ECE 376 - Test #2: Name ____________________

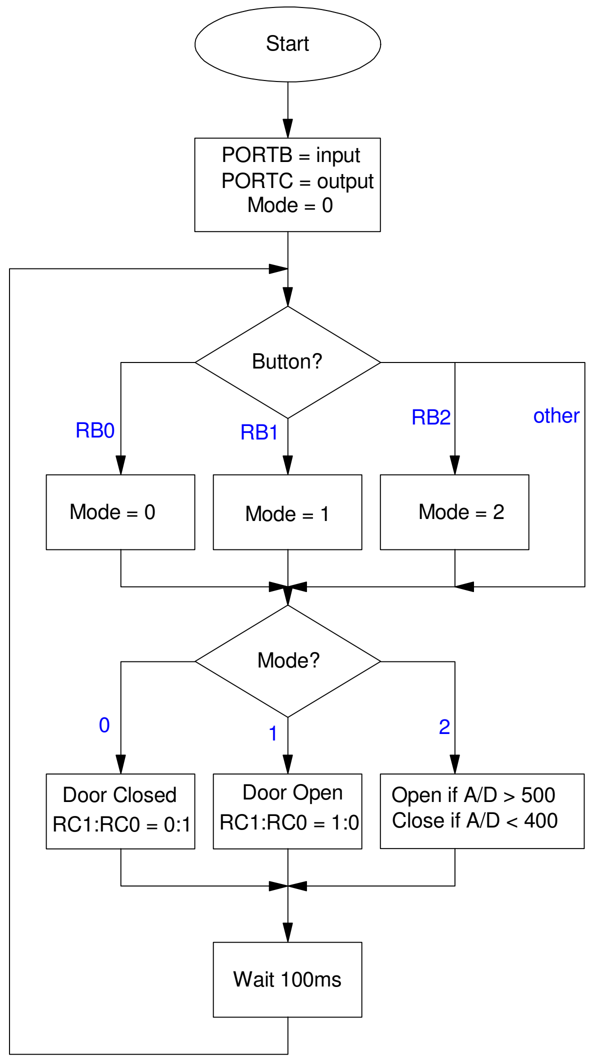
C-Programming on a PIC Processor

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 (25 points)

Write a C program to control a window for a green house. Assume

- Three buttons are connected to RB2:RB1:RB0
- A temperature sensor is connected to RA0, and
- A motor is connected to RC1:RC0
  - RC1:RC0 = 1:0 = open
  - RC1:RC0 = 0:1 = close

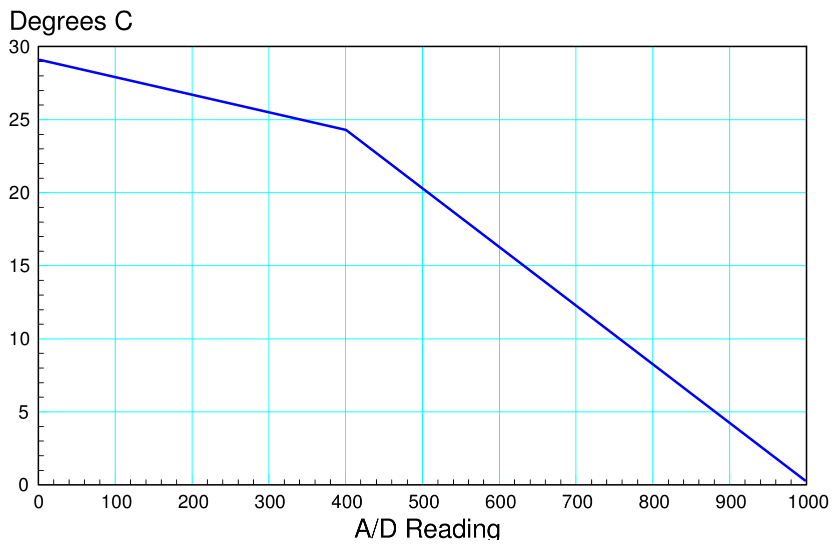



```
void main(void) {

   unsigned char Mode;
   unsigned int A2D;

   Init_A2D();  // A=analog, B/C/D = binary


   TRISB = 0xFF;
   TRISC = 0;
   Mode = 0;

   while(1) {

      if(RB0) Mode = 0;
      if(RB1) Mode = 1;
      if(RB2) Mode = 2;

      if(Mode == 0) PORTC = 1;
      if(Mode == 1) PORTC = 2;
      if(Mode == 2) {
         A2D = A2D_Read(0);
         if(A2D > 500) PORTC = 2;
         if(A2D < 400) PORTC = 1;
         }

      Wait_ms(100);

      }

   }
```

2) Subroutines: (25 points)

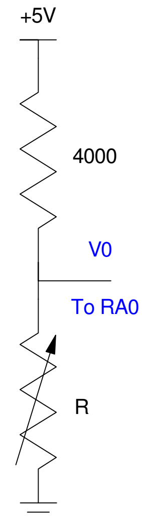
Assume the relationship between the A/D reading and the actual temperature is as follows. Write a C subroutine which is

