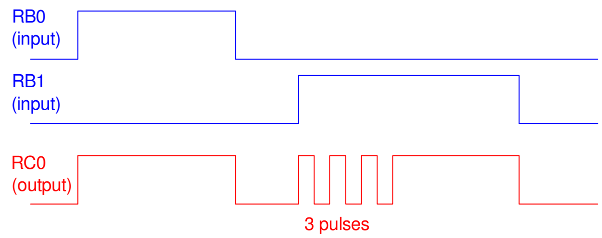
# ECE 376 - Test #2: Name ____________________

## C-Programming on a PIC Processor

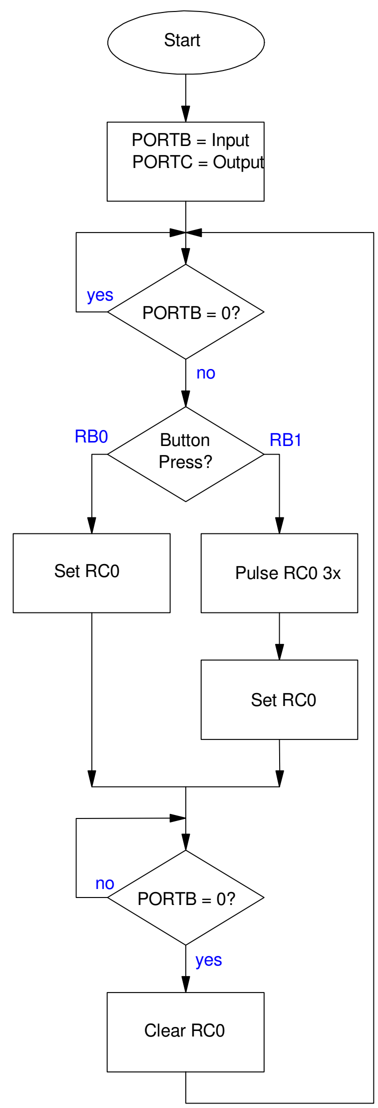
### 1) C Coding & Flow Charts (25 points)

Write the corresponding C code for the flow chart shown. This program

- Waits for RB0 or RB1 to go high
- If RB0 goes high, RC0 goes high.
- If RB1 goes high, RC0 goes high then low three times, with each pulse being 100ms high and 100ms low. After three pulses, RC0 remains high
- Once the button is released (RB0 or RB1), RC0 goes low.



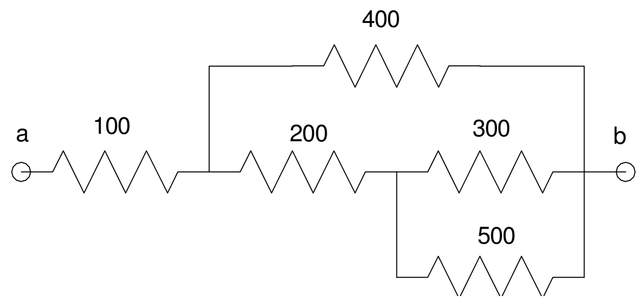

```
void main(void) {

   ADCON1 = 0x0F;

   TRISB = 0xFF;
   TRISC = 0;

   while(1) {

      while(PORTB == 0);

      if(RB0) {

         RC0 = 1;
         }

      else {

         for(i=0; i<3; i++) {
            RC0 = 1;
            Wait_ms(100);
            RC0 = 0;
            Wait_ms(100);
            }

         RC0  =1;
         }

      while(PORTB != 0);

      RC0 = 0;

      }
```



## 2) Subroutines & Bottom-Up Programming: (25 points)

Write three subroutines

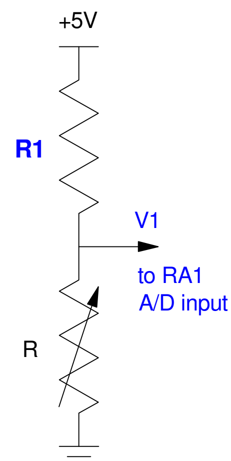
- y = Series(R1, R2);    returns the resistance of two resistors in series
- y = Parallel(R1, R2);    returns the resistance of two resistors in parallel
- y = Network();    returns the resistance Rab of the following network




```
float Series(R1, R2)
{
   float X;
   X = R1 + R2;
   return(X);
   }

float Parallel(R1, R2)
{
   float X;
   X = 1 / (1/R1 + 1/R2);
   return(X);
   }

float Network()
{
   float A, B, C, D;
   A = Parallel(300, 500);
   B = Series(A, 200);
   C = Parallel(B, 400);
   D = Series(C, 100);
   return(D);
   }
```

