EE 337: Microprocessors Laboratory (Spring 2023)
Indian Institute of Technology Bombay
Lab 8: 20 points Date: March 13, 2023

In this lab, you will be learning how to use Timers and Interrupts in Embedded C.

To learn about timers, refer the following document: 8051 Timers
To learn about interrupts, refer the following document: 8051 Interrupts

1. [5 points] Fill in the blanks in the Embedded C code at `https://ee337.github.io/2023/downloads/lab8_1.c` to create unsymmetrical square wave at port P3.6 using timer 1 in polling mode. The square wave should have ON time 4 ms and OFF time 12 ms.
   Observe the output using Keil Logic Analyzer first. Then upload the code on the Pt-51 board and use a Digital Storage Oscilloscope in lab to observe the output.

2. [5 points] Fill in the blanks in the Embedded C code at `https://ee337.github.io/2023/downloads/lab8_2.c` to generate two square waves simultaneously at P3.6 and P3.7 pins of time periods 2 ms and 3 ms using timer 0 and timer 1 respectively in interrupt mode.
   Observe the outputs using Keil Logic Analyzer first. Then upload the code on the Pt-51 board and use a Digital Storage Oscilloscope in lab to observe the outputs.

3. [10 points] Write an Embedded C code to create a **STOP-WATCH** using external event counter and LCD. Steps to perform this task are elaborated.

   - Use timer 0 as an event counter. The timer should be configured to work in mode 1 and the pin P3.4 should be used as input to count the number of events.
   - Provide a $60Hz$ square waveform (with voltage levels $0V$ and $5V$) using an Arbitrary Function Generator to the pin P3.4.
   - Use the DIP switch P1.0 to start and stop the event measurement. When P1.0 is turned ON, the measurement should start and when it is turned OFF, the measurement should stop.
   - Use the LCD to display the measured time in the following format - `MM:SS`. Note that you need to count the number of seconds and minutes.

TA Checkpoints

- Check whether proper ON time and OFF time is obtained for the square wave in Logic Analyzer. Also, check whether the output in DSO is proper.
- Check whether students have set proper TH,TL, TMOD and enabled interrupts appropriately for generating square waves simultaneously.
- Check whether stop-watch is working as expected in LCD and TH,TL,TMOD and interrupt values is set appropriately.