ECE 376 - Test #2: Name _____

C-Programming on a PIC Processor

Flow-Charts & C Programming

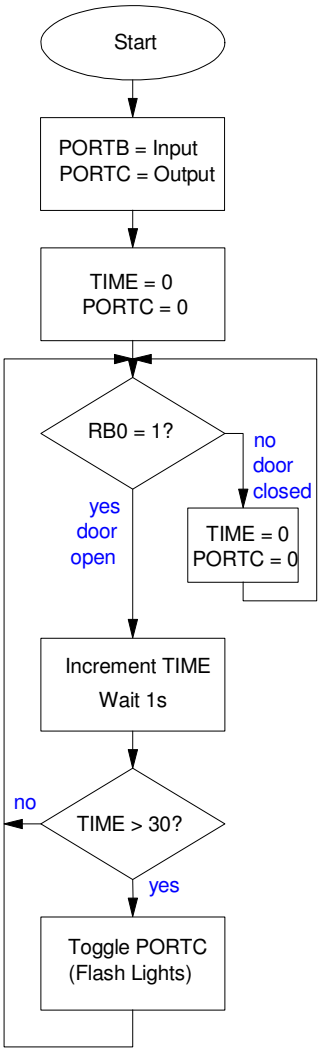
1) (25pt) The following flow chart turns your PIC into refrigerator door alarm

- RB0 is a binary input
- RB0 = 1 means the door is open
- RB0 = 0 means the door is closed

If the door is left open for more than 30 seconds, the lights on PORTC flash on and off (on for one second, off for one second, repeat)

Once the door is closed, the lights turn off and the sensor resets.

Write the corresponding C code




```
void main(void) {

    TRISB = 0xFF;
    TRISC = 0;
    ADCON1 = 0x0F;

    TIME = 0;
    PORTC = 0;

    while(1) {

        if(RB0 == 0) {
            TIME = 0;
            PORTC = 0;
            }

        else {

            TIME += 1;
            Wait_ms(1000);

            if(TIME > 30)
                PORTC ^= 0xFF;

            }
        }
    }
```

C-Programming:

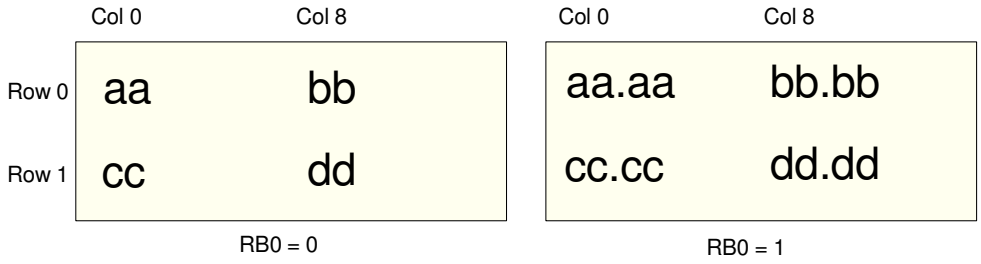
2) (25pt) Write a C subroutine which drives a 16x2 LCD display (like on your PIC board)

Four floating point numbers are passed:

- {A, B, C, D}
- Range is 00.00 to 99.99

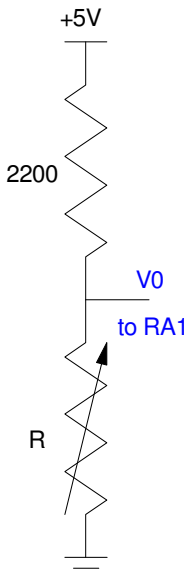
These numbers are displayed on the LCD with

- Zero decimal places if input RB0=0
- Two decimal places if input RB0 = 1




```
void Display(float A, float B, float C, float D) {

    if(RB0 == 0) {

        LCD_Move(0,0);  LCD_Out(A, 2, 0);
        LCD_Move(0,8);  LCD_Out(B, 2, 0);
        LCD_Move(1,0);  LCD_Out(C, 2, 0);
        LCD_Move(1,8);  LCD_Out(D, 2, 0);

        }

    else {

        LCD_Move(0,0);  LCD_Out(A*100, 4, 2);
        LCD_Move(0,8);  LCD_Out(B*100, 4, 2);
        LCD_Move(1,0);  LCD_Out(C*100, 4, 2);
        LCD_Move(1,8);  LCD_Out(D*100, 4, 2);

        }

    }
```