### 3) Analog Inputs (25 points)

Assume the A/D input to a PIC processor has the following hardware connection where R is a light sensor where Lux is the brightness in lux




$$R = 2000 \cdot \left(\frac{1}{Lux}\right)^{0.6} \Omega$$

Let the R1 be your birthday

R1 = 900 + 100*month + day
May 15th would give R1 = 1415 Ohms

If the A/D reads 300, determine

- The lught level in Lux,
- The resistance, R, and
- The voltage, V1

| R1<br>900 + 100*mo + day | Lux | R<br>Sensor - Ohms | V1<br>Volts | A/D Reading |
|---|---|---|---|---|
| **1415** | **7.7177** | **587.13** | **1.4663V** | **300** |

$$V_1 = \left(\frac{300}{1023}\right) 5V = 1.4663V$$

$$V_1 = \left(\frac{R}{R+1415}\right) 5V$$

$$R = \left(\frac{V_1}{5-V_1}\right) 1415\Omega = 587.13\Omega$$

$$R = 587.13\Omega = 2000 \cdot \left(\frac{1}{Lux}\right)^{0.6} \Omega$$

$$Lux = 7.7117$$

## 4) chi-squared test (10 points)

It is conjectured that the time that a refrigerator door is held open has an exponential distribution wuth a mean of 10 seconds:

$$pdf = \frac{1}{10}\exp\left(\frac{-t}{10}\right)u(t)$$

To test this theory, the time that the door was left open was recorded 100 times with the result shown below. Use a chi-squared test to see if the data is consistent with an exponential distribution

| Duration | p<br>binomial distribution | np<br>expected results: n=100 | N<br>actual results | Chi-Squared |
|---|---|---|---|---|
| 0 - 5 seconds | 0.39 | 39 | 30 | 2.0769 |
| 5 - 10 seconds | 0.24 | 24 | 25 | 0.0417 |
| 10 - 15 seconds | 0.14 | 14 | 20 | 2.5714 |
| 15 - 20 seconds | 0.09 | 9 | 15 | 4 |
| > 20 seconds | 0.14 | 14 | 10 | 1.1429 |
| | | | Total | 9.8329 |

Convert 9.93 to a probability using a chi-squared table

- 4 degrees of freedom (five bins minus one)
- p = 95%

***There is a 95% chance that the data does not follow the assumed distribution***

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)**

Over the first five games, the Minnesota Vikings defense has given up {17, 7, 29, 17, 31} points:

- mean = 20.2 points
- standard deviation = 9.8590 points
- sample size = 5

a) How many points does the offense have to score to be 90% certain of winning their next game?

b) How many points does the offense have to score to be 99.9% certain of winning their next game?

Student t-Table (area of tail)

| df \ p | 0.001 | 0.0025 | 0.005 | 0.01 | 0.025 | 0.05 | 0.1 | 0.15 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -636.619 | -318.309 | -63.6567 | -31.8205 | -12.7062 | -6.3138 | -3.0777 | -1.9626 | -1.3764 |
| 2 | -31.5991 | -22.3271 | -9.9248 | -6.9646 | -4.3027 | -2.92 | -1.8856 | -1.3862 | -1.0607 |
| 3 | -12.924 | -10.2145 | -5.8409 | -4.5407 | -3.1824 | -2.3534 | -1.6377 | -1.2498 | -0.9785 |
| 4 | -8.6103 | -7.1732 | -4.6041 | -3.7469 | -2.7764 | -2.1318 | -1.5332 | -1.1896 | -0.941 |
| 5 | -6.8688 | -5.8934 | -4.0321 | -3.3649 | -2.5706 | -2.015 | -1.4759 | -1.1558 | -0.9195 |

Sample size of 5 means 4 degrees of freedom

p = 90% (10% tails)

the t-score is 1.5332

$$points = \bar{x} + 1.5332s$$

$$points = 20.2 + 1.5332 \cdot 9.8590$$

$$points = 35.31$$

***The Vikings need to score 35.31 points to have a 90% chance of winning***

p = 99.9% (0.1% tails)

The t-score is 8.6103

$$points = \bar{x} + 8.6103 \cdot 9.8590$$

$$points = 105.09$$

***The Vikings need to sccore 105.09 points to have a 99.9% chance of winning***