EE 337: Microprocessors Laboratory (Spring 2022)
Indian Institute of Technology Bombay
Assignment 4: 20 points Date: February 01, 2022

1. [5 points] In this experiment, you will be demonstrating that your PT-51 kit works by running the test code for the kit. The test code also checks the peripherals on the kit. Using this, you can also verify that all required software is correctly installed.

   - Know more about the PT-51 kit by going through the slides at the following URL: `https://ee337.github.io/pt51.html#user-manual`
   - Install FLIP (on Windows) or DFU Programmer (on Linux/Mac). This software is used to load programs into the 8051 microcontroller on the PT-51 kit. The steps are here: `https://ee337.github.io/tools.html#flip`
   - The procedure to load a hex file onto the PT-51 kit using Flip is shown in the video at the following URL.

     `https://ee337.github.io/pt51.html#programming-and-testing`

     Follow the procedure and load the `led.hex` file to see that the LEDs on your kit toggle.
   - Download the file `pt51_test.hex` and load it on your PT-51 kit, as described at the following URL.

     `https://ee337.github.io/pt51.html#testing-the-peripherals-of-pt-51`
   - Follow the steps in the slide deck titled "PT-51 Test Program" to do the self-test of the kit. Check if all tests run successfully. If there are failed tests, inform us. **Shoot a video of yourself doing ALL the tests mentioned in the document.** The video needs to be uploaded using the **Video upload link for lab 4** assignment in the course team on MS Teams (it has an option to attach files). **Additionally, you will have to repeat the tests in front of the TAs during viva as well to verify the working of the board**.

2. [8 points] History quite literally is full of dates.

   - 15/08/1947: India gained independence
   - 25/06/1983 and 02/04/2011: Indian Cricket Team won ODI world cups.
   - And so on.

   In this lab, your task is to write an assembly language program to display these dates on a port. You will be first doing this on the logic analyzer in Keil and then on the LEDs located on the PT-51 board. The PT-51 board has LEDs connected to the upper nibble of port 1: P1.7 to P1.4. The goal is to display the above dates on the LEDs.

   Store the dates (there are 8 digits with each digit needing four bits to represent) in four consecutive memory locations starting from 50H. Then using P1.7 (MSB) to P1.4 (LSB), display these digits one by one. Each digit needs to be displayed in binary format. For example, 7 corresponds to 0111. Also, each digit must be held for a fixed duration of 200 ms, for which you can use the delay subroutine provided below.

   The date must be displayed in DD/MM/YYYY format with the '/' being represented by 1111. For example, to display 25/06/1983, the sequence of values (represented in hexadecimal) at the higher nibble of port 1 would be (assume '-' represents a delay

of 200 ms) **2-5-F-0-6-F-1-9-8-3-F-. This must be put in an infinite loop so that the dates are continuously displayed.**

Use `delay_1ms` subroutine shown below that generates 1 ms delay to make a subroutine to generate the required delay.

```
delay_1ms:
    push 00h
    mov r0, #4
    h2: acall delay_250us
    djnz r0, h2
    pop 00h
    ret

delay_250us:
    push 00h
    mov r0, #244
    h1: djnz r0, h1
    pop 00h
    ret
```

When using the logic analyzer in Keil, make sure you change the default clock frequency to 24MHz (as it is on the PT-51 board). To verify the delay amount, refer the instruction set to find number of cycles each instruction runs for and how correct amount delay is achieved. This is called a software delay.

3. [7 points] Edit the delay from the first part so that the delay between each digit is 1 second. Demonstrate this to your TA during viva. Note that MS Teams on a browser will not allow you to simultaneously share screen and turn on camera. So make sure you download the client.

TA Checkpoints

1. For question 1, make sure the student knows how to operate Flip/ DFU Programmer, and shows all the tests mentioned.

2. For question 2, make the student display the date of their viva and their birth date on the logic analyser.

3. For question 2, ask the student to explain why the `delay_1ms` subroutine generates 1 millisecond delay.

4. For question 3, make sure student knows how to generate the hex file, upload it onto the board, and display dates on the LEDs.