EE 337: Microprocessors Laboratory (Spring 2021)
Section: S1 (Second year UG)
Indian Institute of Technology Bombay

Lab 5: 20 points Date: March 8, 2021

1. [10 points] You will use the built-in hardware timers in 8051 to generate delays. This is in contrast to the software delay subfunctions you had used in the previous labs.

   - Write a subroutine that will use a 16-bit number as the count value to program the timer `T0` to generate a proportional delay.

     Recall that the 8051 timers count *up*. These generate an interrupt (if enabled to do so) when the count wraps around from `FFFFH` to `0000H`. If we want a timer to time-out after $N$ cycles, it should be loaded with $-N$ (i.e., 2's complement of N).

     So the subroutine should subtract the 16-bit number from `0000H` and load the result as the initial count in `T0`. While debugging the program with single stepping, you could consider a count value of `1`, and load the timer register with `-1`, so that it overflows at the first increment itself. In actual use, a different count has to be stored.
   - Write a program that will use the above subroutine to blink the onboard LEDs such that these are ON for one second and OFF for one second continuously. Adjust the timer count and the number of times the delay subroutine is called to make the ON and OFF period as close to 1 second as possible.

2. [10 points] You will configure the timer `T0` to generate a pulse width modulated (PWM) signal whose duty cycle is controlled by the user. Figure 1 shows typical PWM signals. Read the switches `P1.0-P1.2` to accept the duty cycle from the user. Write a program to generate a PWM with the duty cycle corresponding to the switch positions as indicated in Table 1. Set the frequency of PWM signal be 0.5 Hz and use the LEDs `P1.4-P1.7` (though one is sufficient) to monitor the generated output. The PWM information has also to be written out on the LCD in the following format. First row of the LCD should display the duty cycle in percent as " Duty cycle: xx ", where `xx` depends on the switch value. Second row should display the pulse width as "Pulse width: tttt", where `tttt` represents $tttt \times 10^{-3}$ s.

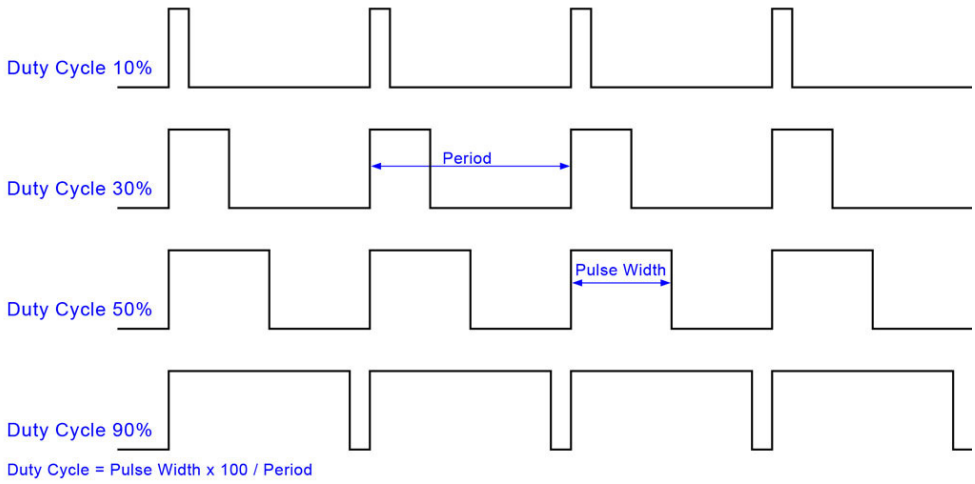


Figure 1: Pulse width modulation

## TA Checkpoints

1. For question 1, ask the students to show the LEDs blinking and check that they use the Timer.
2. For question 2, check that the LEDs turn On and Off, appropriate to the displayed duty cycle on the LCD.

| P1.2-1.0 | Duty cycle( %) |
|---|---|
| 000 | 90% |
| 001 | 80% |
| 010 | 70% |
| 011 | 60% |
| 100 | 50% |
| 101 | 40% |
| 110 | 30% |
| 111 | 20% |

Table 1: Mapping of switch positions to duty cycle.