ECE 376 - Test #3: Name _____

Spring 2023

1a) Single Interrupt. The following C code sets up a Timer2 interrupt to output a square wave on RC0. Determine the frequency that appears on pin RC0.

T2CON = 163 = 0xA3 = 10100111 (A = 5, C = 16)
PR2 = 163 (B = 164)
N = A*B*C = 13,120
f = 10,000,000 / (2*N) = 381.098Hz

b..e) If the following sections of code are deleted, what frequency will you see on pin RC0?

Section of Code	Frequency on RC0 if this section is deleted

`// Global variable`
`unsigned int COUNT`
 	
`void interrupt IntServe(void) {`
	code doesn't compile

`RC0 = !RC0;`	b) **0Hz (RC0 is never toggled)**
`TMR2IF = 0;`	c) **100kHz (N = 50, stuck in the interrupt)**

`}`
`void main(void) {`
`  TRISC = 0;`
`  ADCON1 = 0x0F;`
	code doesn't compile

`  T2CON = 163;` `  PR2  = 163;`	d) **unknown. A,B,C could be anything**

`  TMR2ON = 1;`
`  TMR2IE = 1;`
`  TMR2IP = 1;`
`  PEIE = 1;`
`  GIE = 1;`
	e) **0Hz. Interrupts don't happen**

`  while(1) {`
`  RC1 = !RC1;`
`  }`
`  }`
	code doesn't compile

2) Multiple Interrupts: Give the interrupt service routine and interrupt initialization code so that the PIC outputs a

- M Hz square wave on RC0 using Timer0 interrupts (M = your birth month, 1..12)
- D Hz square wave on RC1 using Timer1 interrupts (D = your birth date, 1..31), and
- X Hz square wave on RC2 using Timer3 interrupts (X = 800 + 100*M + D. May 14th gives 1314Hz)

Interrupt Initialization

	Timer0 M Hz square wave on RC0	Timer1 D Hz square wave on RC1	Timer3 XHz square wave on RC2
frequency (Hz)	**5 Hz**	**14 Hz**	**1314 Hz**
# Clocks between interrupts	**1,000,000**	**357,142**	**3805**
PS	**16** (affects code below)	**8**	**1**

Interrupt Service Routines

Timer0
M Hz square wave on RC0

```
if(TMR0IF) {
   TMR0 = -62500;
   RC0 = !RC0;
   TMR0IF = 0;
   }
```

Timer1
D Hz square wave on RC1

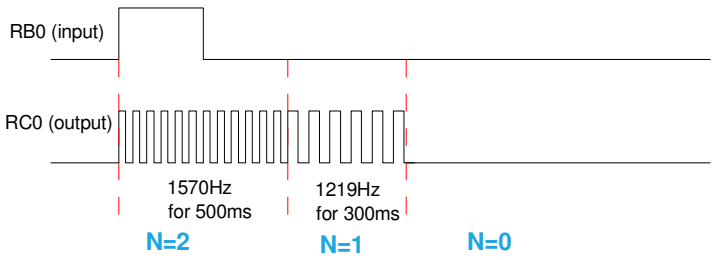
```
if (TMR1IF) {
   TMR1 = -44643;
   RC1 = !RC1;
   TMR1IF = 0;
   }
```

Timer3
XHz on RC2

```
if (TMR3IF) {
   TMR3 = -3805;
   RC2 = !RC2;
   TMR3IF = 0;
   }
```

3) Electronic Chickadee: Write a C program which uses interrupts to play the song of a chickadee (type of bird) when you press RB0:

- When RB0 is pressed (INT0 interrupt)
- RC0 plays 1570Hz for 500ms, the
- RC0 plays 1219Hz for 300ms



Let

- INT0 detect the button press
- Timer0 set the duration of the note (500ms then 300ms)
- Timer1 sets the frequency of the note (1570Hz then 1219Hz)

a) Interrupt Initialization: (affects the interrupt service routine)

INT0 rising or falling edge	PS0 prescalar for Timer0 (1,2,4,8,...,256)	PS1 prescalar for Timer1 (1,2,4,8)
rising	**PS = 256**	**PS = 1**

b) Write the interrupt service Routines

INT0 trigger on RB0	Timer0 play for 100ms	Timer1 play XHz

`if (INT0IF) {`
`  N = 2;`
`  TMR0 = -19531;`
`  INT0IF = 0;`
`  }`
	`if(TMR0IF) {`
	`  if(N) N = N - 1;`
	`  if(N == 1) TMR0=-11718;`
	`  TMR0IF = 0;`
	`  }`
		`if(TMR1IF) {`
		`  if(N == 2) TMR1 = -3184;`
		`  else TMR1 = -4101;`
		`  if(N) RC0 = !RC0;`
		`  else RC0 = 0;`
		`  TMR1IF = 0;`
		`  }`

4) Filter Analysis: Assume X and Y are related by the following transfer function

$$Y = \left(\frac{2(z-0.9)}{(z-0.8)(z-0.5)}\right)X = \left(\frac{2z-1.8}{z^2-1.3z+0.40}\right)X$$

a) What is the difference equation that relates X and Y?

$$y(k+2) - 1.3y(k+1) + 0.40y(k) = 2x(k+1) - 1.8x(k)$$

b) Find y(t) assuming

$$x(t) = 6 + 2\cos(250t) + 5\sin(250t)$$

Assume a sampling rate of T us where

- T = 800 + 100*(your birth month) + (your birth date) micro-seconds

T = 1314us
$y(t) = 12 + 0.682\cos(250t) + 17.972\sin(250t)$

DC:

s = 0

z = exp(sT) = 1

$$Y = \left(\frac{2(z-0.9)}{(z-0.8)(z-0.5)}\right)_{z=1} \cdot (6) = 12$$

AC:

s = j250

z = exp(sT) = 0.947 + j0.323

$$Y = \left(\frac{2(z-0.9)}{(z-0.8)(z-0.5)}\right)_{z=0.947+j0.323} \cdot (2 - j5) = 0.682 - j17.972$$

$$y(t) = 0.682\cos(250t) + 17.972\sin(250t)$$