## ECE 376 - Homework \#9

Timer 0/1/2/3 Interrupts - Due Wednesday, April 3rd

1) Write a C routine using Timer0 interrupts to measure time to 100 ns . Using this routine, determine how long a the following operations in C take:
a) Integer operations
```
int A, B, C;
A = 5;
B = 7;
C = 2*A + 3*B + 4;
```

b) Floating Point Operations

```
float A, B, C;
A = 3.14159;
B = 2.71718;
C = 2.1*A + 3.7*B + 4.16;
```

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

```
TRISB = 0xFF;
```

```
for(i=0; i<10; i++) { // start
```

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

```
    } // end
```

2) Write a C routine using Timer0 / Timer1 / Tirme 2 / Timer3 interrupts to play 4 notes at the same time when you press button RB0.. RB3 at the same time (each note plays if its input button is pressed)

| Input Pin | RB0 | RB1 | RB2 | RB3 |
| :---: | :---: | :---: | :---: | :---: |
| Output Pin | RC0 | RC1 | RC2 | RC3 |
| Note | F 2 | G 2 | A 2 | B 2 |
| Frequency $(\mathrm{Hz})$ | 87.307 Hz | 97.999 Hz | 110.000 Hz | 123.471 Hz |
| Interrupt | Timer0 | Timer1 | Timer2 | Timer3 |

## Three-Phase Sine Wave

Write a program to output the positive votlage for a 3-phase sine wave using Timer interrupts

- Timer2 interrupt triggers every 1 ms and sets pins RC0 (phase A), RC1 (B), and RC2 (C)
- When Timer2 triggers, it sets up a Timer0/1/3 interrupt $\mathrm{nA} / \mathrm{nB} / \mathrm{nC}$ clocks in the future
- Timer0 interrupt then clears RC0 (setting the pulse width of phase A)
- Timer1 interrupt then clears RC1 (setting the pulse width of phase B)
- Timer3 interrupt then clears RC2 (setting the pulse width of phase C)
- The pulse width is determined by $\mathrm{nA} / \mathrm{nB} / \mathrm{nC}$
- $100=1 \%$
- $9900=99 \%$
- The main routine is responsible for setting the values of NA, NB, and NC


3) Give a flow chart for this program

- There should be five flow charts (one for each interrupt and one for the main routine)

4) Write the corresponding $C$ code
5) Verify the interrupts are working

- If $\mathrm{nA}=1000(10 \%)$, you read 0.50 V on RC 0 with multimeter (or $10 \%$ on an oscilloscope)
- If $n B=2500(25 \%)$, you read 1.25 V on RC1
- If $\mathrm{nC}=8000(80 \%)$ you read 4.00 V on RC 2
- Timer2 kicks in every 1.00 ms

6) Demo: Demonstrate a 3-phase rectified sine wave with a period of 3 seconds

- Phase A cycles from $0 \%$ to $100 \%$ then back to $0 \%$
- Phase B lags phase A by 120 degrees
- Phase C lags phase A by 240 degrees

