ECE 376 - Homework #3

Binary Outputs, Timing, and LEDs. Due Monday, September 11th
Please submit as a hard copy, submit on BlackBoard, or email

Binary Outputs

1) Design a circuit which allows your PIC board to turn on and off an RGB Piranah LED at 0mA (off) and 10mA (on). Assume the specifications for the LEDs are:

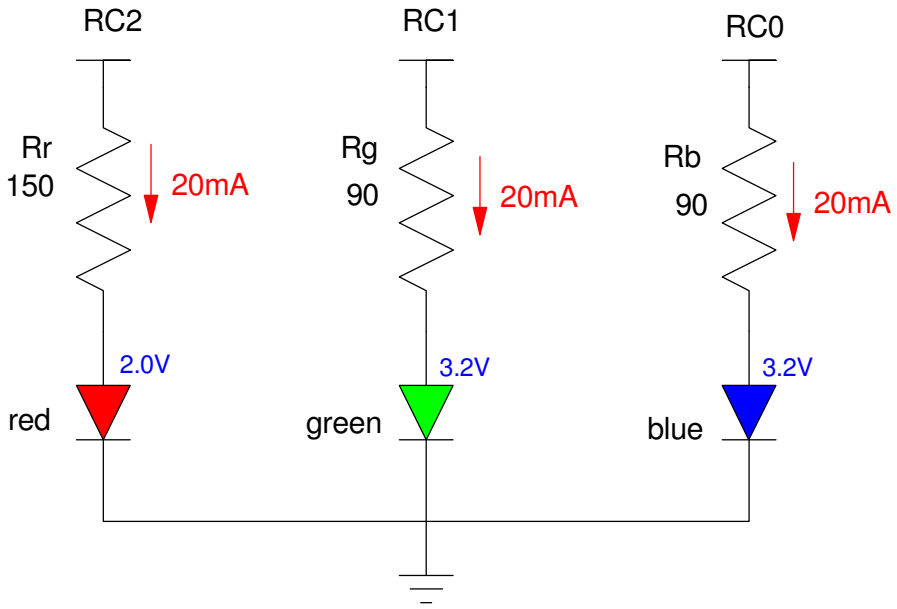
Color	Vf @ 20mA	mcd @ 20mA
red	2.0V	10,000
green	3.2V	10,000
blue	3.2V	10,000

Calculations:

$$R_r = \left(\frac{5V-2.0V}{20mA}\right) = 150\Omega$$

$$R_g = \left(\frac{5V-3.2V}{20mA}\right) = 90\Omega$$

$$R_b = \left(\frac{5V-3.2V}{20mA}\right) = 90\Omega$$



2) Design a circuit which allows your PIC board to turn on and off a 5W LED at 100mA. The specs for the LED are:

- Vf = 6.0-7.0V
- Current = 700mA
- 500-600 Lumens (equivalent to a 60W light bulb).

https://www.ebay.com/itm/1W-3W-5W-10W-50W-100W-High-power-SMD-Chip-LED-COB-White-Blue-Red-Light-Beads/124011607823

Assume you have a 6144 NPN transistor:

- max continuous current = 3A
- current gain = 300
- Vbe = 0.7V, Vce(sat) = 0.2V

Step 1: Pick Rc to set the current to 100mA.

Assume Vd = 6.5V. For Ic = 100mA

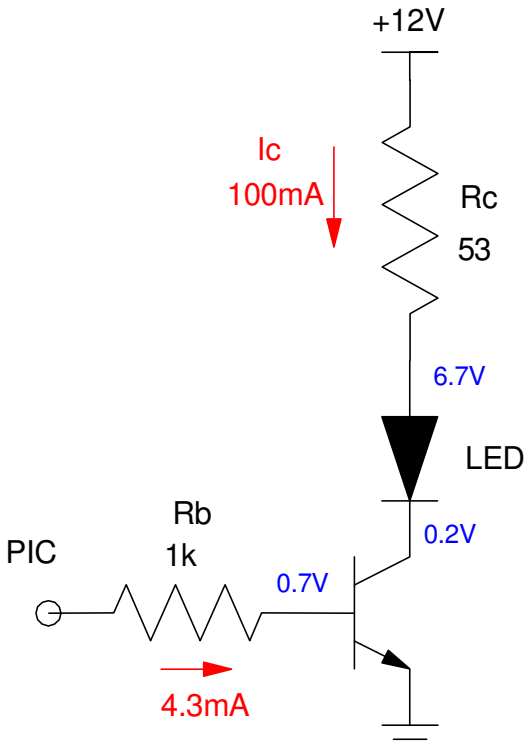
$$R_c = \left(\frac{12V - 6.5V - 0.2V}{100mA}\right) = 53\Omega$$

