EEE 212 Microprocessors Spring 23-24
Lab 1: 8051 Tutorial

Due Date: 11 February 23.55

This tutorial document ensures that you have a better understanding of the software tools required for the first two lab assignments (Proteus Design Suite & MCU 8051 IDE), provides guidelines for their implementation, and expects you to run some demo on Proteus Design Suite software with some basic questions regarding this tutorial. The Proteus Design Suite is a software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and an emulator where you can utilize virtual boards, oscilloscopes, keypads, etc. MCU 8051 IDE serves as your coding environment for 8051 assembly language. In other words, you will write your 8051 assembly code in MCU 8051 IDE and demonstrate your work to your TAs using Proteus. Below, you can find installation guides and general instructions on how to use the programs at a basic level. Please ensure that you follow these steps thoroughly to ensure that everything runs without any errors or bugs.

For the first two lab assignments, you need to download

- **MCU 8051 IDE** as your code environment for writing 8051 assembly language codes,
- **Proteus Design Suite** for creating schematics with 8051 microprocessors and showing your demos to TAs.

Please go through all the steps of this document before you come to the tutorial lab next week. In the folder, you find the following:

1. test program that is used for the Proteus tutorial (TEST.asm),
2. keypad code that you should attach to the 8051 codes that you will write in MCU 8051 IDE (keypad.asm.txt),
3. virtual keypad configuration that you should add to your Proteus projects (keypad.pdsclip),
4. Proteus Tutorial video (Proteus_Tutorial.mp4),
5. MCU IDE 8051 Tutorial video (MCU_Tutorial.mp4), and

6. MCU IDE 8051 installation file. (mcu8051ide-1.4.7-setup)

These documents are further explained as we go through the Proteus Tutorial in section 3.

Tutorial Assignment Requirements

We want you to familiarize yourself with the software tools for the 8051 assignments before the labs start.

- You need to download the code file **'TEST.asm'** provided in the folder, compile this test code on MCU 8051 IDE, and show that it is working properly on your Proteus Design Suite environment without any error or bug. You can follow the steps detailed in sections 2 and 3 to complete this part after you have successfully downloaded Proteus Design Suite and MCU 8051 IDE detailed in section 1. You need to show your working demo to your TA (%1, Due Date: Your Lab Hours). For this part, you do not upload any file to Moodle, just showing your working demo during lab hours is enough.
- You need to answer some basic questions given below and upload your answers in '.pdf' format to Moodle (%1, Due Date: 11.02.2024 - 23.55). We want you to answer questions shortly, so there is no need to give long answers. Please refer to Section 4 or examine the code file **'TEST.asm'** to answer questions. The questions are as follows:
  - "What does the LCD screen display if the register A is assigned the hexadecimal value $35h$ and the **ACALL SEND_DATA** command is executed in your program?
  - What is the name of the subroutine in the provided keypad code that activates the LCD?
  - In which register does the output from the **ACALL KEYBOARD** instruction store? What value is stored in that register if '3' is pressed on the keyboard? What value is stored if '7' is pressed on the keyboard?
  - What happens to LCD screen if $A = C0h$ and **ACALL SEND_COMMAND** command is executed in your program?

1 Installation Guides

To download 8051 IDE of Proteus Design Suite, **you must have a Windows operating system** as it is not compatible with Linux or macOS. If you are using macOS or Linux, you can use the laboratory computers for your upcoming lab assignments.

1.1 MCU 8051 IDE Installation Guide

Please install the following setup provided in the folder namely *mcu8051ide-1.4.7-setup.exe* .

1.2 Proteus Installation Guide

IMPORTANT NOTE: Please note that Windows 11 may not be compatible with the original download steps explained below. If you encounter such issues, you can visit the following link and follow the steps to safely download Proteus without any problems. If you opt to download Proteus using this method, you do not need to follow the steps outlined below.

