MCU. & INDUSTIAL APP. 1 2022-2023 SPRING MIDTERM EXAM

NAME & SURNAME:	SCORES
NUMBER:	Q: 100
HONOUR CODE: I affirm that I will not give or receive any unauthorized help on this exam, and that all work will be my own. SIGN:	<u>90 MINUTES</u>

ANNOUNCEMENT

The midterm exam of the course will be carried out between 13:15 and 14:45 (in total 90 minutes) on Wednesday, 26 April 2023, via online.yildiz.edu.tr system. The exam question will be announced at online.yildiz.edu.tr, and you need to submit/upload your solution to online.yildiz.edu.tr until the end of the exam. The upload link will be active and visible until the end of the exam. You must upload your solution within the given time interval. It is very important to point out that you must submit your solutions to online.yildiz.edu.tr on time. If your solutions are not submitted to the online system on time, they will not be evaluated. The solutions received via e-mail will not be evaluated. An important advice about time management during the exam is that you should use the last 10 minutes of the exam for solution upload/submission to the online system since the first 80 minutes will be sufficient to solve each question in the midterm. It is your responsibility to check that your solutions can be opened and read properly.

You should write the following **honor code** to the first page of your **handwritten solution** and sign below it: "*I affirm that I will not give or receive any unauthorized help on this exam, and that all work will be my own.*". In addition, you must write down **your student number, name, and signature at the top of each A4 paper.**

It will be a classical exam with open book and open notes. You may also benefit from your personal computer to check your code only with programs used in the lectures, but your solution which will be uploaded to the system, should be **handwritten on A4 papers**. 40% of the points will be given to the **comments**, so each assignment line should be explained with enough comment on the same line.

Solution papers should be scanned and converted to pdf files, and this file will be uploaded to online.yildiz.edu.tr system as your solution. All the solutions you submit will also be evaluated for similarity and cheating. Hence, if a cheating issue is detected via the similarity evaluation, the student who sends this solution will get 0 as the exam grade, and the necessary discipline procedure will be carried out for these students.
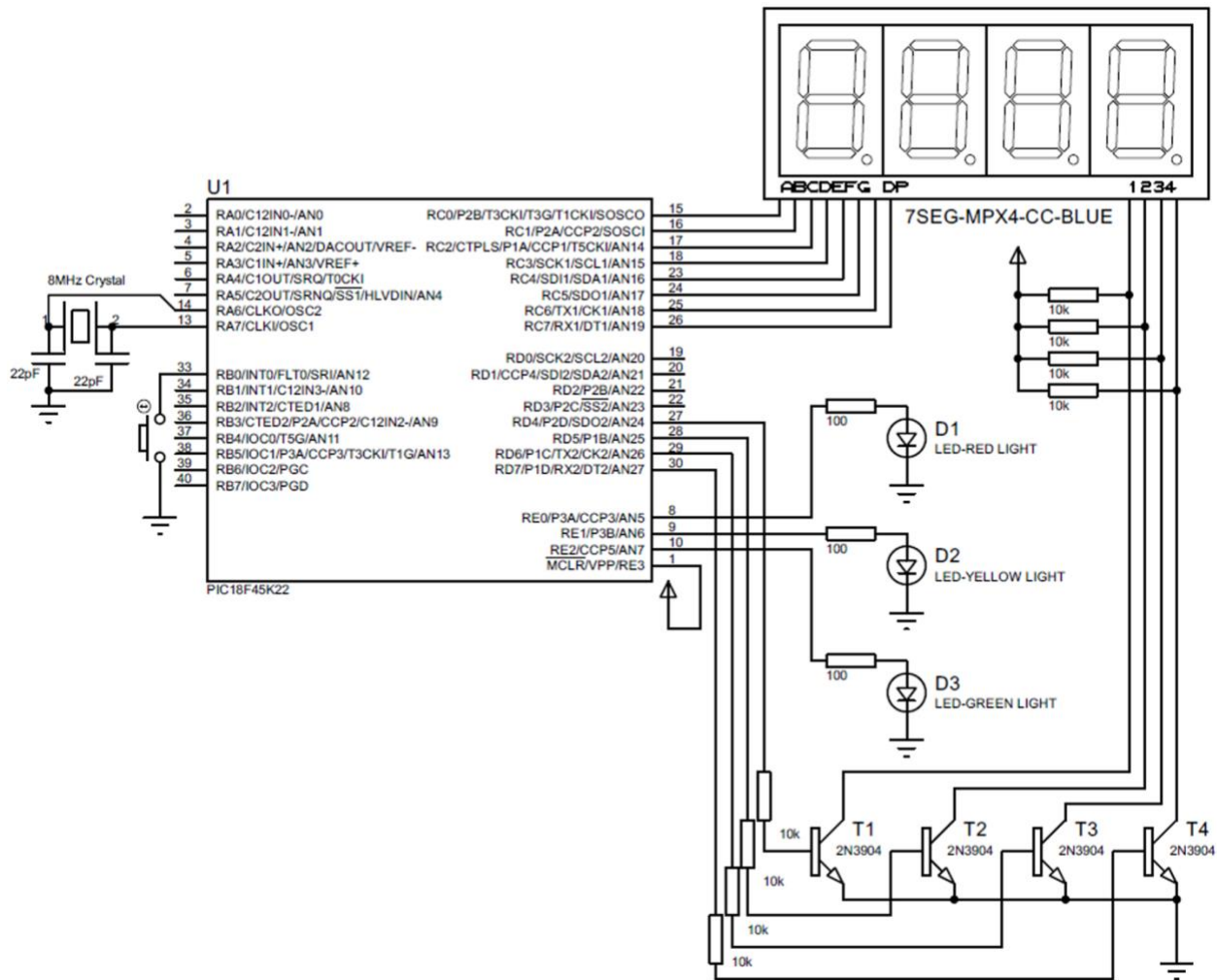
QUESTION:

