THE MICROPROCESSORS & MICROCONTROLLERS

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PRACTICE EXERCISE #2:
COMMUNICATION WITH 7-SEGMENT LED AND TIMER

I. Student preparation

- Knowledge of Timer configuration.
- Learn how to use 7-segment led (7-segment light).

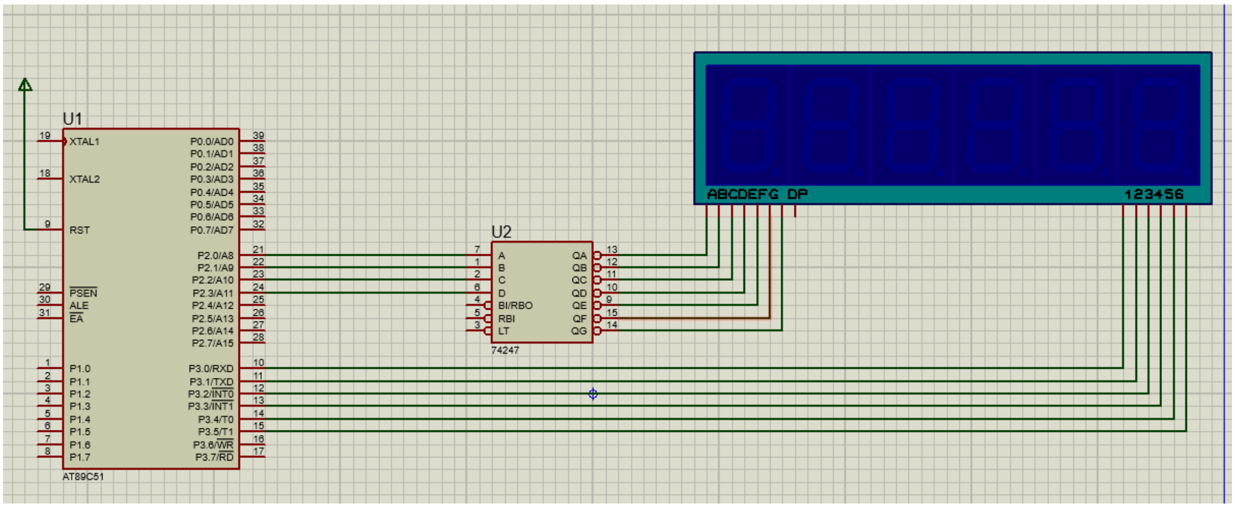
II. Practice content (4 points)

Google Drive Link: LAB02_23520200_NguyenHoangQuocCuong

1. Present and draw a flowchart of the LED scanning algorithm applied to display 7-segment led. **(2 points)**
   - First, LED will display only one digit at a time,basically if we have a long enough timer to set, we will see the serial led light up, it will display like this.

     serial_lightup_led.mkv - Google Drive

   - So the LED scanning technique will help us to set the time fast enough to pretending human's eye that the LED is all light up at a time
   - Flowchart: Flowchart.drawio - draw.io
2. Using the 8051 microcontroller's Timer, design a clock circuit with 24h format with the initial time set in the source code. **(2 points)**

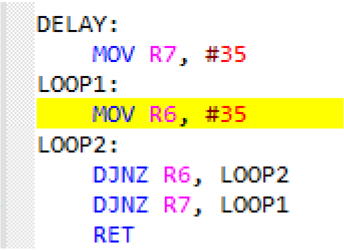


   - This is the design of clock circuit with 24h format
   - The source code: Lab2_code.txt - Google Drive

III. Exercises

With the above clock design, use a loop to create a delay instead of Timer. State the advantages and disadvantages of the two methods.

