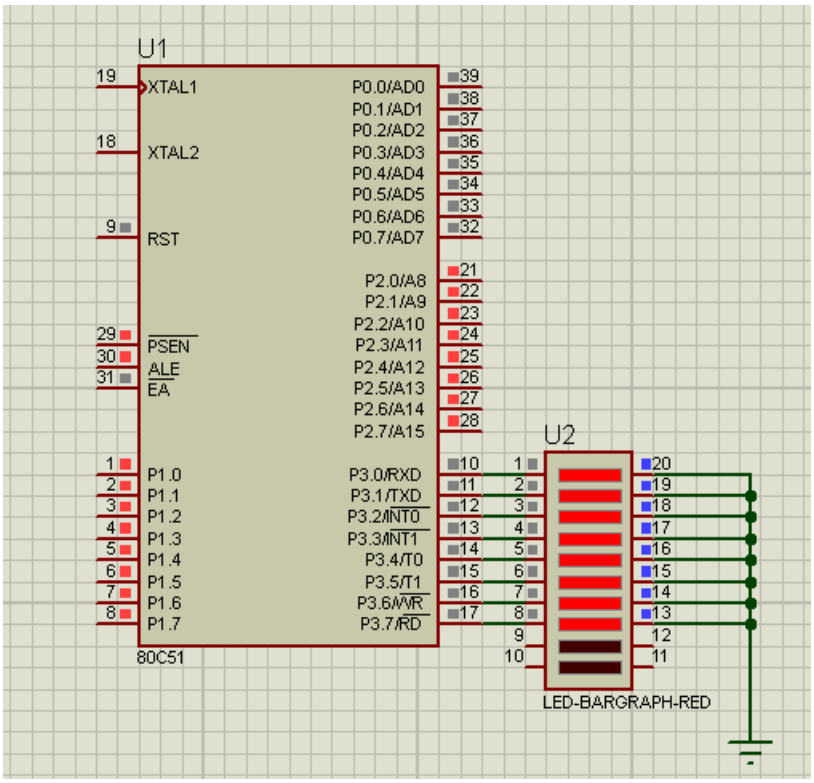
Problem 3

In this problem, we connect 8 LEDs to port 3, and will make them all blink at a given rate (1 second).



To do that, we use a delay subroutine that will make a delay a number of seconds = R4.

Section 1 Variables

```
1  ; VARIABLES
2
3  LEDs EQU P3
4
```

We have only one variable that defines the output port for LEDS

Section 2 Code

```
18  START:
19
20  Loop:
21     MOV LEDS,#0
22     MOV R4,#1
23     CALL DELAY
24     MOV LEDS,#0FFH
25     MOV R4,#1
26     CALL DELAY
27     JMP LOOP
```

In this section, first reset all LEDs to OFF as in line 21, then we pause for 1 second by calling the subroutine/function 'DELAY'.

Then we make all LEDS ON as in line 24, then pausing for one second and repeats.

Section 3 Subroutine

```
29  ; SUBROUTINE TO MAKE A DELAY TIME
30  DELAY:
31  L4:
32     MOV R5,#10
33  L3:
34     MOV R6,#179
35  L2:
36     MOV R7,#0
37  L1:
38     DJNZ R7,L1
39     DJNZ R6,L2
40     DJNZ R5,L3
41     DJNZ R4,L4
42  RET
```

This subroutine makes 8051 loops for nothing to make a pause.

Basically we depend on the loop instruction 'Decrement and Jump if Not Zero' (DJNZ).

Focusing on the most inner loop

```
36     MOV R7,#0
37  L1:
38     DJNZ R7,L1
```

R7 starts by 0, and the instruction DJNZ will first decrement it, so R7 will become =255 (not zero) and hence the DJNZ will jump to L1 and repeats the loop until R7 reaches 0. So this loop will be executed 256 times.

To calculate the time consumed during this loop, we must first know how many cycles it takes "DJNZ" to execute and multiply it by the 8051 cycle time.

- DJNZ takes 2cycles each cycle of 8051 takes Frequency/12
- So with Frequency = 12 MHz, the cycle takes 1us
- DJNZ will take 2 cycles, and this corresponds to 2us
- Now the loop will take 2us * 256 = 512us
- So the maximum time delay for single loop is 512 us, and to make larger time delay we need nested loops to increase the number of executions.
- We used 3 nested loop with 256*196 *2us = 998400 us (1 second approximately).

Also, we add another outer loop with R4 to repeat the whole process as many times as the value of R4. So this function will produce a delay of approximately 1 second multiplied by the value of R4

In our problem, we set R4 to 1 as in lines 22,25 before calling the delay function, so our delay will be 1 second.