Analog Inputs



3) (25pt) Assume the A/D input to a PIC processor has the following hardware connection where R is a 3k light sensor where lux is the light intensity

$$R = 5000 \cdot (lux)^{-0.6}\Omega$$

$$lux = \left(\frac{5000}{R}\right)^{1.666}$$

If the A/D reading is your birthday, determine the voltage, resistance, and light level

- A/D = (month * 80) + (day)
- May 14th would be 414

lux	R Ohms	V0 Volts	A/D Reading month*80 + day
7.469 lux	1495.6 Ohms	2.023V	414

$$V_o = \left(\frac{A/D}{1023}\right)5V$$

$$V_o = \left(\frac{414}{1023}\right)5 = 2.023V$$

$$R = \left(\frac{V_o}{5-V_o}\right)2200\Omega$$

$$R = 1495.6\Omega$$

$$lux = \left(\frac{5000}{R}\right)^{1.666}$$

$$lux = 7.469$$

t-Tests

4) (13pt) The average temperature in degrees F in Minneapolis and Fargo in November are

	2024	2023	2022	2021	2020	mean	st dev
Minneapolis	38.35	38.55	35.60	36.97	38.06	37.506	1.228
Fargo	32.28	34.13	27.18	32.72	32.180	31.698	2.643

a) Use a student t-test to determine the probability that Fargo will be warmer than Minneapolis this coming November?

Let W = Msp - Far

$$\bar{x}_w = \bar{x}_m - \bar{x}_f = 5.808$$

$$s_w^2 = s_m^2 + s_f^2 = 8.4934$$

$$s_w = 2.9143$$

The t-score is

$$t = \frac{\bar{x}_w}{s_w} = 1.9929$$

From StatTrek, a t-score of 1.9929 with 4 degrees of freedom (sample size = 5) corresponds to a probability of 0.05831

There is a 5.831% chance that Fargo will be warmer than Minneapolis this coming November

b) What is the probability that the overall average November temperature in Fargo is warmer than it is in Minneapolis?

This is a population question. For populations, you divide the variance by the sample size

$$\bar{x}_w = \bar{x}_m - \bar{x}_f = 5.808$$

$$s_w^2 = \frac{s_m^2}{5} + \frac{s_f^2}{5} = 1.6987$$

$$s_w = 1.3033$$

$$t = \frac{\bar{x}_w}{s_w} = 4.4563$$

From a t-table with 4 degrees of freedom, this corresponds to a probability of 0.005596

There is a 0.5596% chance that Fargo is on average warmer than Minneapolis in November

Student t-Table

df \ p	0.001	0.0025	0.005	0.01	0.025	0.05	0.1	0.15	0.2
4	-8.610	-7.173	-4.604	-3.747	-2.776	-2.132	-1.533	-1.190	-0.941

Chi-Squared Test

5) (12pt). Fargo's temperatures have been recorded since 1900 (126 years of data). In the first 296 days of 2025 (n=296), Fargo has had

- 6 record highs
- 2 record lows
- 288 days that are not records

The odds of any given day being a record high in any given year is 1/126 (126 years of data) and 1/126 for a record low.

Use a chi-squared test to determine if 2025 is a normal year (i.e. if 6 record highs and 2 record lows in 296 days is due to chance).

Bin	p	np	N	chi-squared
record high	1/126	2.349	6.000	5.674
record low	1/126	2.349	2.000	0.052
non-record	124/126	291.302	288.000	0.037
			Total	5.763

From a chi-squared table, a chi-squared score of 5.763 with 2 degrees of freedom (3 bins) corresponds to a probability of 0.94395

There is a 94.395% chance that 2025 is not an average year (1/126 chance of any given day is a record high or record low)

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	7.880	6.640	5.020	3.840	2.710	0.020	0.000	0.000	0.000	0.000
2	10.600	9.210	7.380	5.990	4.610	0.210	0.100	0.050	0.020	0.010
3	12.840	11.350	9.350	7.820	6.250	0.580	0.350	0.220	0.120	0.070
4	14.860	13.280	11.140	9.490	7.780	1.060	0.710	0.480	0.300	0.210
5	16.750	15.090	12.830	11.070	9.240	1.610	1.150	0.830	0.550	0.410