1. With loop delay:



```
DELAY:
    MOV R7, #35
LOOP1:
    MOV R6, #35
LOOP2:
    DJNZ R6, LOOP2
    DJNZ R7, LOOP1
    RET
```

Using this Delay func to display

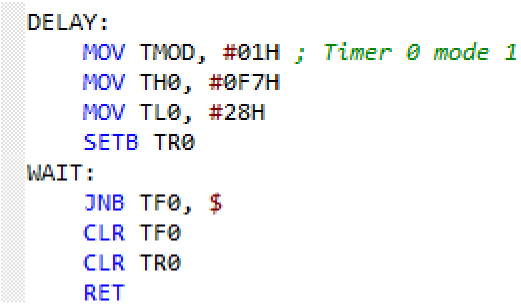
a) Advantages:

- Simple to implement
- No need to configure Timer or special reg.
- Useful for small, quick delays or testing

b) Disadvantages

- Not accurate
- Consumes CPU
- Hard to scale
- No multitasking

2. With Timer delay



```
DELAY:
    MOV TMOD, #01H ; Timer 0 mode 1
    MOV TH0, #0F7H
    MOV TL0, #28H
    SETB TR0
WAIT:
    JNB TF0, $
    CLR TF0
    CLR TR0
    RET
```

Using this Delay func to display

a) Advantages

- Precise
- Efficient CPU usage
- Easier to maintain accuracy

b) Disadvantages

- More complex
- Limited number of Timers

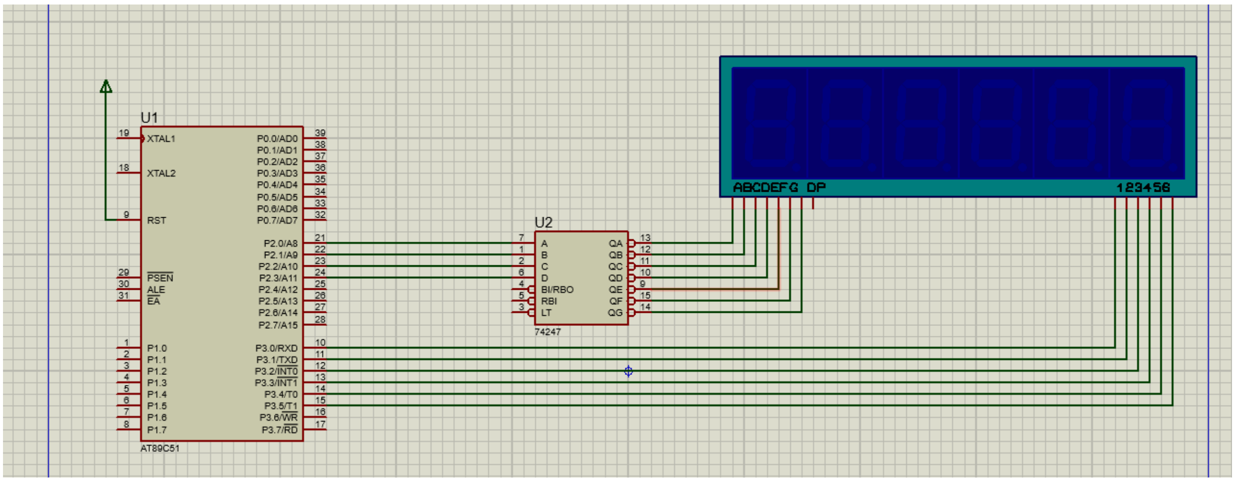
IV. Report (6 points)

Compress design files and report files into a file named as follows:

[<LAB...>]-[<Student code>]-Full name

The required report file contains the following contents:

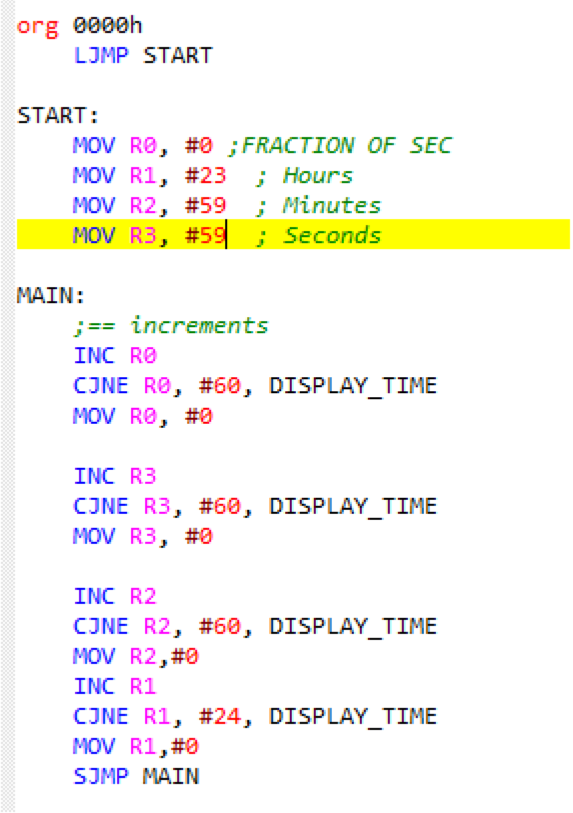
1. Design result (screenshot and pasted in the report). **(1 point)**



2. Explain the operating principle of the effects, accompanied by a video (send a Google Drive link) to demonstrate the circuit operation in case the instructor cannot run the design file. **(3 points)**

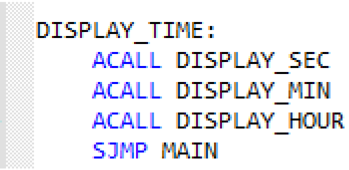
   [LED_TIMER.mkv - Google Drive]

3. Exercise report. **(2 points)**



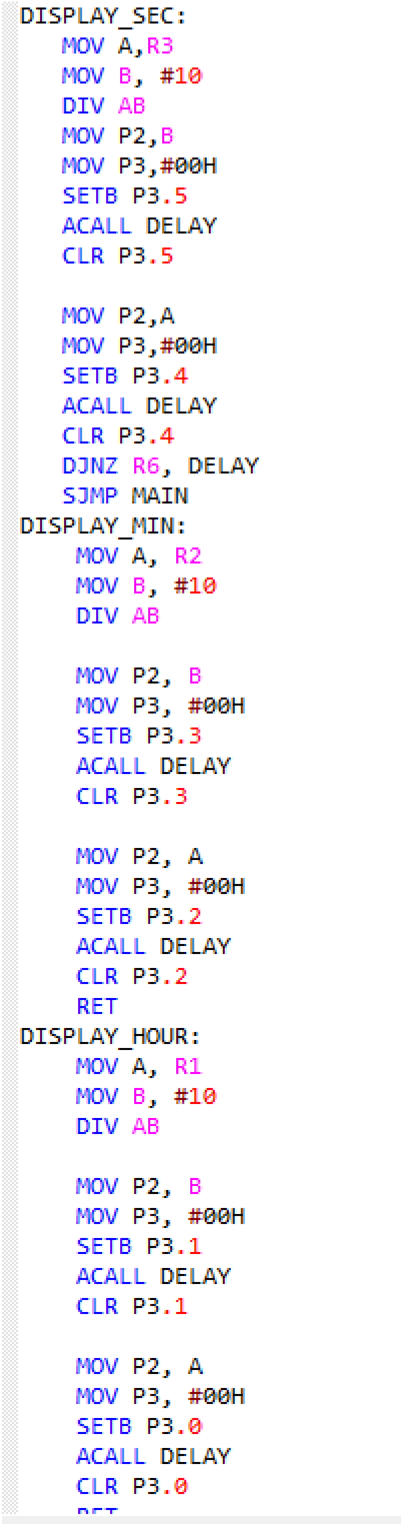
```
org 0000h
    LJMP START

START:
    MOV R0, #0 ;FRACTION OF SEC
    MOV R1, #23   ; Hours
    MOV R2, #59   ; Minutes
    MOV R3, #59   ; Seconds

MAIN:
    ;== increments
    INC R0
    CJNE R0, #60, DISPLAY_TIME
    MOV R0, #0

    INC R3
    CJNE R3, #60, DISPLAY_TIME
    MOV R3, #0

    INC R2
    CJNE R2, #60, DISPLAY_TIME
    MOV R2,#0
    INC R1
    CJNE R1, #24, DISPLAY_TIME
    MOV R1,#0
    SJMP MAIN
```

