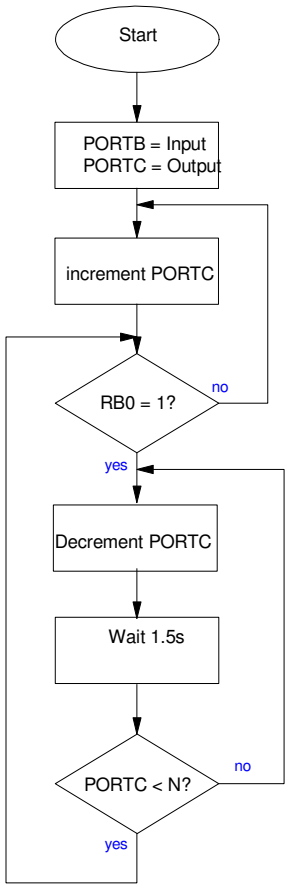
ECE 376 - Test #2: Name _____

C-Programming on a PIC Processor

Open book, open notes. Calculators and Matlab permitted. Individual effort (help from other people or web sites where other people help you solve the problems not permitted).

1) C Coding & Flow Charts. Write a C program for an random count-down timer.

- Let N be Your Birth Date (1..31).
- When you press RB0 (PORTB pin 0), a random number (0..255) is placed in PORTC
- The counter then counts down, one count every 1.5 seconds (i.e. problem #4), until PORTC < N
- It then repeats, waiting for you to press RB0



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N = 14 (birth date 1..31)

```
#include <pic18.h>

void main(void) {
  ADCON1 = 0x0F;


   TRISB = 0xFF;
   TRISC = 0x00;
   TRISC = 0;

   while(1) {

      while(RB0 == 0) {
         PORTC = PORTC + 1;
         }

      while(PORTC >= 14) {

         PORTC = PORTC - 1;

         Wait_ms(1500);

         }

      }
```

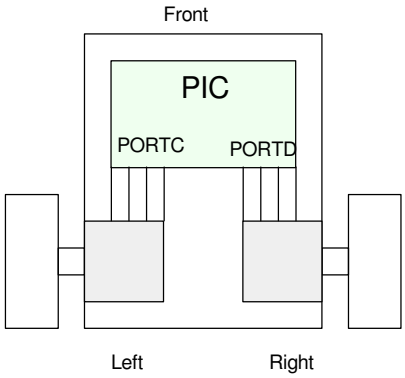
2) Battle Bots! Write a C program to control a battle bot.

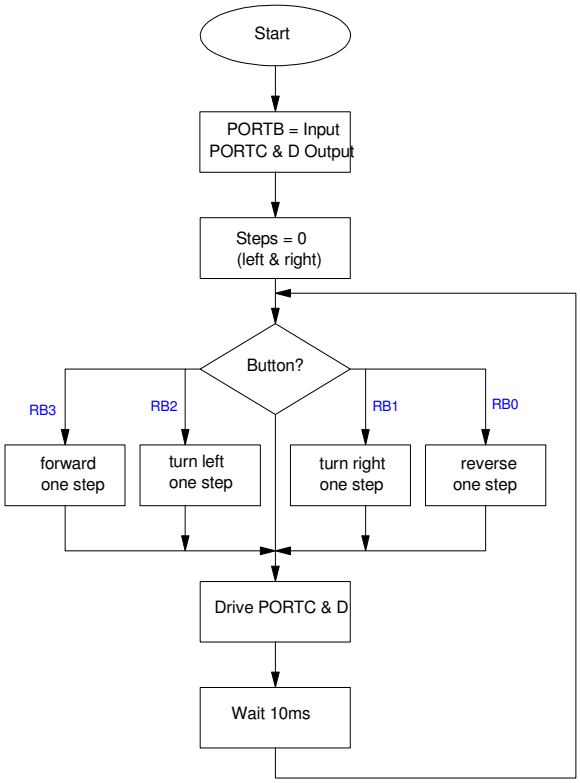
- A stepper motor is connected to PORTC (left motor) and PORTD (right motor)
- The motor spins forward when PORTX goes through the sequence {1, 2, 4, 8, repeat}
- The motor spins in reverse when PORTX goes through the sequence {8, 4, 2, 1, repeat}

PORTB controls the motor (10ms/step when the motor is spinning)

Button	none	RB3 forward	RB2 turn left	RB1 turn right	RB0 reverse
Left Motor (PORTC)	stop	forward 1-2-4-8	reverse 8-4-2-1	forward 1-2-4-8	reverse 8-4-2-17
Right Motor (PORTD)	stop	forward 1-2-4-8	forward 1-2-4-8	reverse 8-4-2-1	reverse 8-4-2-1

