ECE 376 - Test #3: Name _____

Fall 2022. Open-Book, Open Note

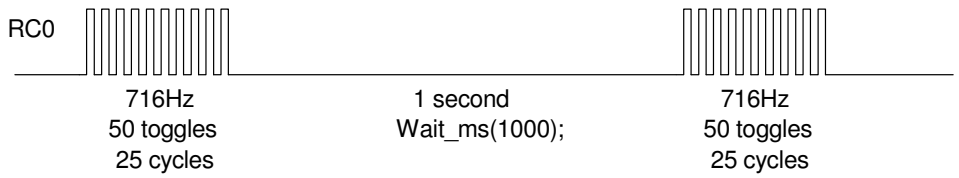
1) Single Interrupt: Write a program for a back-up alarm using TImer2 interrupts.

a) Set up Timer2 to output a 716Hz square wave on RC0

N f = 716Hz	A	B	C
6983.24	**7**	**249**	**4**

Write the main routine and interrupt servive routine which

- Plays 716 Hz on RC0
- For 50 toggles (25 cycles)
- Waits (pauses) for 1 second,
- Then repeats



Main Routine - main loop Play 716 Hz for 25 cycles every second Assume Timer2 has been initialized for 716Hz	Timer2 Interrupt Routine Play 716Hz for 25 cycles every second

`while(1) {`
`  N = 50;`
`  while(N);`
`  Wait_ms(1000);`
`  }`
	`void Interrupt(void) {`
	`if(TMR2IF) {`
	`  if(N) {`
	`  N = N - 1;`
	`  RC0 = !RC0;`
	`  }`
	`  else RC0 = 0;`
	`TMR2IF = 0;`
	`}`

Main Routine - main loop Play 716 Hz for 25 cycles every second Assume Timer2 has been initialized for 716Hz	Timer2 Interrupt Routine Play 716Hz for 25 cycles every second

`while(1) {`
`  }`
	`void Interrupt(void) {`
	`if(TMR2IF) {`
	`  N += 1;`
	`  if(N > 716*2) N = 0;`
	`  if(N < 50) RC0 = !RC0;`
	`  else RC0 = 0;`
	`TMR2IF = 0;`
	`}`

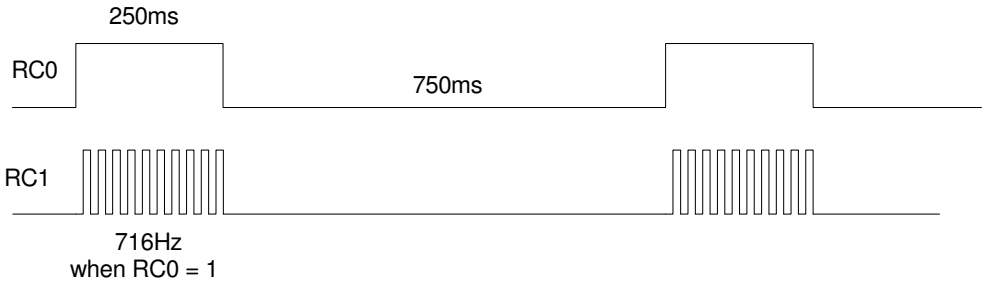
2) Multiple Interrupts: Write a C program for a back-up alarm

Timer0 controls the output on RC0:

- RC0 is set for 250ms then cleared for 750ms, then repeats

Timer1 controls the output on RC1:

- RC1 outputs 716Hz whenever RC0 = 1



a) Specify the pre-scalar used for Timer0 and Timer1

Timer0 Pre-Scalar	Timer1 Pre-Scalar
256	**1**

Interrupt Service Routines

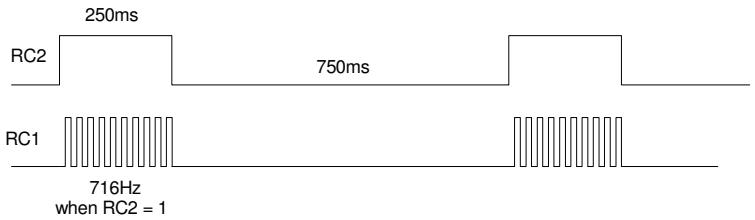
Timer0 Set RC0 for 250ms then Clear RC0 for 750ms & repeat	Timer1 Toggle RC1 at 716Hz whenever RC0 = 1

