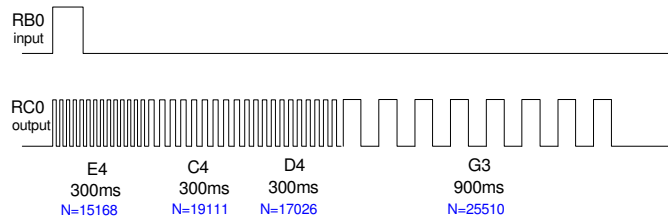


ECE 376 - Test #3: Name _____

Spring 2024. Open-Book, Open Note

1) Single Interrupt: Write a C program to play Westminster Chimes when you detect a rising edge on RB0. Use only a single interrupt to set the frequency and the main routine to detect the button and set the note frequency and duration



Main Routine

play Westminster Chimes when RB0 is pressed
assume I/O and interrupts are set up correctly

Timer1 Interrupt Service Routine

Assume PS=1

```
while(1) { // main loop
```

```
    while(RB0);  
    while(!RB0);
```

```
    N = 15186;  
    Play = 1;  
    Wait_ms(300);
```

```
    N = 19111;  
    Wait_ms(300);
```

```
    N = 17026;  
    Wait_ms(300);
```

```
    N = 25510;  
    Wait_ms(900);
```

```
    Play = 0;
```

```
}
```

```
if(TMR1IF) {
```

```
    TMR1 = -N;
```

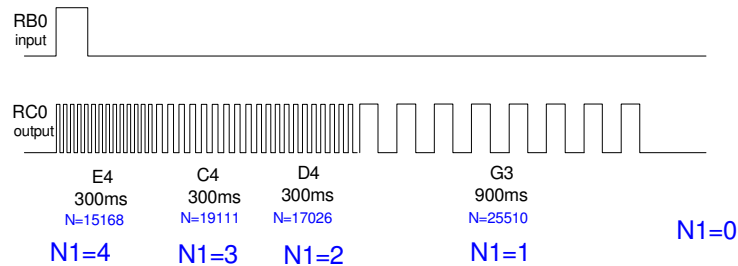
```
    if(PLAY) RC0 = !RC0;  
    else RC0 = 0;
```

```
    TMR1IF = 0;
```

```
}
```

2) Multiple Interrupts: Write a C program to play Westminster Chimes when you detect a rising edge on RB0. Use multiple interrupts so that the main routine is not needed to play a tune:

- INT0: Detect the rising edge on RB0 (starts the tune)
- Timer0: Sets the duration of each note (300ms or 900ms)
- Timer1: Sets the frequency of the notes



Interrupt Set-Up:

INT0 Rising / Falling Edge	Timer0 Pre-Scalar	Timer1 Pre-Scalar
Rising	256	1

Interrupt Service Routines

INT0 Rising / Falling Edge	Timer0 Sets the duration	Timer1 Sets the frequency
<pre> if (INT0IF) { N1 = 4; N = 15168; TMR0 = -11718; INT0IF = 0; } </pre>	<pre> if (TMR0IF) { if (N1) N1 -= 1; if (N1==3) { TMR0 = -11718; N = 19111; } if (N1==2) { TMR0 = -11718; N = 17026; } if (N1==1) { TMR0 = -35156; N = 25510; } TMR0IF = 0; } </pre>	<pre> if (TMR1IF) { TMR1 = -N; if (N1) RC0 = !RC0; else RC0 = 0; TMR1IF = 0; } </pre>

3) Timer2 Interrupts: Write a subroutine which when called

- Uses Timer2 interrupts
- To play note A3# (233.08Hz, N = 21,452)
- For one second (233 cycles or 466 toggles)

Timer2 Initialization (233.08Hz, N = 21,452)

A	B	C
9	149	16

Subroutine & Timer2 Interrupt Service Routine

Subroutine Play A3# for 1.000 second when called	Timer2 Interrupt
<pre>void PlayA3sharp(void) { N = 466; while(N); } -- Another option ----- Play = 1; Wait_ms(1000); Play = 0; }</pre>	<pre>if(TMR2IF) { if(N) N -= 1; if(N) RC0 = !RC0; else RC0 = 0; TMR2IF = 0; } ----- Anther Option ----- if(PLAY) RC0 = !RC0; else RC0 = 0; TMR2IF = 0; }</pre>

4) **Filter Analysis:** Assume X and Y are related by the following transfer function where T = 0.01 second

$$Y = \left(\frac{0.25(z+0.9)}{(z-0.9)(z-0.8)} \right) X$$

Find y(t) assuming

$$x(t) = 2 \cos(15t) + 3 \sin(15t)$$

$$s = j15$$

$$z = e^{sT} = e^{j0.15}$$

$$X = 2 - j3$$

$$Y = \left(\frac{0.25(z+0.9)}{(z-0.9)(z-0.8)} \right)_{z=e^{j0.15}} \cdot (2 - j3)$$

$$Y = -35.14 - j20.75$$

$$y(t) = -35.14 \cos(15t) + 20.75 \sin(15t)$$