Name Key CM _____ Section _____

ME430 - Mechatronics
Examination I
September 18, 2012

Problem	Score
1	/ 15
2	/ 8
3	/ 12
4	/ 6
5	/ 9
6	/ 10
Total	/ 60

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
- 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).
- ANGEL for code submission.

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Problem 1 – Number systems:

(a) A variable that is 4 bits is called a nibble.

I. If you had a nibble with the value 6, what bits would be stored in memory? (Show leading zeros as appropriate to show the entire nibble in memory.)

0110

3 pts

II. Assuming a nibble uses the standard two's complement convention for negative numbers show the bits stored in memory for the value -3. (Show leading zeros as appropriate to show the entire nibble in memory.)

1101

3 pts

III. What is the largest positive number that a signed nibble can store? (Give this answer as a decimal value.)

7

3 pts

IV. What is the most negative number that a nibble can store? (Give this answer as a decimal value.)

-8

3 pts

(b) What is the minimum number of bits needed to store the decimal value 300 in a signed variable?

10

3 pts

Problem 2 – Operators:

Assume you have a variable called `eggs` which is a char. You want to determine how many dozen eggs you have, and how many remaining eggs you have. Write a line of C code that calculates the number of `dozen_eggs` and another line of code to determine the `remaining_eggs`. For example, if eggs was 15 then `dozen_eggs` should become 1, and `remaining_eggs` should become 3.

```
char eggs = 75;
```

`char dozen_eggs =` eggs / 12 ; 4 pts

`char remaining_eggs =` eggs % 12 ; 4 pts

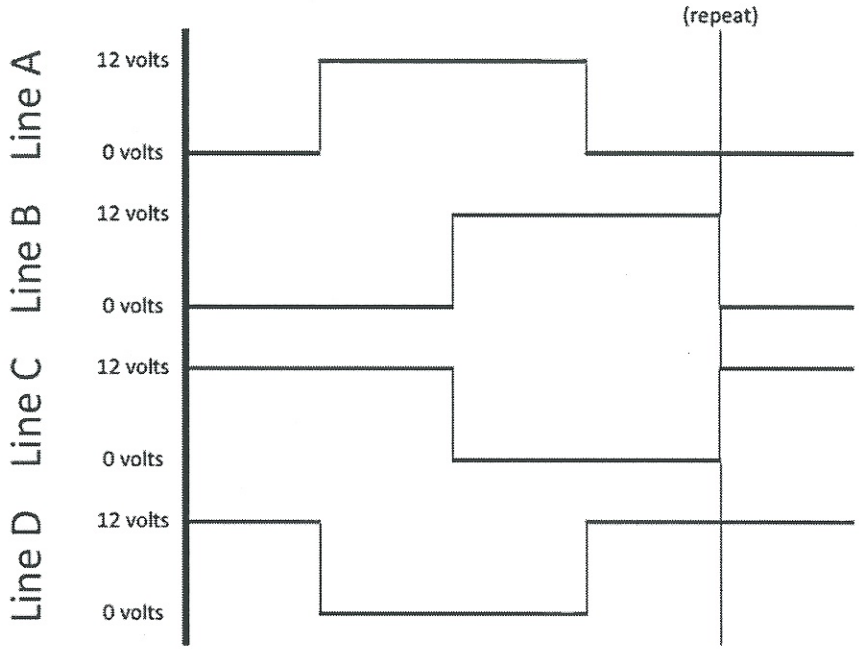
Problem 3 – Variables and operators:

True is defined as any **non-zero** value. **False** is defined as **zero**. Determine if each statement is true or false.

