NPTEL
Summer Workshop on Microcontrollers
WEL, IIT Bombay

Quiz-2 (Duration: 1:30pm - 3:30pm) Date: June 16, 2023

General Instructions:

- You are **ONLY** allowed to use your codes from previous labs. Sharing your previous codes and resources to other students during exam is strictly **not permitted**.
- Use of internet during the course of this examination will be considered as copying and strict action will be taken.
  - **You must put your laptops in airplane mode.**
  - **No internet browser should be opened during the exam**
  - **Install a non-browser pdf reader to read pdf files during the exam.** Examples are Acrobat Reader, Nitro PDF Reader, Sumatra PDF Reader.
- Any discussion during exam is **not permitted**.

1. Two students Steven and Thomas have designed different multiplication algorithms to be implemented on Pt-51 board.

   Algorithm designed by Steven:

```
input x, y
x1 = x/10
x0 = x%10
y1 = y/10
y0 = y%10
z0 = x0*y0
z1 = x0*y1
z2 = x1*y0
z3 = x1*y1
z = z0 + (z1 + z2)*10 + z3*100
output z
```

   Algorithm designed by Thomas:

```
input x, y
x1 = x/10
x0 = x%10
y1 = y/10
y0 = y%10
z0 = x0*y0
z1 = (x0+x1)*(y0+y1)
z2 = x1*y1
z = z0 + (z1 - z0 - z2)*10 + z2*100
output z
```

   Your task is to figure out whose algorithm performs better.

   - Implement both these algorithms in C independently (2 separate programs). Inputs can be assumed to be in the range 0 to $2^{16} - 1$. Use long unsigned int for all variables.
   - Directly give inputs $x = 14571$ and $y = 8636$ for both the programs.
   - Use **timer0** to measure the time taken to perform a single multiplication. You need to start the timer just before the algorithm is started and stop the timer just after the algorithm is completed.

- To measure the execution time of the algorithm, you need to monitor the contents of timer0 registers TH0 and TL0. You can view these registers in debug session (Memory window) as follows:
  - address of register TH0 : 8Ch
  - address of register TL0 : 8Ah

  For example, to access register TH0 type ”D:8Ch” in memory window and hit enter.

Which algorithm is faster? What do you think is the reason for the difference in performance?

2. Write an Embedded C code to create a **STOP-WATCH** timer and LCD. Steps to perform this task are elaborated.

   - Use **timer0** in interrupt mode. The timer should be configured to work in mode 1.
   - Use the DIP switch P1.0 to start and stop the timer. When P1.0 is turned ON, the timer should start and when it is turned OFF, the timer 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.
     (Hint:: one upcount in timer register takes 0.5 microseconds)