1. All users are required to install "Proteus V8.10 SP3" by executing the installation file available at the link. Ensure that you are connected to the **Bilkent VPN** before accessing the link.

2. Write the following username and password (without spaces) to continue the downloading process.
   Username: proteus811
   Username: swift196CHAIN

3. After the downloading process is complete, please execute the downloaded file named *proteus8.10.SP3.exe*.

4. Choose the option *"Use a cloud or server based license key"* and click on *Next*.

5. Inside the "server address" box, type *licensing.labcenter.com:8885/pcls/BilkentUni/* and continue installation.

6. Choose 3 options in the following page after you have completed the previous step and choose typical download option.

7. Wait until Proteus installation is completed. Open Proteus after the installation is complete. Login screen will show up. You can enter the user name and password below to use Proteus.
   Username: BilkentUni
   Username: UGt5VO4n7-

8. Close and open back Proteus if the login screen (that is seen in step 6) does not appear. Please repeat step 6 if you have this problem.

2 MCU 8051 IDE Tutorial

Please refer to the video titled *'MCU_Tutorial.mp4'* in the provided folder as you open your first project in MCU 8051. The video is short (approximately a minute) and self-contained, guiding you to open an example project and compile

an example code. After compiling, you need to observe a message that compilation is successful in Messages and four different files are created. We need a '.hex' file later to be coordinated with the Proteus. MCU 8051 IDE project files ends with '.asm' meaning that you can open ".asm" files with MCU 8051 IDE.

3 Proteus Tutorial

This tutorial aims to create

1. your schematic that you will use in the upcoming lab assignments,
2. your first demo with a basic 8051 assembly code for you to understand how you will show your demos to your TAs.

Please refer to the video titled *'Proteus_Tutorial.mp4'* in the provided folder as you follow the instructions given below. The video is comprehensive and self-contained, guiding you through the steps outlined below (without audio). If you find the video confusing, you can consult the following steps for additional clarification.

1. Create a new project as shown in Figure 1.

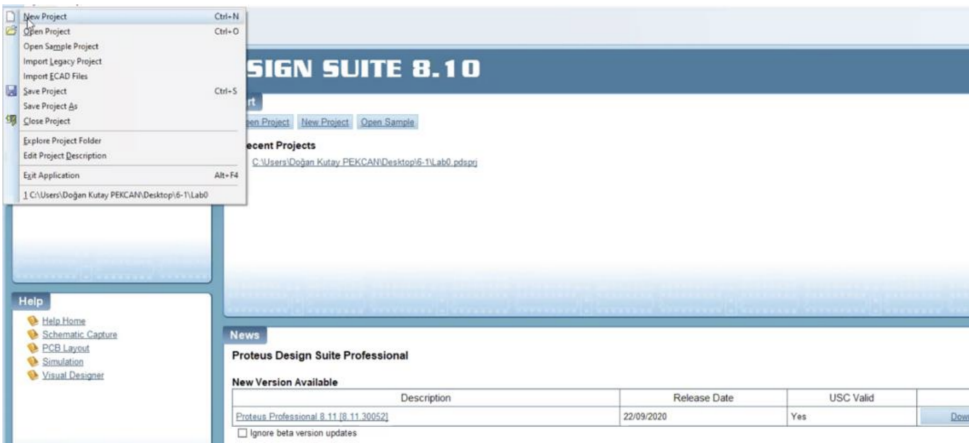

Figure 1: Create a new project.

2. Please choose the options displayed in Figures 2, 3, and 4 sequentially before finalizing the settings for the new project.

