EE 2004
Week 9 Homework
Solution

Note: As defined in lectures, we denote a pin inside a port as RXY, where X is the port ID ranging from A-E, and Y is the pin number ranging from 0-7.

1. A switch is connected to RB0 and an LED to RB7. Write a program to get the status of the switch and send it to the LED.

```
            bsf TRISB, 0; set RB0 as input
            bcf TRISB, 7; set RB7 as output
Again:      btfss PORTB, 0
            bra Over; RB0 is low
            bsf PORTB, 7; RB0 is high
            bra Again
Over:       bcf PORTB, 7
            bra Again
            end
```

2. Assume that RB3 is an input and represents whether the door is opened. If it goes LOW, it means that the door is opened. Monitor the bit continuously. Whenever it goes LOW, send a HIGH-to-LOW pulse to RC5 to turn on the buzzer.

```
            bsf   TRISB, 3; make RB3 an input
            bcf   TRISC, 5; make RC5 an output
HERE:       btfsc PORTB, 3; keep monitoring RB3 for low
            bra HERE; stay in the loop if high
            bsf   PORTC, 5; make RC5 H and L.
            bcf   PORTC, 5
            end
```

3. Write a program to generate a square wave of 50Hz frequency and output it to RB5. Use 16-bit mode of Timer 0 in all of the following settings. Assume the clock frequency is 4MHz. Ignore time delay generated by instructions required to detect TMR0IF after the flag is raised.
    a. Use Timer0 with the maximum prescaler.
    b. Use Timer0 with no prescaler.
    c. Use Timer0 with a prescaler = 4.

    We need a time delay equals to half of the period of the desired wave = 10ms. We toggle the status of RB5 at the end of each delay of 10ms.

    a. Maximum prescaler for Timer0 = 256. Time Delay = (65536-x)*Prescaler*Instruction cycles.
    Instruction Period = 1us (4MHz clock frequency) and x denotes the initial value loaded to TMR0 hereafter. Solving the equation: Time Delay = (65536-x)*256*1us = 10,000us yields x = 0xFFD9. Here is the program we should write:

```
        bcf     TRISB, 5                ; Set PB5 as output
        bcf  PORTB, 5                   ; turn off PORTB.5
        movlw   B '00000111'            ; 16-bit, int clk,
                                      Prescaler=256
        movwf  T0CON
Here    movlw  0xFF                     ; TMR0H = 0xYY
        movwf  TMR0H
        movlw  0xD9                     ; TMR0L = 0xXX
        movwf  TMR0L
        bcf    INTCON, TMR0IF           ; Clear timer interrupt flag
        bsf    T0CON, TMR0ON            ; start Timer 0
Again   btfss  INTCON, TMR0IF
        bra    Again
        btg    PORTB, 5
        bcf    T0CON, TMR0ON
        bra    Here                     ; load TMR0H and TMR0L again
```

    b. Time Delay = (65536-x)*1*1us = 10,000us yields x = 0xD8F0. Use the above program, just change TMR0 and T0CON.

    c. Time Delay = (65536-x)*4*1us = 10,000us yields x = 0xF63C. Use the above program, just change TMR0 and T0CON.

4. If we are generating a square wave on RB7, what are the lowest and the highest frequency that we can be generated using Timer0 in 16-bit mode if we load 0000 to TMR0?

    The maximum time delay = 65536*256*1us = 16.777216s
    Period of the square wave = 2*The maximum time delay
    Lowest frequency = 1/Period of the square wave = 0.0298 Hz
    The minimum time delay = 65536*1us = 65536us
    Period of the square wave = 2*The minimum time delay= 0.131072s
    Highest frequency = 1/Period of the square wave = 7.63Hz

5. Find the TMR0H, TMR0L values needed to generate the following time delays. Assume the clock frequency is 4MHz. Ignore time delay generated by instructions required to detect TMR0IF after the flag is raised.
    a. 2ms. Use 16-bit, no prescaler mode.
    b. 5ms. Use 16-bit mode and the largest prescaler possible.
    c. 0.2ms. Use 8-bit, no prescaler mode. TMR0H is not used. Only specify TMR0L.

    a. Time Delay = (65536-x)*1*1us = 2000us. x = 0xF830. TMR0H = F8; TMR0L = 30.
    b. Time Delay = (65536-x)*256*1us = 5000us. x = 0xFFEC. TMR0H = FF; TMR0L = EC.
    c. Time Delay = (256-x)*1*1us = 200us. x= 0x38.