Solution for HW#4: Timer and Counter (50 points)
ECE473/ECE573, Microprocessor System Design

[Timer]
1. Indicate which mode and which timer are selected for each of the following.
   (a) MOV TMOD, #01H ⇒ Timer 0, Mode 1 is selected
   (b) MOV TMOD, #20H ⇒ Timer 1, Mode 2 is selected
   (c) MOV TMOD, #12H ⇒ Timer 1, Mode 1 and Timer 0, Mode 2 are selected

2. Find the timer’s clock frequency and its period for various 8051-based systems, with
   the following crystal frequencies. (3 points)
   (a) 12MHz ⇒ 1us
   (b) 16MHz ⇒ 0.75us
   (c) 11.0592MHz ⇒ 1.085us

3. Find the value for TMOD if we want to program timer 0 in mode 2, use 8051 crystal
   for the clock source, and use instructions to start and stop the timer. (3 points)

   MOV TMOD, #02H

4. Find the delay generated by timer 0 in the following code. Do not include the overhead
   due to instructions. (6 points)

   CLR P2.3
   MOV TMOD, #01H
   HERE:  MOV TL0, #3EH
          MOV TH0, #0B8H
          SETB P2.3
          SETB TR0
   AGAIN: JNB TF0, AGAIN
          CLR TR0
          CLR TF0
          CLR P2.3

   (FFFF-B83E+1)*1.085 = 47C2 (hex) *1.085 = 18370 (decimal) *1.085
   = 19.93145ms

5. Modify TL and TH in Example 4 to get the largest time delay possible. Find the delay
   in ms. In your calculation, exclude the overhead due to the instructions in the loop. (6
   points)

   MOV TL0, #0
   MOV TH0, #0

   ⇒ 65536*1.085 = 71.1065ms
6. The following program generates a square wave on pin P1.5 continuously using timer 1 for a time delay. Find the frequency of the square wave if XTAL = 11.0592 MHz. In your calculation do not include the overhead due to instructions in the loop. (6 points)

```
MOV TMOD, #10H
AGAIN: MOV TL1, #34H
      MOV TH1, #76H
      SETB TR1
BACK:  JNB TF1, BACK
      CLR TR1
      CPL P1.5
      CLR TF1
      SJMP AGAIN
```

`(FFFF-7634+1) = 89CC (hex) = 35276 (dec)
35276 * 1.085 = 38.274ms
1/38.274ms = 26.127 Hz`

7. Assume that XTAL=11.0592 MHz, write a program to generate a square wave of 2 kHz frequency on pin P1.5. (6 points)

```
T=1/f = 1/2kHz = 500us
500us/2 = 250 us
250us/1.085us = 230 = n
65536 – 230 = 65306 = FF1A (hex) ➔ TH = FF, TL=1A
```

```
MOV TMOD, #10H
Again: MOV TL1, #1AH
      MOV TH1, #0FFH
      SETB TR1
Back:  JNB TF1, Back
      CPL P1.5
      CLR TF1
      SJMP Again
```
8. Find the frequency of a square-wave generated on pin P1.0. (6 points)

```
MOV TMOD, #02H
MOV TH0,#0
AGAIN: MOV R5, #250
       ACALL DELAY
       CPL P1.0
       SJMP AGAIN
DELAY: SETB TR0
BACK:  JNB TF0, BACK
       CLR TR0
       CLR TF0
       DJNZ R5, DELAY
       RET
```

\[ T = 2 \times (250 \times 256 \times 1.085) = 138.88 \text{ms} \]

\[ f = 1/T = 7.2 \text{Hz} \]
9. Assume that a 1-Hz frequency pulse is connected to input pin P3.4. Write a program to display counter 0 on an LCD. Set the initial value of TH0 to -60. (10 points)

```assembly
ACALL LCD_SET_UP
MOV TMOD, #06H
MOV TH0, #-60
Again: CPL P3.4
SETB TR0
Back: MOV A, TL0
ACALL CONV
ACALL Display
JNB TF0, Back
CLR TR0
CLR TF0
SJMP Again

; convert 8-bit binary to ASCII
CONV: MOV B, #10
DIV AB
MOV R2, B  ; Save Low Digit
MOV B, #10
DIV AB
ORL A, #30H ; make it ASCII (first digit)
MOV R4, A
MOV A,B
ORL A, #30H ; make it ASCII (second digit)
MOV R3, A
MOV A, R2
ORL A, #30H ; make it ASCII (third digit)
MOV R2, A
RET
```