

ECE 376 - Homework #6

A/D Converters, Data Collection, Chi-squared Test, Student t-Test.
Due Monday, October 10th

Analog Inputs

1) Determine how long it takes to do an A/D conversion with a PIC processor

```
void main(void)
{
    TRISC = 0;
    ADCON1 = 0x0F;

    // Turn on the A/D input
    TRISA = 0xFF;
    TRISE = 0x0F;
    ADCON2 = 0x95;
    ADCON1 = 0x07;
    ADCON0 = 0x01;

    while(1) {
        A2D = A2D_Read(0);
        PORTC = PORTC + 1;
    }
}
```

Result:

- RC5 outputs 478.8Hz
- RC0 outputs 32x that frequency (15,321.6 Hz)

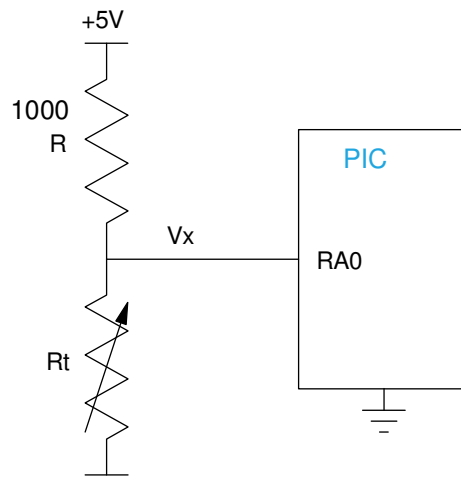
$$N = \left(\frac{10,000,000}{2 \cdot \text{Hz}} \right)$$

$$N = 326.33 \text{ clocks}$$

It takes about 326 clocks to do an A/D read (32.6us)



2) Assume the A/D reads 371 for the following circuit.



What is the voltage, V_x ?

$$V_x = \left(\frac{371}{1023} \right) 5V = 1.8133V$$

What is the resistance, R_t ?

$$V_x = \left(\frac{R_t}{R_t + 1000} \right) 5V$$

$$R_t = \left(\frac{V_x}{5 - V_x} \right) \cdot 1000\Omega$$

$$R_t = 569.02\Omega$$

What is the temperature?

$$R_t = 1000 \cdot \exp \left(\frac{3905}{T + 273} - \frac{3905}{298} \right) \Omega = 569.02\Omega$$

$$T = 38.39^\circ C$$

Analog Inputs

Electronic Watering System

3) Requirements: Specity

Input

- Analog Input RA0 (0..5V)
- Button RB0

Output

- LCD Display
- PORTC

Relationship

- Adjust the analog input from 0 to 1023
- Press RB0
- The lights on PORTC will turn on for N seconds where $N = 0.0$ to 102.3 seconds
- The time remaining is displayed on the LCD display
- When the time reaches 0.0 seconds, the lights on PORTC turn off and the program repeats

4) C-code and flow chart

< include C code >

Memory Summary:
Program space used 976h (2422) of 10000h bytes (3.7%)
Data space used 27h (39) of F80h bytes (1.0%)
EEPROM space used 0h (0) of 400h bytes (0.0%)
ID Location used 0h (0) of 8h nibbles (0.0%)
Configuration used 0h (0) of 7h words (0.0%)

5) Testing and Validation

- Collect data to shot you met the requirements

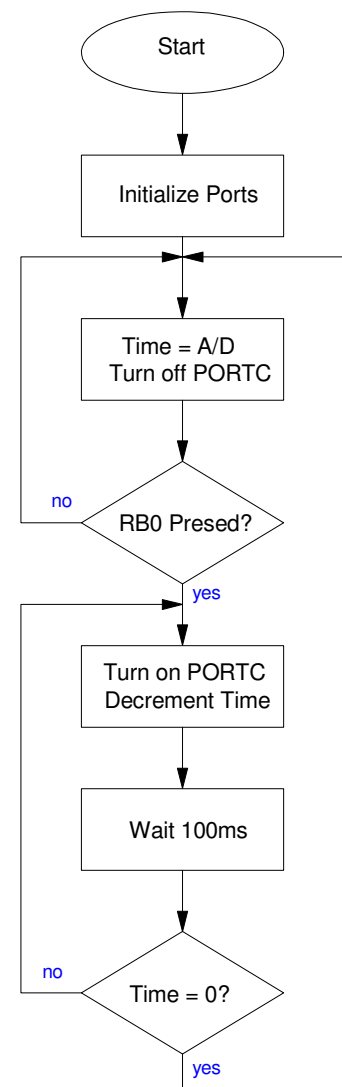
Analog input reads 000.0 to 102.3

RB0 starts the process

- PORTC turns on
- The timer decreases one count every 100ms
- When the count gets to zero, it stops and PORTC turns off

Using a stopwatch app

- 40.0 seconds takes 40.2 seconds (stopwatch app)
- 71.0 seconds takes 70.66 seconds



Chi-Squared Test

6) Determine experimentally using a chi-squared test whether or not the following C code produces a fair 6-sided die:

```
while(1) {  
    while(!RB0);  
    while(RB0) DIE = (DIE + 1) % 6;  
    DIE += 1;  
    LCD_Move(1,0); LCD_Out(DIE, 1, 0);  
    SCI_Out(DIE, 1, 0);  
    SCI_CRLF();  
}
```

Result:

Roll	p	np	N	chi-squared
1	1/6	13.17	10	0.76
2	1/6	13.17	12	0.1
3	1/6	13.17	12	0.1
4	1/6	13.17	10	0.76
5	1/6	13.17	15	0.25
6	1/6	13.17	20	3.54
Total				5.53

From StatTrek. this corresponds to a probability of 0.64533

There is a 64.5% chance that this is not a fair die

- Enter value for degrees of freedom.
- Enter a value for one, and only one, of the other textboxes.
- Click **Calculate** to compute a value for the remaining textbox.