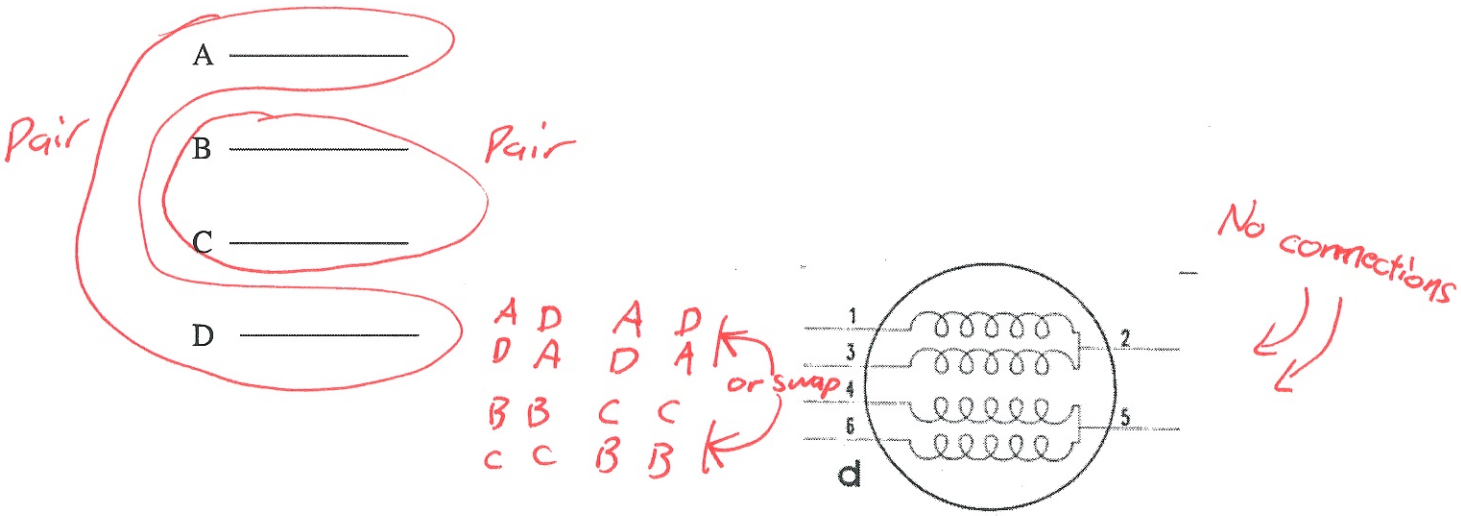
	Circle one
15 >> 4	T or F
(7 ^ 5) – 2	T or F
30 % 10	T or F
(2 - 2) || (2 + 2)	T or F
7 && 0 && 15	T or F
(6 | 2) – 6	T or F

Problem 4 – Wiring a stepper motor:

You are taking over a circuit where someone was connecting to a 12 volt stepper motor. You find the four wires that were going to the motor and monitor them on an oscilloscope. They look like this:



Draw connections to the stepper motor for these lines for full wave drive.



6pts

Just check for the pairs.

Problem 5 – Special function registers:

Give the commands to make all of PORT A and PORT C digital outputs and all of PORT B and PORT D digital inputs.

```
ADCON1 = 0x0F;   ← 3pts
TRISA  = 0x00;   ← 3pts
TRISC  = 0x00;
TRISB  = 0xFF;   ← 3pts
TRISD  = 0xFF;
```

Problem 6 – Instruction cycles:

Write the line(s) of code necessary to perform the specified tasks.

Write the code that sets up the PIC to use the external 4MHz crystal.

```
#pragma config OSC = EC
```

~~3pt~~ 2 pts

Write the code to delay for 25 milliseconds, still using the 4MHz crystal. Show your calculations for the delay time and give the command itself.

Freq Clock = 4 MHz

Freq Instr = 1 MHz

Period Instr = 1 μS

Need 25 instructions for 25 μS so need 25,000 instructions for 25 mS.

```
#include <delays.h>

Delay1KTCYx(25);
```

Work 3pts

Code 4pts

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ME430 - Mechatronics
Examination I – Computer Portion
September 18, 2012