To saturate the transistor

$$I_b > \left(\frac{I_c}{\beta}\right) = \left(\frac{100mA}{300}\right) = 0.33mA$$

Let Ic = 4.3mA. (overkill but it makes Rb a nice round number)

$$R_b = \left(\frac{5V - 0.7V}{4.3mA}\right) = 1k\Omega$$



Timing:

3) Write a program which outputs the music note F3 (174.61 Hz)

- Verify the frequency of the square wave you generate
- (Pano Tuner app on you cell phone works well for this)

First, calculate the number of clocks between toggles

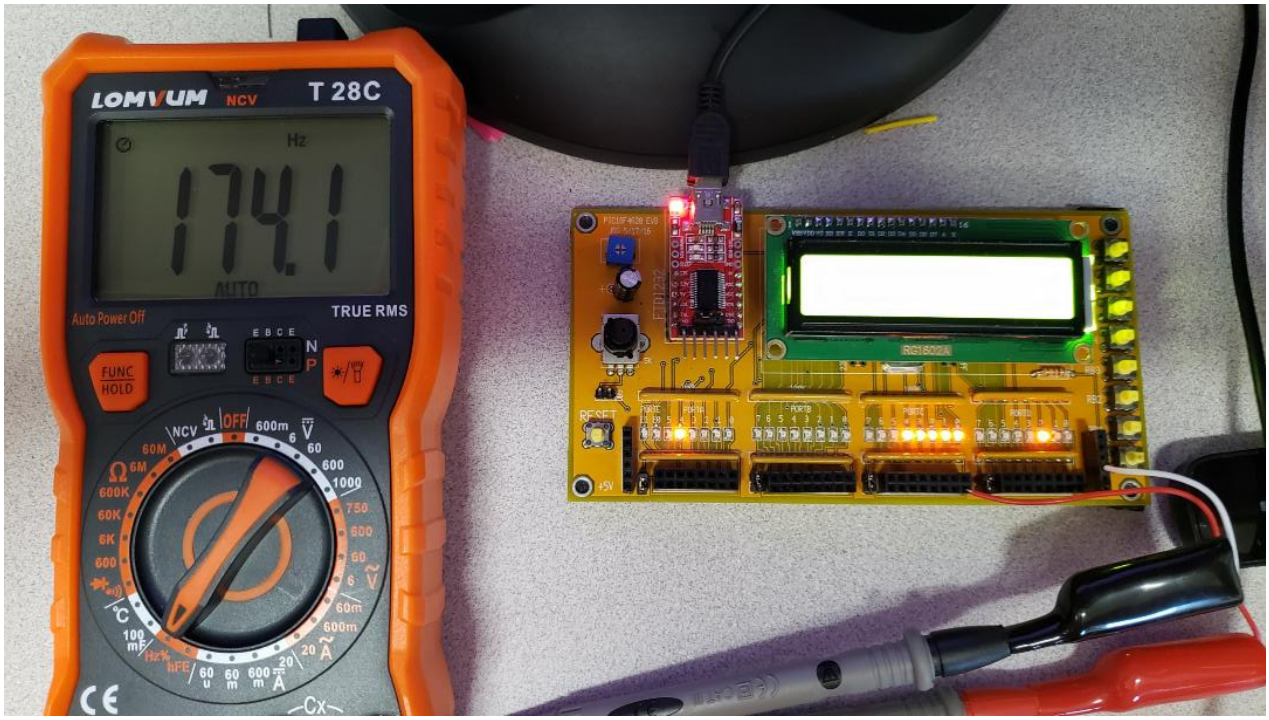
$$N = \left(\frac{10{,}000{,}000}{2 \cdot Hz}\right) = 28{,}635.2443$$