Degrees of freedom

5

Chi-square critical value (x)

5.53

Probability: $P(X^2 \leq 5.53)$

0.64533

Probability: $P(X^2 \geq 5.53)$

0.35467

Calculate

7) Determine experimentally using a chi-squared test whether or not the following C code produces a fair 6-sided die:

```
while(1) {
    while(!RB0);
    while(RB0) {
        DIE = (DIE + 1) % 6;
        X = (X + 1) % 101;
    }
    DIE = DIE + 1;
    if(X < 10) DIE = 6;

    LCD_Move(1,0); LCD_Out(DIE, 1, 0);
    SCI_Out(DIE, 1, 0);
    SCI_CRLF();
}
```

Roll	p	np	N	chi-squared
1	1/6	16.5	20	0.74
2	1/6	16.5	15	0.14
3	1/6	16.5	22	1.83
4	1/6	16.5	7	5.47
5	1/6	16.5	12	1.23
6	1/6	16.5	23	2.56
Total				11.97

From StatTrek, this corresponds to a probability of 0.9648

There is a 96.48% chance this is not a fair die

- Enter value for degrees of freedom.
- Enter a value for one, and only one, of the other textboxes.
- Click **Calculate** to compute a value for the remaining textbox.

Degrees of freedom

5

Chi-square critical value (x)

11.97

Probability: $P(X^2 \leq 11.97)$

0.96480

Probability: $P(X^2 \geq 11.97)$

0.03520

Calculate

Am I Psychic?

8) Determine whether or not you're psychic:

- Guess which number you're going to roll with the fair 6-sided die.
- Roll the dice a bunch of times and count how many times you're right (N>10)

Use a chi-squared test to determine whether or not you're guessing (correct 1/6th of the time)

Code:

```
while(1) {  
    :  
    :  
    C Code  
    :  
    :  
}
```

Result:

- Correct: 14 times
- Incorrect: 27 times

Result	p	np	N	chi-squared
Correct	1/6	6.83	14	7.52
Incorrect	5/6	34.16	27	1.5
			Total	9.02

From a Chi-Squared table (StatTrek was down), a chi-squared score of 9.02 with 1 d.o.f. corresponds to a probability > 0.995

I'm 99.5% certain that I'm not just guessing

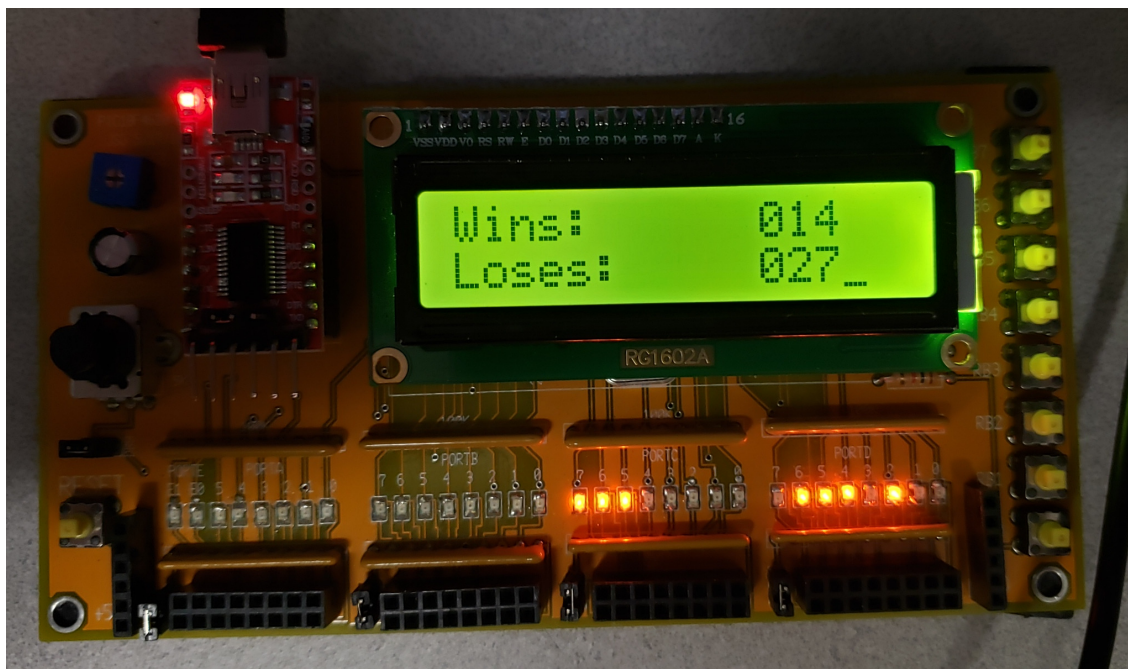
be afraid....

- Enter value for degrees of freedom.
- Enter a value for one, and only one, of the other textboxes.
- Click **Calculate** to compute a value for the remaining textbox.

Degrees of freedom	<input type="text" value="1"/>
Chi-square critical value (x)	<input type="text" value="9.02"/>
Probability: $P(X^2 \leq 9.02)$	<input type="text" value="0.99733"/>
Probability: $P(X^2 \geq 9.02)$	<input type="text" value="0.00267"/>

Calculate

*StatTrek: 99.733% chance of rejecting the null-hypothesis
(99.733% I'm not just guessing)*



PIC Board: It keeps track of how many times my guess is right (wins) & wrong (losses)