Figure 1: Schematic of traffic light that will be programmed in the exam.

The circuit shown in the Figure 1 is the schematic diagram of a traffic light. Traffic light has red, yellow, green leds and 4 seven segment display to show remaining time on it.

In this traffic light, red, yellow, and green lights have 30-second, 3-second, and 15-second periods, respectively. Seven segment displays show remaining time in active light and update this information at each 1 second as shown in Figure 2, Figure 3, and Figure 4 below. First two digits of seven segment displays show remaining seconds. Last two digits of seven segment displays is always constant and it is as shown in Figure 2, Figure 3, and Figure 4.

When microcontroller is powered on, red light is on and other leds are off as shown in Figure 2. After 30 seconds, red light led is closed and yellow light led is opened as shown in Figure 3. After 3 seconds yellow light led is closed and green light led is opened as shown in Figure 4. After 15

seconds, green light led is closed and red light led is opened as shown in Figure 2. Loop continues like this until the button connected to PORT B RB0 pin is pressed. When button is pressed, light timing continues inside of the microcontroller but power of leds and seven segment displays are toggled. In the initial condition, leds and seven segment displays are enabled but when button is pressed once, leds and seven segment displays will be powered off. When button pressed once more leds and seven segment displays will be powered on and it will be continued like that.

You are assigned to complete the code below to realize explained behavior above by following the instructions listed below:
- Fosc = 8MHz
- All unconnected pins of microcontroller must be configured as digital input.
- You are not allowed to use any delay functions such as __delay_ms() function.
- Timer0 interrupt with high priority should be utilized to generate delays and scan seven segment displays.
- Timer0 should be utilized in 8-bit mode.
- Seven segment displays should be scanned at each 1 milliseconds using Timer0 interrupt
  - Clue: You can use the same interrupt routine to create the 1 second timing for the count down).
- You need to update remaining time on the first two digits of seven segment displays at 1 Hz.
  - Clue: Notice that seven segment displays are connected to different pins from examples in the lecture.
- INT0 interrupt should be utilized to activate and deactivate leds and seven segment displays.
  - Clue: If you change configuration of a pin from digital output to digital input inside the interrupt service routine (isr, internet handling function), you will prevent sending any signal to connected peripherals or vice versa.
  - Another Clue: Do not forget to activate internal pull-ups of PORT B