`if(TMR0IF) {`
`  if(RC0) {`
`  RC0 = 0;`
`  TMR0 = -29296;`
`  }`
`  else {`
`  RC0 = 1;`
`  TMR0 = -9765;`
`  }`
`  TMR0IF = 0;`
`  }`
	`if(TMR1IF) {`
	`  TMR1 = -6983;`
	`  if(RC0) RC1 = !RC1;`
	`  else RC1 = 0;`
	`  TMR1IF = 0;`
	`  }`

3) Timer1 Compare: Backup Alarm

Write the interrupt service routine for a back-up alarm.

- RC2 outputs a 250ms pulse every 1000ms (controlled by Timer1 Compare1 inerrupts)
- RC1 outputs a 716Hz square wave when RC2 = 1 (controlled by Timer1 Compare2 interrupts)




```
// Interrupt Initialization
```

Timer1 pre-scalar (1 / 2 / 4 / 8)	Compare1 (RC2) Set RC2 / Clear RC2 / No Change	Compare 2 (RC1) Set RC1 / Clear RC1 / No Change
1	Set (once) No change (249 times) Clear (once) No change (749 times)	set then clear (alternate)

```
// Global Variables (if needed)
```

```
// Interrupts
```

Timer1	Compare 1 Output a 250ms pulse every 1000ms	Compare 2 Output 716Hz when RC2 = 1

if(TMR1IF) {
TMR1IF = 0;
}
 	
Comment:
Timer1 doesn't do much other than run so that Compare1 and 2 work
	if(CCPR1IF) {
	CCPR1 += 10000;
	ms = (ms + 1)%1000;
	if(ms == 0) CCP1CON = 8;
	elseif(ms == 250) CCP1CON = 9;
	else CCP1CON = 10;
	CCP1IF = 0;
	}
	
	Comment:
	Capture1 interrupts every 1.000ms
	ms counts mod 1000
	when ms = 0, RC2 is set
	when ms = 250 RC2 is cleared
	no change for other numbers
		if(CCPR2IF) {
		CCPR2 += 6983;
		if(RC2) {
		if(CCP2CON == 8)
		CCP2CON = 9;
		else CCP2CON = 8;
		CCP2IF = 9;
		}
		else CCO2CON = 9;
		CCP2IF = 0;
		}
		
		Comment
		Capture2 toggles RC1 every interrupt
		(it alternates between set and clear)

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

$$Y = \left(\frac{0.02(z+1)}{(z-0.9)(z-0.7)}\right)X = \left(\frac{0.02z+0.02}{z^2-1.6z+0.63}\right)X$$

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

$$\boxed{y(k+2) - 1.6y(k+1) + 0.63y(k) = 0.02(x(k+1) + x(k))}$$

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**

x(t) = 6

s = 0

z = 1

$$Y = \left(\frac{0.02(z+1)}{(z-0.9)(z-0.7)}\right)_{z=1} \cdot (6)$$

$$Y = 8.00$$

x(t) = 2 cos(250t) + 5 sin(250t)

s = j250

$$z = e^{sT} = 1\angle 18.82^0$$

$$X = 2 - j5$$

$$Y = \left(\frac{0.02(z+1)}{(z-0.9)(z-0.7)}\right)_{z=1\angle 18.82^0} \cdot (2 - j5)$$

$$Y = -1.5632 + j0.3666$$

$$y(t) = -1.5632\cos(250t) - 0.3666\sin(250t)$$

The total answer is DC + AC

$$\boxed{y(t) = 8.000 - 1.5632\cos(250t) - 0.3666\sin(250t)}$$