

# 16.317: Microprocessor Systems Design I

Fall 2015

## Lecture 26: Key Questions

November 6, 2015

1. Describe the operation of the given subroutine, which implements a 10 ms delay loop.

```
.*****
;
; TenMs subroutine and its call inserts a delay of exactly ten milliseconds
; into the execution of code.
; It assumes a 4 MHz crystal clock. One instruction cycle = 4 * Tosc.
; TenMsH equ 13 ; Initial value of TenMs Subroutine's counter
; TenMsL equ 250
; COUNTH and COUNTL are two variables
TenMs
    nop ; one cycle
    movlw TenMsH ; Initialize COUNT
    movwf COUNTH
    movlw TenMsL
    movwf COUNTL
Ten_1
    decfsz COUNTL,F ; Inner loop
    goto Ten_1
    decfsz COUNTH,F ; Outer loop
    goto Ten_1
    return
```

2. Describe the operation of the given subroutine, which toggles a series of 3 LEDs in sequence, assuming those LEDs are attached to bits 0-2 of Port D.

**BlinkTable**

```
movf    PORTD, W      ; Copy present state of LEDs into W
andlw   B'00000111'   ; and keep only LED bits
addwf   PCL,F         ; Change PC with PCLATH and offset in W
retlw   B'00000001'   ; (000 -> 001) reinitialize to green
retlw   B'00000011'   ; (001 -> 010) green to yellow
retlw   B'00000110'   ; (010 -> 100) yellow to red
retlw   B'00000010'   ; (011 -> 001) reinitialize to green
retlw   B'00000101'   ; (100 -> 001) red to green
retlw   B'00000100'   ; (101 -> 001) reinitialize to green
retlw   B'00000111'   ; (110 -> 001) reinitialize to green
retlw   B'00000110'   ; (111 -> 001) reinitialize to green
```

*In calling program*

```
call    BlinkTable    ; get bits to change into W
xorwf   PORTD, F      ; toggle them into PORTD
```

3. Explain the basic operation of stepper motors.

4. Explain how a microcontroller can be used to control a bipolar stepper motor.

5. Explain the key parts of the stepper motor control code shown below (initialization not shown).

```
Loop:                                     ; Return Here for Next Value
    movlw  HIGH ((250000 / 5) + 256)
    movwf  Dlay
    movlw  LOW ((250000 / 5) + 256)
    addlw  -1                             ; 250 ms Delay
    btfsc  STATUS, Z
    decfsz Dlay, f
    goto   $ - 3

    movf   i, w
    call   SwitchRead
    movwf  PORTC

    incf   i, f                           ; i = (i + 1) % 8;
    bcf    i, 3
    goto   Loop
```

```
SwitchRead:
    addwf  PCL, f                         ; Staying in First 256 Instructions
    dt     b'011100', b'010100', b'000100', b'100100'
    dt     b'100000', b'101000', b'111000', b'011000'
    end
```