ECE 376 - Test #2: Name ____________________

C-Programming on a PIC Processor

Open book, open notes. Calculators and Matlab permitted.
Individual effort (giving or receivinghelp from others of from Chegg not allowed).

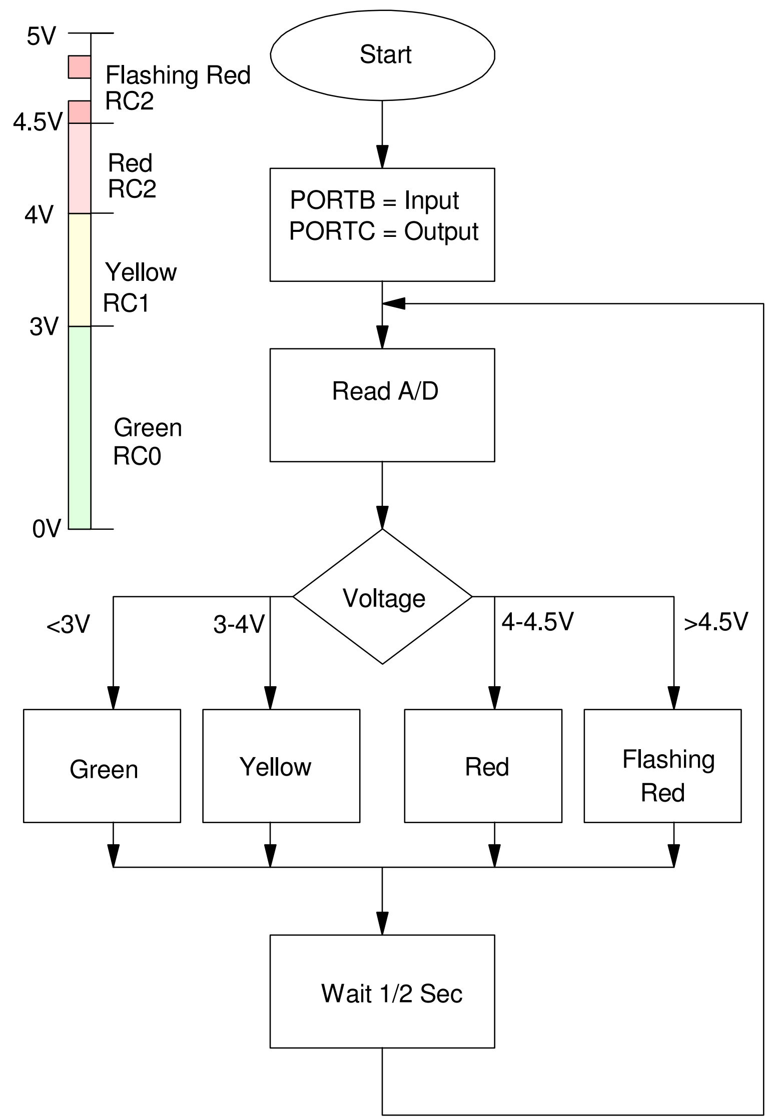
1) C Coding (25 points)

A thermistor is connected to the analog input (RA0) so that the voltage goes up as temperature goes up. Write a C program that turns on lights based upon voltage:

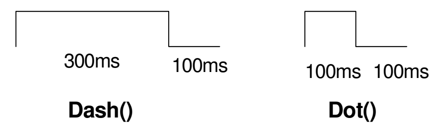
- A/D > 4.5V   Red LED blinks on for 500ms, then off for 500ms (RC1)
- 4V<A/D<4.5V Red LED turns on (RC2 = 1)
- 3V<A/D<4V   Yellow LED turns on (RC1 = 1)
- A2D < 3V: Green LED turns on (RC0 = 1)

Assume the A/D is initialized and
subrouting A2D_Read(x) is avilable.

```
void main(void)

     unsigned int mV;
     unsigned int A2D;

     ADCON1 = 0x0F
     A2D_Init();

     TRISB = 0xFF;
     TRISC = 0;

     while(1) {

          A2D = A2D_Read(0);
          mV = A2D * 4.88;

          if(mV > 450) {
               RC0 = 0;
               RC1 = 0;
               RC2 = !RC2;
               }
          elseif(mV > 400)
               PORTC = 4;

          elseif(mV > 300)
               PORTC = 2;

          else
               PORTC = 1;

          Wait_ms(500);

          }

     }
```



2) Morse Code: Bottom Up Programming (25 points)

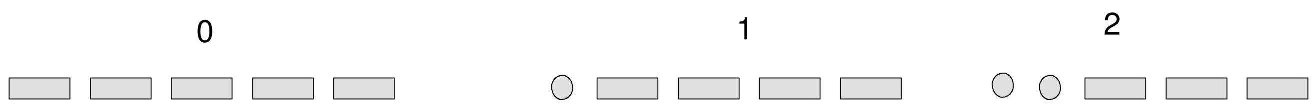


a) Write a subroutines Dash() and Dot() which output a single dash and dot for Morse code when called:

- Dash(): RC0 goes high for 300ms the low for 100ms
- Dot(): RC0 goes hight for 100ms then low for 100ms

```
void Dash(void) {
     RC0 = 1;
     Wait_ms(300);
     RC0 = 0;
     Wait_ms(100);
     }

void Dot(void) {
     RC0 = 1;
     Wait_ms(100);
     RC0 = 0;
     Wait_ms(100);
     }
```

b) Write a subroutine which outputs Morse code for numbers {0, 1, 2} when numbers {0, 1, 2} are passed to it:

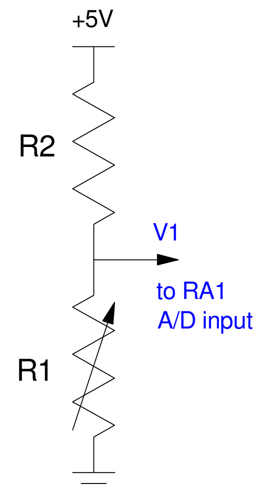



```
void Morse(unsigned char X) {
     if(X == 0) {
          Dash(); Dash(); Dash(); Dash(); Dash();
          }

     if(X == 1) {
          Dot(); Dash(); Dash(); Dash(); Dash();
          }

     if(X == 2) {
          Dot(); Dot(); Dash(); Dash(); Dash();
          }

     }
```

3) Analog Inputs (25 points)

A light sensor has a resistance vs. lux relationship of

$$R_1 = \left(\frac{10{,}000}{(Lux)^{0.6}}\right)\Omega$$



Determine the following assuming

- The A/D reading is 513, and
- R2= 800 + 100(your birth month) + (your birth date)

R2 800 + 100*mo + day	V1	A/D Reading	R1	Lux
1,314	**2.5073V**	513	**1321.7**	**29.158**

$$V_1 = \left(\frac{513}{1023}\right)5V = 2.5073V$$

$$V_1 = \left(\frac{R_1}{R_1+R_2}\right)5V$$

$$R_1 = \left(\frac{V_1}{5-V_1}\right)1314\Omega = 1321.729\Omega$$

$$R_1 = 1321.729\Omega = \left(\frac{10{,}000}{(Lux)^{0.6}}\right)\Omega$$

$$Lux = 29.158$$

4) chi-squared test (10 points)

Hector has been recording temperatures in Fargo since 1942 (81 years). For the past 27 years, 16 years where in the hottest 33%, six in the middle 33%, and five in the coldest 33%.

Use a chi-squared test to determine if the weather in Fargo is changing (probability of rejecting the null hypothesis: each interval is equally likely)

# Wins wins after 16 games	p binomial distribution	np expected results	N actual results	Chi-Squared
Hottest 33%	1/3	9	16	5.44
Middle 33%	1/3	9	6	1
Coldest 33%	1/3	9	5	1.78
			Total	8.22

$$\chi^2 = \left(\frac{(np-N)^2}{np}\right)$$

Sample size = 3, meaning 2 degrees of freedom

A chi-squared score of 8.22 corresponds to a probability of about 98%

I can reject the null hypothesis with a confidence level of 98%

There is a 98% chance that the yearly average temperature in Fargo is changing.

Chi-Squared Table

Probability of rejecting the null hypothesis

dof	99%	95%	90%	80%	60%	40%	20%	10%	5%	1%
1	6.64	3.84	2.71	1.65	0.71	0.28	0.06	0.02	0	0
2	9.21	5.99	4.61	3.22	1.83	1.02	0.45	0.21	0.05	0.01
3	11.35	7.82	6.25	4.64	2.95	1.87	1.01	0.58	0.22	0.07
4	13.28	9.49	7.78	5.99	4.05	2.75	1.65	1.06	0.48	0.21
5	15.09	11.07	9.24	7.29	5.13	3.66	2.34	1.61	0.83	0.41
6	16.81	12.59	10.64	8.55	6.21	4.57	3.07	2.20	1.63	0.87
7	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)

Hector airport has been monitoring the weather in Fargo since 1942.

Population	mean	standard deviation	sample size
A: 1996 - 2022	42.7559F	2.1936F	27
B: 1942-1968	40.5330F	1.7303F	27

Use a student t-test to determine the probability that population A has a higher mean than population B.

- What is the probablity that Fargo is getting warmer?
- Note: population question. What is the chance that Fargo is getting warmer?

Create a new variable, W = A - B

$$\bar{x}_w = \bar{x}_a - \bar{x}_b = 2.2229$$

$$s_w = \sqrt{\frac{s_a^2}{27} + \frac{s_b^2}{27}} = 0.5377$$

Find the t-score

$$t = \left(\frac{\bar{x}_w}{s_w}\right) = 4.1342$$

Convert this to a probability using a t-table with 26 degrees of freedom

p = 0.99984

From the data, it is 99.984% certain that the weather in Fargo has changed since 1942

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	3.09	3.29