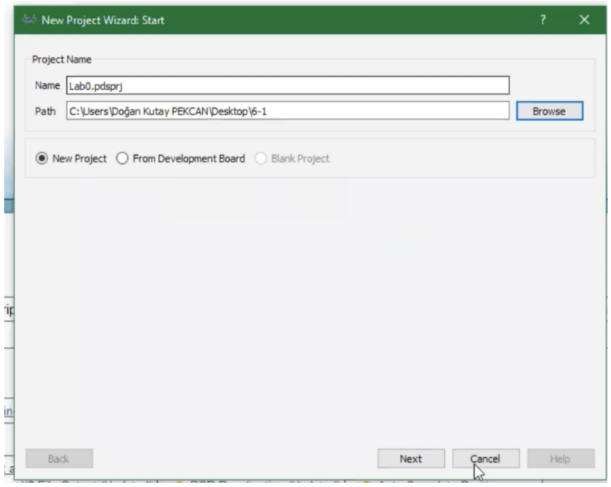

Figure 2: Label your project name.

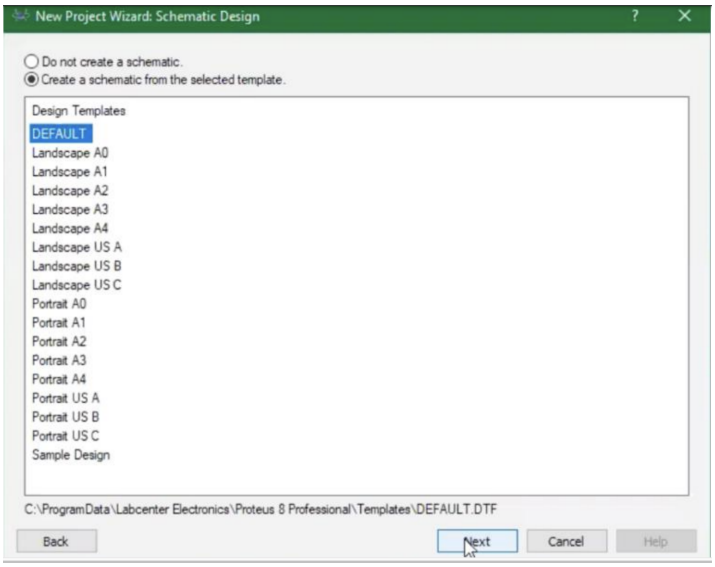

Figure 3: Choose a DEFAULT schematic design.

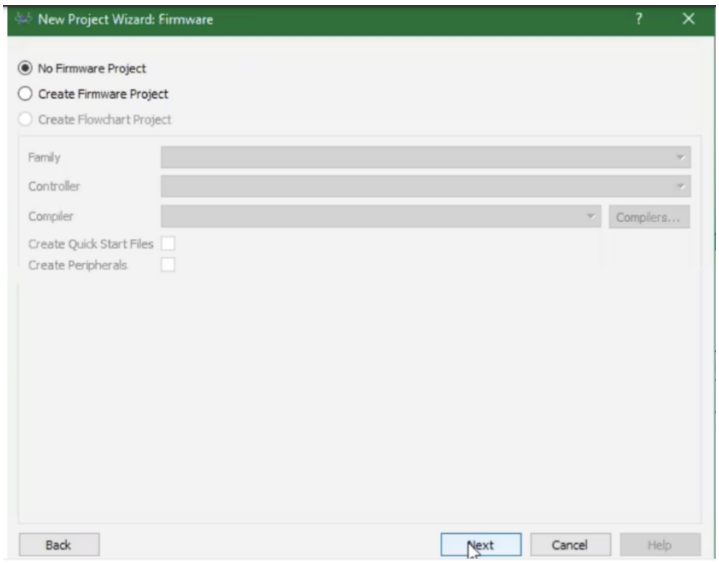

Figure 4: Choose a no firmware project setting.

3. Click on the "P" button with a blue background as shown in Figure 5. Next, on the opened page (Figure 6), select the microprocessor (AT89C51). Please type 'AT89C51' into the search field (Figure 7). Then, click the 'OK' button to drag it (Figure 8).

Figure 5: Click on the "P" button with a blue background.