Problem	Score
7	/ 25
8	/ 15
Total	/ 40

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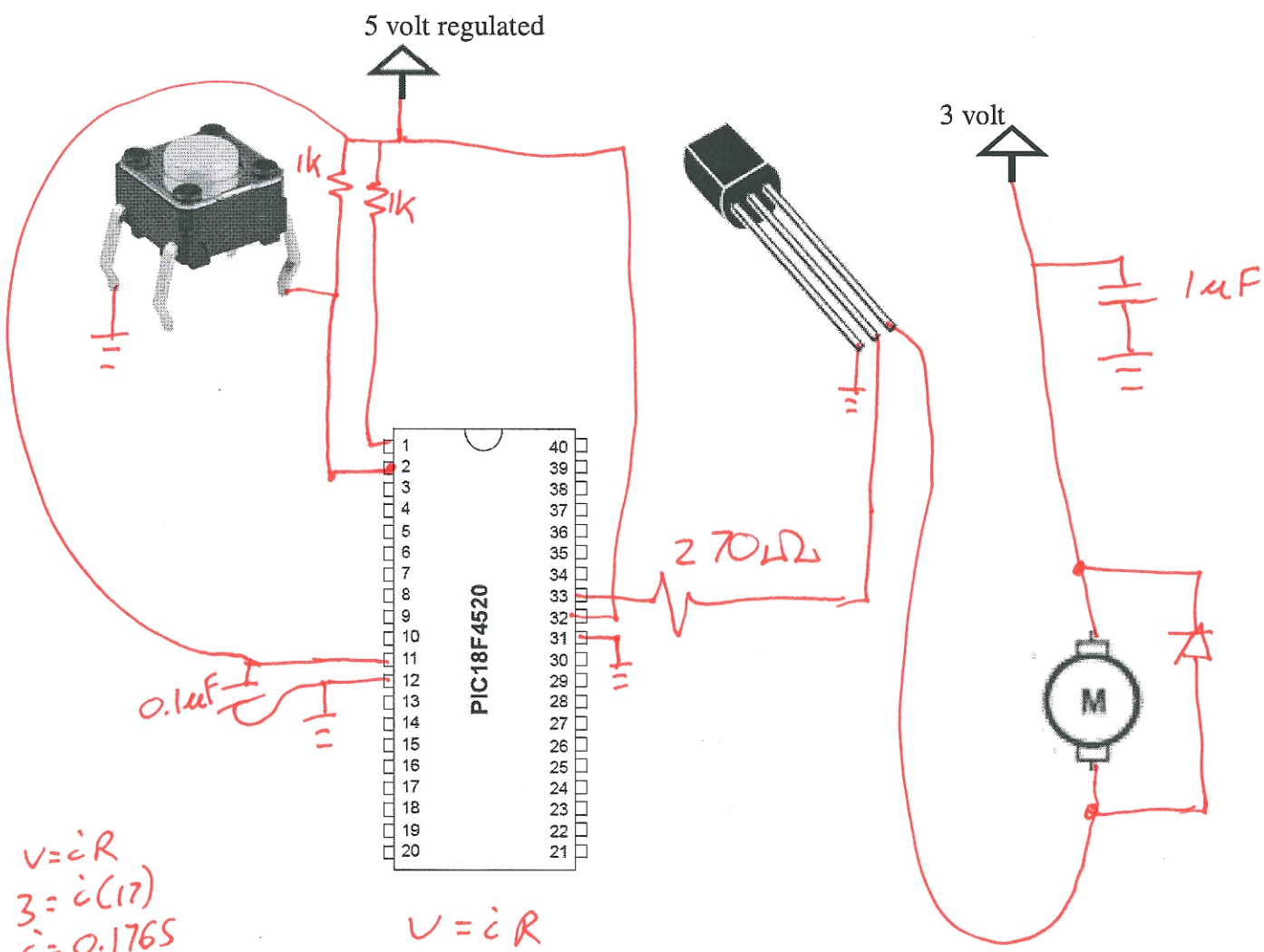
Problem 7 – Resistor sizing BJT (NPN):

We wish to create an NPN BJT circuit to drive a pager motor. (On the diagram below, make connections to the physical devices shown, don't redraw a schematic symbols for those items.)

- Draw the power, ground, and enable (MCLR) connections on the PIC.
- Draw a basic switch into pin 2 of the PIC.
- Assume the PIC is using pin 33 to drive the BJT. The pager motor uses a 3 volt source and we have measured its resistance to be 17 ohms. Draw the resistor(s), ground, and wires to the PIC, transistor, power sources, and pager motor shown below.
- Show the calculations to size any resistors that are needed to drive the BJT. Choose standard E12 series (10%) size resistors and label them on the diagram.
- Add inductive kick protection to your circuit as appropriate.



$V = iR$
$3 = i(17)$
$i = 0.176S$

$\frac{i}{10} = 0.0176S$

$V = iR$
$5 = .0176R$
$R = 283.3\,m\Omega \Rightarrow^{Real} 270\Omega$ (or 330Ω)

Problem 8 -- Digit Lights Program

Start this program with the template.c file but rename it to **problem8_yourName.c.**

Create a program that displays a light pattern. Use the following pattern that occurs exactly one time.

- Just RB0 & RB3 on
- Delay 0.5 seconds
- Just RB1 & RB2 on
- Delay 1 second
- Just RB0 on
- Delay 2 seconds
- All lights off

Put your finished code (just the *.c file) in the Angel dropbox.

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

/*************************************************************
*******
* Function:        void main(void)
*************************************************************
*******/
#pragma code
void main (void)
{
  ADCON1 = 0x0F;
  TRISB = 0x00;

  PORTB=0b1001;
  Delay10KTCYx(50);
  PORTB=0b0110;
  Delay10KTCYx(100);
  PORTB=0b0001;
  Delay10KTCYx(200);
  PORTB=0b0000;

  while (1){
    }
}
```