Write the corresponding C code

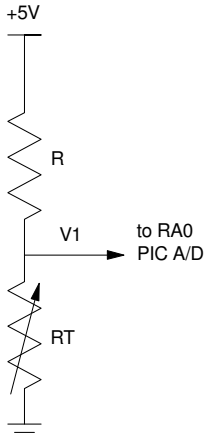





```
const unsigned char TABLE[4] = {1, 2, 4, 8};

void main(void) {
   unsigned char LEFT, RIGHT;
   ADCON1 = 0x0F;

   TRISB = 0xFF;
   TRISC = 0;

   LEFT = 0;
   RIGHT = 0;

   while(1) {

      if(RB3) {  LEFT = LEFT + 1;  RIGHT = RIGHT + 1; }
      if(RB2) {  LEFT = LEFT - 1;  RIGHT = RIGHT + 1; }
      if(RB1) {  LEFT = LEFT + 1;   RIGHT = RIGHT - 1; }
      if(RB0) {  LEFT = LEFT - 1;   RIGHT = RIGHT - 1;  }

      PORTC = TABLE[ LEFT % 4 ];
      PORTD = TABLE[ RIGHT % 4 ];

      Wait_ms(10);
      }
   }
```

Analog Inputs

3) Assume the A/D input to a PIC processor has the following hardware connection where R_T is a 3k thermistor where T is the temperature in degrees C



$$R_T = 3000 \cdot \exp\left(\frac{3200}{T+273} - \frac{3200}{298}\right)\Omega$$

Let R be a resistor

R = 1000 + 100*(your birth month) + (your birth date).

For example, May 14th would result in R = 1514 Ohms

If the A/D reading is 372, determine **Test - Do Not Post**

- The voltage at V1
- The temperature in degrees C, and
- How much the temperature would have to change for the PIC to detect that change

R 1000 + 100*mo + day	A/D Reading	V1 volts	RT (Ohms)	Temperature degrees C
1514 Ohms	**372**	**1.818V**	**865 Ohms**	**64.03C**

$$V_1 = \left(\frac{372}{1023}\right)5.00V = 1.818V$$

$$V_1 = \left(\frac{R_T}{R_T+1514}\right)5V$$

$$R_T = \left(\frac{1.818V}{5V-1.818V}\right)1514\Omega = 865.1\Omega$$

$$T = 64.03^0C$$

chi-squared test

4) (10pt). A 5-sided die is rolled 33 times. The results are

1	2	3	4	5
8	9	7	6	13

Use a chi-squared test to determine the probability that this is a fair die (all numbers have equal probability)

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Chi-Squared Table

Probability of rejecting the null hypothesis

dof	99.5%	99%	97.5%	95%	90%	10%	5%	2.5%	1%	0.5%
1	7.88	6.64	5.02	3.84	2.71	0.02	0	0	0	0
2	10.6	9.21	7.38	5.99	4.61	0.21	0.1	0.05	0.02	0.01
3	12.84	11.35	9.35	7.82	6.25	0.58	0.35	0.22	0.12	0.07
4	14.86	13.28	11.14	9.49	**7.78**	1.06	0.71	0.48	0.3	0.21
5	16.75	15.09	12.83	11.07	9.24	1.61	1.15	0.83	0.55	0.41

roll	p	np	N	chi squared
1	1/5	6.6	8	0.3
2	1/5	6.6	9	0.87
3	1/5	6.6	7	0.02
4	1/5	6.6	6	0.05
5	1/5	6.6	13	6.21
			Total	**7.45**

From the Chi-squared table with 4 degrees of freedom, a chi-squared score of 7.45 corresponds to a probability of 90%

I am 90% certain this is not a fair die

t-Tests

5) (15pt) Through week #5, the opponents of the Minnesota Vikings have scored:

- { 27, 34, 17, 14, 17 } points
- mean = 21.800 points per game
- standard deviation = 8.408 points per game

a) Use a t-test to determine how many points the Vikings have to score on offense to be 99% certain of winning the game?

b) Assume the Vikings score 34 points in game #6. What is the chance they will win that game?

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Student t-Table area of tail										
dof \ p	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0
1	1	1.38	1.96	3.08	6.31	12.71	31.82	63.66	318.31	636.62
2	0.82	1.06	1.39	1.89	2.92	4.3	6.97	9.93	22.33	31.6
3	0.77	0.98	1.25	1.64	2.35	3.18	4.54	5.84	10.22	12.92
4	0.74	0.94	1.19	1.53	2.13	2.78	3.75	4.6	7.17	8.61
5	0.73	0.92	1.16	1.48	2.02	2.57	3.37	4.03	5.89	6.87
infinity	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.29

a) 5 data points means 4 degrees of freedom

99% certain means a tail with 1% area

We're looking for a t-score of 3.75

$$points = x + 3.75s$$

$$points = 21.80 + 3.75 \cdot 8.408$$

points = 53.33 points

This Vikings need to score 53.33 points to be 99% certain of winning.

b) If the Vikings score 34 points,

The t-score is

$$t = \left(\frac{34-21.8}{8.408}\right) = 1.451$$

This corresponds to a tail with an area of about 13%

If the Vikings score 34 points, there is a 13% chance they will lose

If the Vikings score 34 points, there is an 87% chance they will win