Beginning of the code:

```c
#include <stdio.h>
#include <stdlib.h>
#include <pic18f45k22.h>
#include <htc.h>

#define _XTAL_FREQ 8000000   // 8 Mhz crystal is connected to microcontroller as always

#pragma config FOSC = HSHP
#pragma config WDTEN = OFF

unsigned char state = 0; // traffic light state information.
                         // It is 0 for red, 1 for yellow, 2 for green.
                         // System will start with red light
unsigned char redLightPeriod = 30;   // period of red traffic light
unsigned char yellowLightPeriod = 3;  // period of yellow traffic light
```

```
unsigned char greenLightPeriod = 15;  // period of green traffic light
unsigned char countDownTimer = 30;   // Countdown timer variable.
                                     // It will start from 30 seconds because traffic light opens
                                     // in red light state and counts down


// Other variable declarations…

// Main function
    // Port initializations…
    // Timer initializations…
    // Interrupt settings…
    // Infinite while loop…

// Interrupt function
    // Timer0 interrupt handling…
    // INT0 interrupt handling…
```
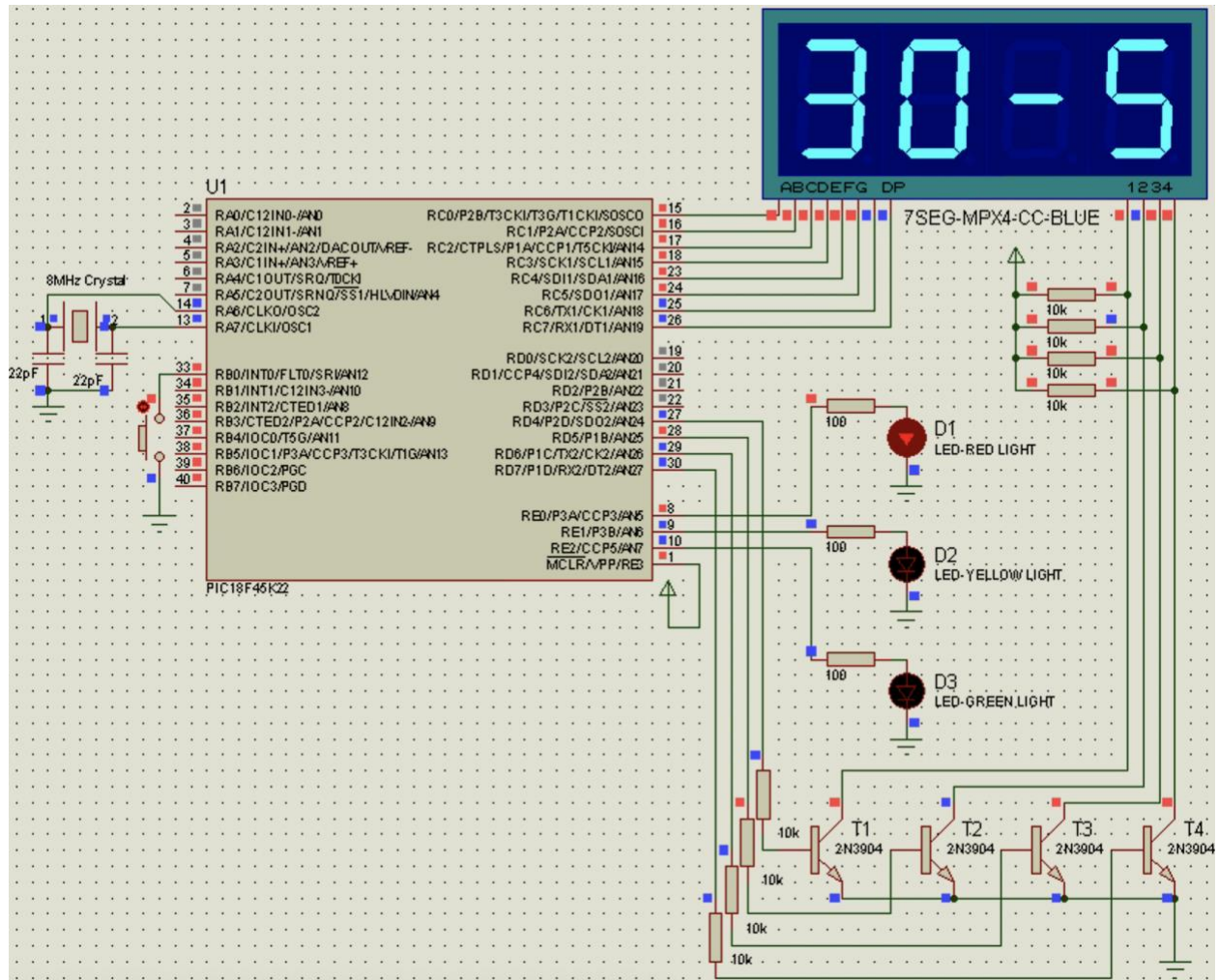
Figure 2: Illustration of start-up condition of traffic light. At the same time, it is also the first second of red light period.
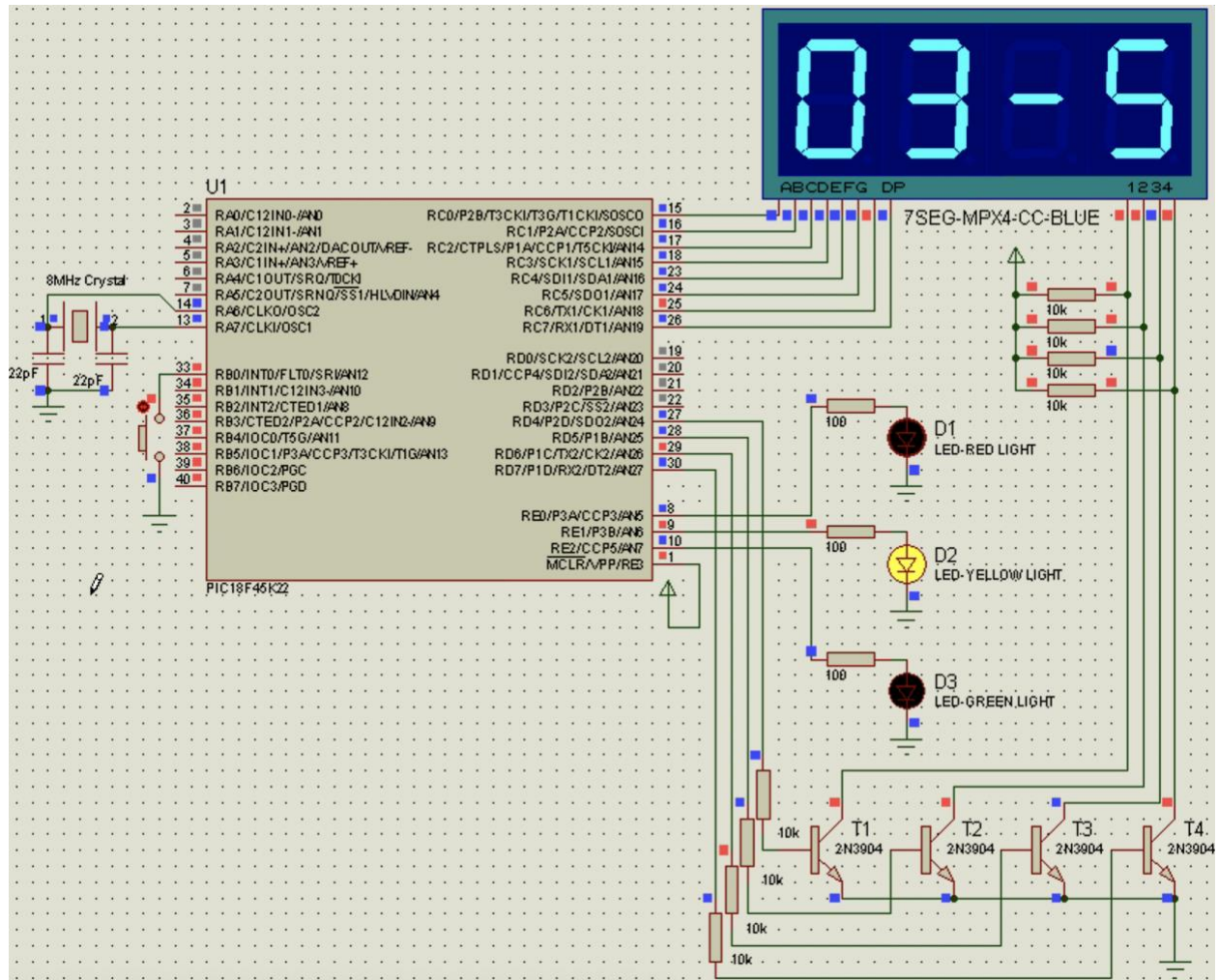
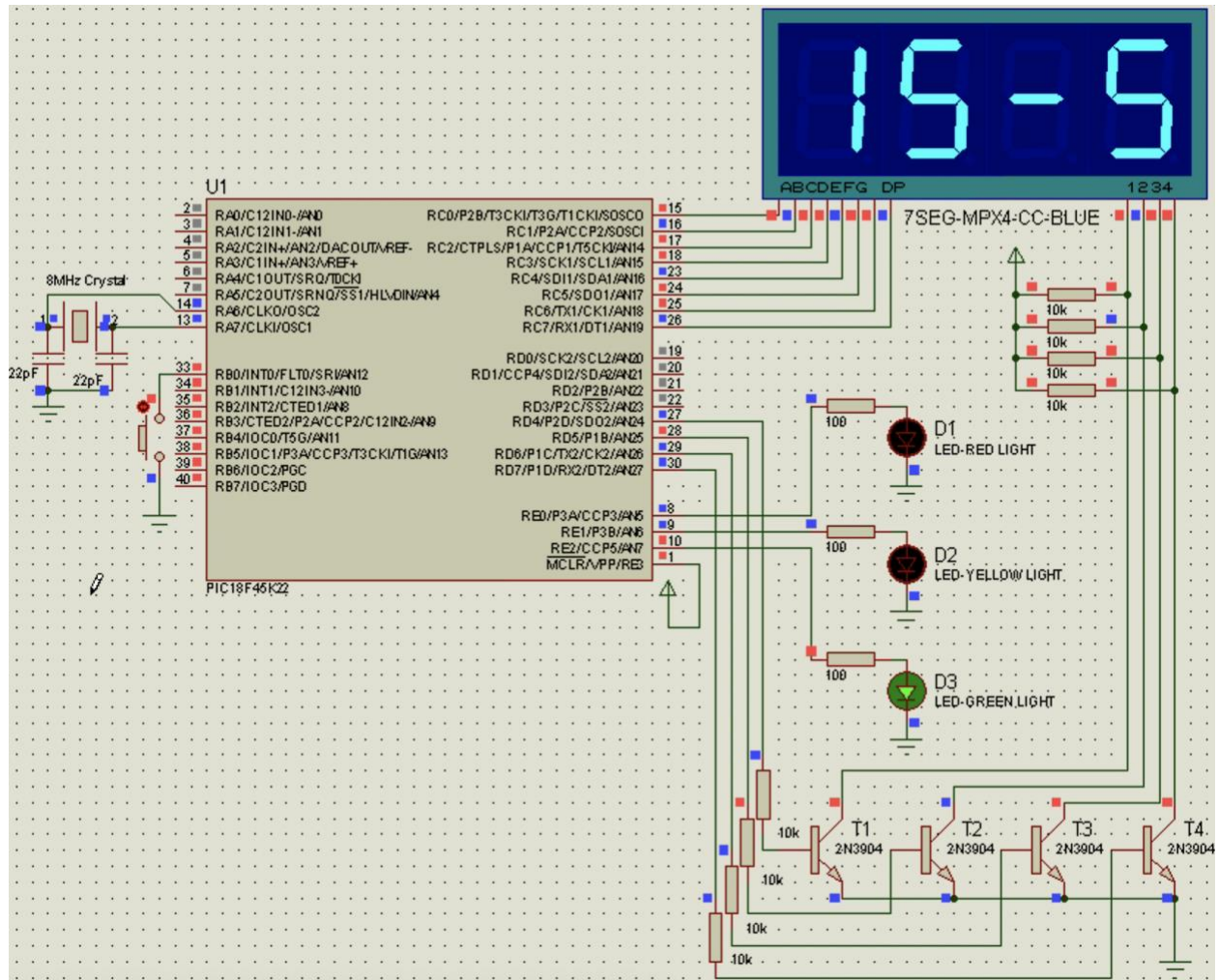*Figure 3: Illustration of first second of yellow light period.*

Figure 4: Illustration of first second of green light period.