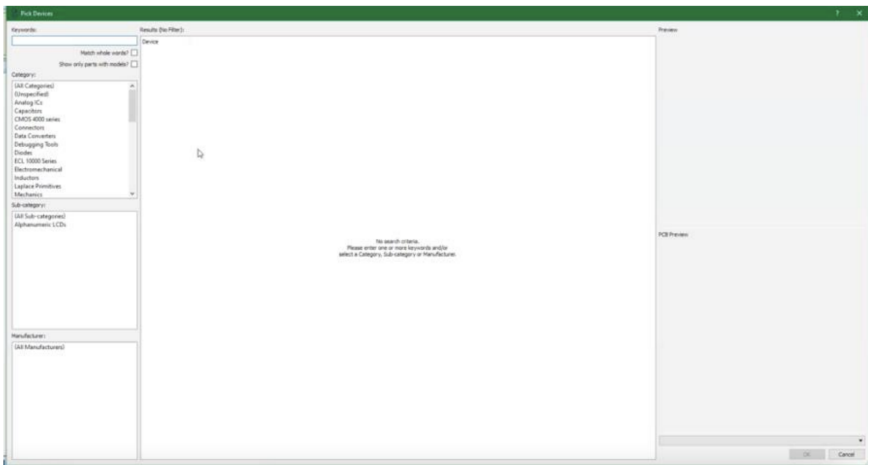

Figure 6: Select the microprocessor (AT89C51) by typing 'AT89C51' into the search field.

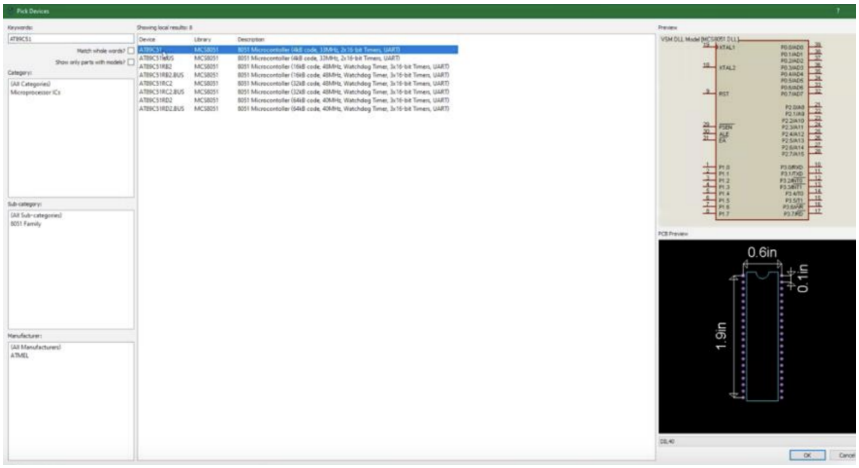

Figure 7: Select the microprocessor (AT89C51) by typing 'AT89C51' into the search field.

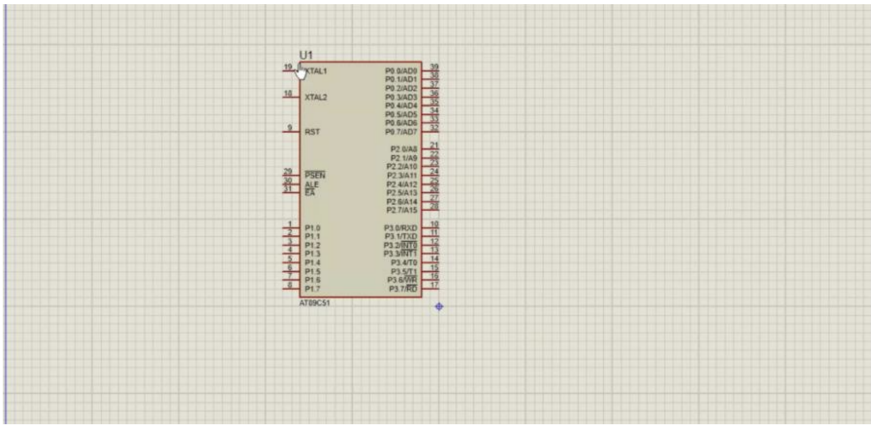

Figure 8: Then, click the 'OK' button to drag it and you can see that virtual microprocessor is added to your project.