Come up with a wait look that burns 28,635 clocks

N = 10*A*B + 5*A + 9 = 28,635

A = 12, B = 239 results in N = 28,749 (off by +0.40%)

```
#include <p18f4620.inc>

; Variables
CNT0 EQU 1
CNT1 EQU 2

; Program
   org 0x800
   call Init
Loop:
   incf  PORTC,F
   call Wait
   goto Loop

; --- Subroutines ---

Init:
   clrf TRISA
   clrf TRISB
   clrf TRISC
   clrf TRISD
   clrf TRISE
   movlw 0x0F
   movwf ADCON1 ;everyone is binary
   return

Wait:
   movlw 12         ; A
   movwf CNT1
W1:
      movlw 239     ; B
      movwf CNT0
W0:
         nop        ; 10 clocks
         nop
         nop
         nop
         nop
         nop
         nop
         decfsz CNT0, F
         goto W0
      decfsz CNT1, F
      goto W1
   return
```



Finding frequency using a multimeter: frequency = 174.1Hz (174.61Hz ideally)

Pano Tuner also works (cell phone app)

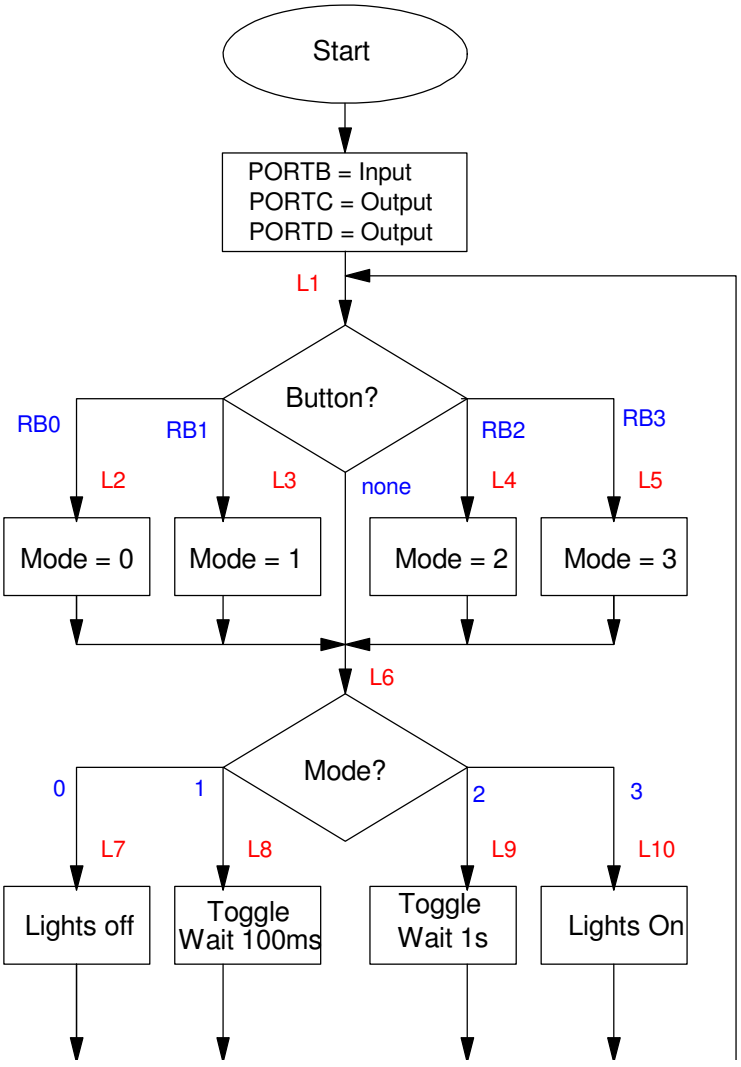
Lab: LED Flashlight

4) Give the flow chart for a program to turn your PIC board into an LED flashlight:

- PORTB = input
- PORTC & D are output (the LED's)
- RB0: All lights turn off (PORTC = PORTD = 0);
- RB1: Lights on PORTC and D blink on and off every 1000ms
- RB2: Lights on PORTC and D blink on and off every 100ms
- RB3: Lights on PORTC and D are 100% on (no blinking)