- This first image show us how to set up register and increase it,so the limit of minute and second is 60 and fraction of second can use to adjust it for counting faster or slower. With this implementation we will start the time at 23:59:59



```
DISPLAY_TIME:
    ACALL DISPLAY_SEC
    ACALL DISPLAY_MIN
    ACALL DISPLAY_HOUR
    SJMP MAIN
```

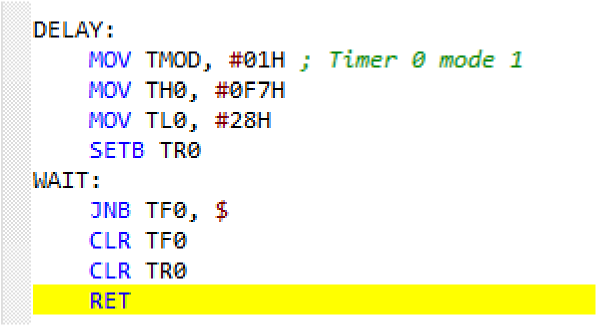
- DISPLAY_TIME func to make all the led maintain light up. If we didn't have this func, the led would show separately from second, minute to hour



```
DISPLAY_SEC:
   MOV A,R3
   MOV B, #10
   DIV AB
   MOV P2,B
   MOV P3,#00H
   SETB P3.5
   ACALL DELAY
   CLR P3.5

   MOV P2,A
   MOV P3,#00H
   SETB P3.4
   ACALL DELAY
   CLR P3.4
   DJNZ R6, DELAY
   SJMP MAIN
DISPLAY_MIN:
    MOV A, R2
    MOV B, #10
    DIV AB

    MOV P2, B
    MOV P3, #00H
    SETB P3.3
    ACALL DELAY
    CLR P3.3

    MOV P2, A
    MOV P3, #00H
    SETB P3.2
    ACALL DELAY
    CLR P3.2
    RET
DISPLAY_HOUR:
    MOV A, R1
    MOV B, #10
    DIV AB

    MOV P2, B
    MOV P3, #00H
    SETB P3.1
    ACALL DELAY
    CLR P3.1

    MOV P2, A
    MOV P3, #00H
    SETB P3.0
    ACALL DELAY
    CLR P3.0
    RET
```

- The 3 DISPLAY function show second, minute and hour will DELAY at

2264 ticks (2,26ms delay). Furthermore, the display function have plenty things to focus, let's take example at second display, we have A and B register for division, A for Quotient(tens part) and B for Remainder(units part). Thus, we take turn to light the led up from unit to tens (MOV P2, B and MOV P2, A) at that time we should turn all the led off with MOV P3, #00H and only turn on if it has mission to display (SETB P3.# with # from 0-5). Summary, this will take turn to displaying the time so that we can see the time displaying on the LED properly.



```
DELAY:
    MOV TMOD, #01H ; Timer 0 mode 1
    MOV TH0, #0F7H
    MOV TL0, #28H
    SETB TR0
WAIT:
    JNB TF0, $
    CLR TF0
    CLR TR0
    RET
```

- And lastly the DELAY func setup with Timer 0 mode 1 with 2264 count from 0xF728 to 0xFFFF so the time will be approximately equal to 2,26ms delay. This function has mission to create delay instead of creating delay by loop-based. In other words, the aim to make the led count slower and display better, we can separate it in large project, in this project we want to adjust in one function.