below to accomplish the tasks on the list. ***Note: you should not be adding any schematics to the figure—make your connections to the pictures of the components.***

7 1. Create a regulated 5V power line from the 6.3V supply. To keep your diagram neater, after you have created the regulated 5V power line use the symbol and label, ⏚ +5V, where it is needed. Similarly, use the standard ground symbol for necessary ground points. Assume all the grounds are interconnected. – 1 is don't follow instructions

7 2. Make the appropriate connections to the PIC for the
   a. MCLR line (always held high) 3
   b. ground(s) 2
   c. power(s) 2

4 3. Create a basic switch and connect the signal line to RA1 on the PIC.

8 **4.** Make appropriate connections to allow the RB1 pin on the PIC to turn the magic box on and off. The magic box runs on 12V and draws 40 mA of current.