5) Write the corresponding assembler code

```
MODE equ 0

    org 0x800

    movlw 0xFF
    movwf TRISB
    clrf  TRISC
    clrf  TRISC
    movlw 0x0F
    movwf ADCON1
L1:
    btfsc PORTB,0
    goto  L2
    btfsc PORTB,1
    goto  L3
    btfsc PORTB,2
    goto  L4
    btfsc PORTB,3
    goto  L5
    goto  L6
L2:
    clrf  MODE
    goto  L6
L3:
    movlw 1
    movwf MODE
    goto  L6
L4:
    movlw 2
    movwf MODE
    goto  L6
L5:
    movlw 3
    movwf MODE
L6:
    movff MODE,PORTA
    movlw 0
    cpfsgt MODE
    goto  L7
    movlw 1
    cpfsgt MODE
    goto L8
    movlw 2
    cpfsgt MODE
    goto L9
    movlw 3
    cpfsgt MODE
    goto L10
```



```
L7:
   clrf  PORTC
   clrf  PORTD
   goto  L1
L8:
   comf  PORTC,F
   comf  PORTD,F
   movlw 10
   call  Wait
   goto  L1
L9:
   comf  PORTC,F
   comf  PORTD,F
   movlw 100
   call  Wait
   goto  L1
L10:
   movlw 0xFF
   movwf PORTC
   movwf PORTD
   goto  L1


Wait:
   movwf CNT2
W2:
   movlw 100
   movwf CNT1
W1:
   movlw 100
   movwf CNT0
W0:
   nop
   nop
   nop
   nop
   nop
   nop
   nop
   decfsz  CNT0,F
   goto  W0

   decfsz  CNT1,F
   goto  W1

   decfsz  CNT2,F
   goto  W2

   return
```

6) Test your code.

- Compile and program your PIC board
- Verify each button's operation

Button 0:

- PORTA displays 0
- Lights off

Button 1:

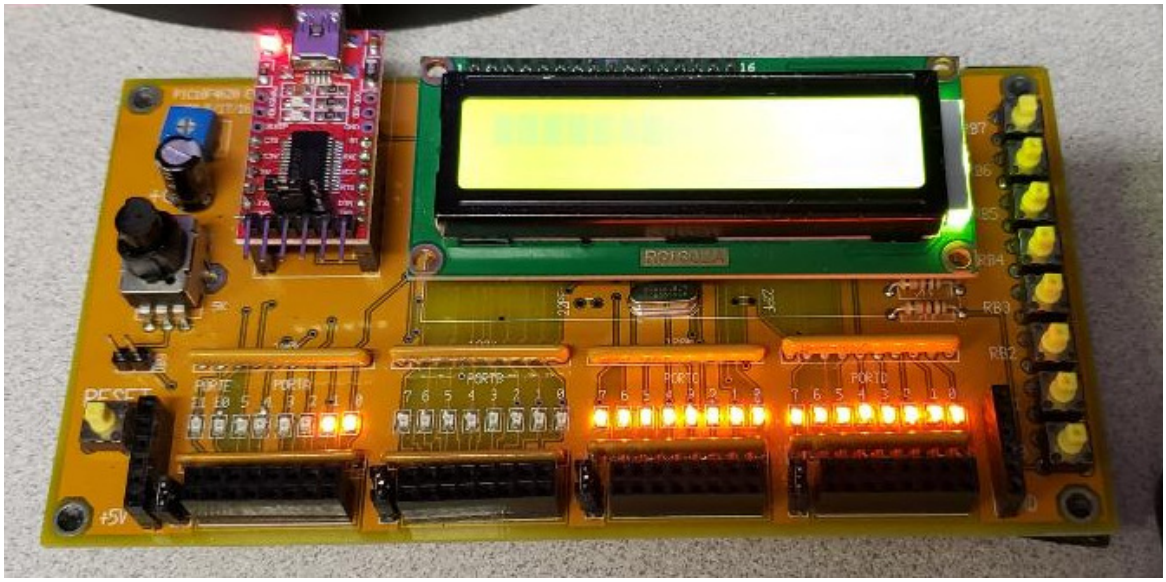
- PORTA displays 1
- Lights blink at 100ms

Button 2:

- PORTA displays 2
- lights blink at 1 second

Button 3

- PORTA displays 3
- Lights fully on



7) (20 points) Demonstration

- In-person of with a video