- Passes the raw A/D reading (0..1023),
- Returns the temperature in degrees C, and
- Takes into account the bend in the curve when the A/D reading is 400




```
float Problem2(unsigned int A2D) {

   unsigned char Temp;

   if(A2D < 400)
      Temp = 29 - 0.0125*A2D;
   else
      Temp = 0.04*(1000 - A2D);

   return(Temp);

   }
```

3) Analog Inputs (25 points)



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

$$R = 5000 \cdot \exp\left(\frac{3200}{T+273} - \frac{3200}{298}\right)\Omega$$

Let T be your birth date (1..31) in degrees C

At this temperature, determine

- The resistance, R,
- The voltage, V0,
- The A/D reading, and
- The smallest change in termperature you can detect

T (degees C) birth date (1..31)	R Ohms	V0 Volts	A/D Reading 0 .. 1023	Smallest change in T you can detect
15	**7259.37**	**3.2237V**	**659**	**0.1106C**

at 15C

$$R = 7259.3768\Omega$$

$$V_0 = \left(\frac{R}{R+4000}\right)5V = 3.2237V$$

$$A2D = \left(\frac{3.2237V}{5.000V}\right)1023 = 659.56$$

round up or round down (result wil be an integer)

If the A/D changes by one (smallest change you can see with using integers), V0 changes by 4.88mV

$$dV = \left(\frac{1}{1023}\right)5V = 0.004888V$$

$$V_0 + dV = 3.228590V$$

$$R = \left(\frac{V_0}{5-V_0}\right)4000\Omega = 7290.4431\Omega$$

$$T = 14.889355^0C$$

$$dT = -0.1106^0C$$

4) chi-squared test (10 points)

It's conjectured that numbers, such as stock prices, have a logarithmic distribution (it's more likely that a stock price is in the range of 10..19 than 90..99). To test this, the frequency of the first digit of 100 random stocks were recorded. Determine using a chi-square test if the data fits a log distribution.

1st Digit of Stock Price	p log distribution	np expected results: log pdf	N actual results	Chi-Squared
1	0.3155	31.55	27	**0.6562**
2-3	0.3155	31.55	45	**5.7338**
4-5	0.1845	18.45	12	**2.2549**
6-7	0.1309	13.09	15	**0.2787**
8-9	0.1016	10.16	1	**8.2584**
			Total	**17.1820**

Use a chi-squared table with 4 degrees of freedom. 17.28 corresponds to a probability of slightly less than 99.9%. Call it 99.8%.

Based upon this data, there is a 99.8% chance that numbers are not distributed logarithmically.

Chi-Squared Table

Probability of rejecting the null hypothesis

dof	99.9%	99%	95%	90%	80%	60%	40%	20%	10%	5%	1%
1	10.81	6.64	3.84	2.71	1.65	0.71	0.28	0.06	0.02	0	0
2	13.81	9.21	5.99	4.61	3.22	1.83	1.02	0.45	0.21	0.05	0.01
3	16.25	11.35	7.82	6.25	4.64	2.95	1.87	1.01	0.58	0.22	0.07
4	**18.46**	13.28	9.49	7.78	5.99	4.05	2.75	1.65	1.06	0.48	0.21
5	20.50	15.09	11.07	9.24	7.29	5.13	3.66	2.34	1.61	0.83	0.41
6	22.43	16.81	12.59	10.64	8.55	6.21	4.57	3.07	2.20	1.63	0.87
7	24.31	18.47	14.06	12.02	9.80	7.28	5.49	3.82	2.83	2.17	1.24

5) t-Tests (15 points)

The value of five 100nF capacitors were recorded:

- Data = {104.0nF, 94.19nF, 104.1nF, 104.7nF, 105.2nF}
- mean = 102.439nF
- st dev = 4.6362nF

a) Use a student-t test to determine the probability that a random 100nF capacitor has a value less than 90nF

Compute the t-score

$$t = \left(\frac{102.439nF - 90nF}{4.6362nF} \right) = 2.6830$$

From a t-table with 4 dof, this corresponds to a probability of about 2.5%

There is about a 2.5% chance that a random capacitor will be less than 90nF

b) Use a student t-test to determine the 99% confidence interval for the value of a random capacitor.

Use the t-table with 4 dof to find 0.5% tails

t = 4.60

The 99.9% confidence interval is then

$$\bar{x} - 4.60s < C < \bar{x} + 4.60C$$

$$\boxed{81.11nF < C < 123.76nF}$$

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	0.0005
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
6	0.72	0.91	1.13	1.44	1.94	2.45	3.14	3.71	5.21	5.96
7	0.71	0.90	1.12	1.41	1.89	2.36	3.00	3.50	4.78	5.41
infinity	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.29