ECE 376 - Homework #9

Timer 0/1/2/3 Interrupts.   Due Monday, April 3rd
Please email to jacob.glower@ndsu.edu, or submit as a hard copy, or submit on BlackBoard

1) Write a C routine using Timer0 interrupts to measure time to 100ns. Using this routine, determine how long a the following operations in C take:

a) LCD display routine

```
long int A;
A = 3141592654;
LCD_Out(A, 10, 9);   // time to execute this instruction
```

b) The time it takes you to press all buttons on PORTB sequentially

```
TRISB = 0xFF;
while(!RB0);          // start
while(!RB1);
while(!RB2);
while(!RB3);
while(!RB4);
while(!RB5);
while(!RB6);
while(!RB7);          // end
```

c) The time it takes you to press and release RB0 10 times

```
TRISB = 0xFF;
for(i=0; i<10; i++) {      // start
   while(!RB0);
   while(RB0);
   }                       // end
```

2) Write a C routine using Timer0 / Timer1 / Tirme2 / Timer3 interrupts to play 4 notes at the same time when you press button RB0 (4-string Violin)

Output Pin	RC0	RC1	RC2	RC3
Note	C3	D3	E3	F3
Frequency (Hz)	130.81 Hz	146.83 Hz	164.81 Hz	174.61 Hz
Interrupt	Timer0	Timer1	Timer2	Timer3

Roulette Wheel

Use multiple interrupts to create a Roulette wheel which drives a stepper motor:

- Timer0: Set to 10ms. Steps the motor every 10ms
- Timer1: Keeps track of time to 100ns. Also used to generate random numbers
- Timer2: Set to 1ms. Controls the duration of the beep noise (100ms beep)
- Timer3: Set to 174.61Hz. Sets the frequency of the note to F3 (174.61Hz)

- Start the game by pressing RB0.
    - This generates a random number, N, in the range of 0..7 by taking the current time (TMR1) mod 8.
- When RB0 is pressed, the stepper motor then turns three rotations (600 steps) plus 25*N steps
- The stepper motor spins at 10ms per step
- Every 25th step (each number), the speaker plays note F3 for 100ms
- The winning number is the the angle of the stepper motor, mod 200
    - Winning Number = (STEPS mod 200) / 8
- The LCD displays
    - The current number the stepper motor is pointing at
    - The current time, accurate to 100ns (Timer1)
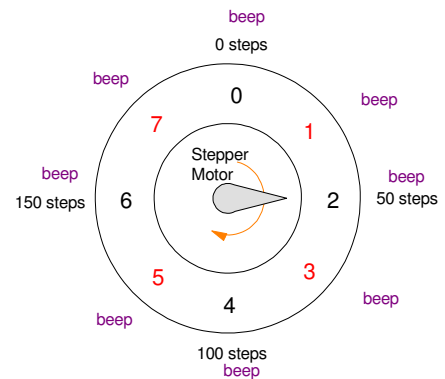
3) Give the flow charts for this program
- note: you need a separate flow chart for the main routine and each interrupt

4) Write the corresponding C code

5) Validation: Verify your code works
- Winning numbers are random in the range of 0..7
- The stepper motor is spinning at 10ms/step
- The beep noise is at 174.61Hz
- The duration of each beep is 100ms

6) Statistical Analysis: Use a chi-squared test to determine if using the current time (mod 8) generates a uniform distribution (all numbers have equal probability)

7) Demonstration (20pt). In person or on a video