4. Again, click on the "P" button with a blue background (as done in step 3). Select the LCD by typing 'LM016L'(Figure 9). Then, click the 'OK' button to drag it (Figure 10).

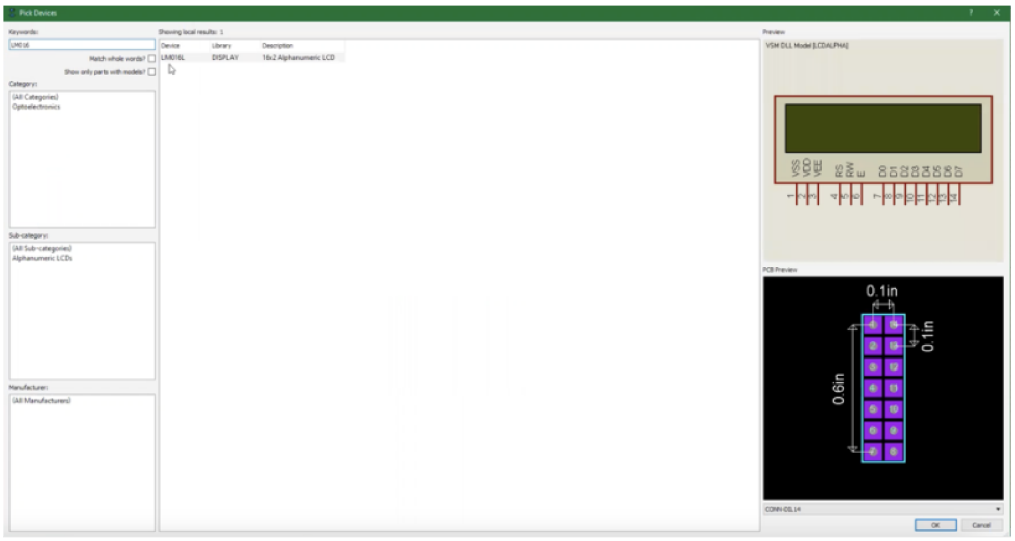

Figure 9: Select the LCD by typing 'LM016L'

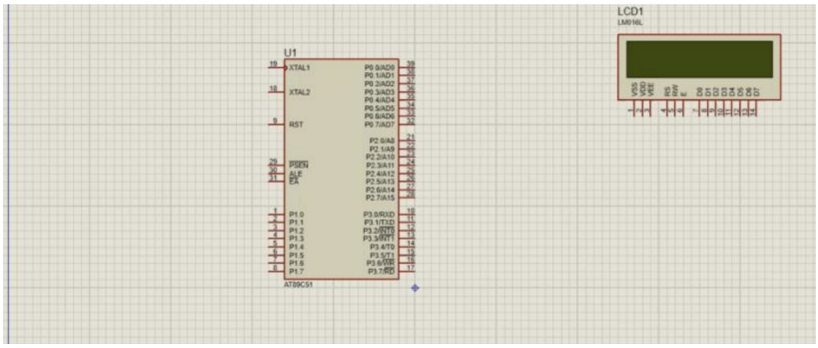

Figure 10: Click the 'OK' button to drag it and you can see that LCD display screen is added to your project.

5. Please download the file "*keypad.pdsclip*" provided in the folder. In the 'Import Project Clip' section (Figure 11), select the "keypad.pdsclip" file (Figure 12) to add the keypad to your Proteus project. Then you can observe the keypad added to your project (Figure 13).

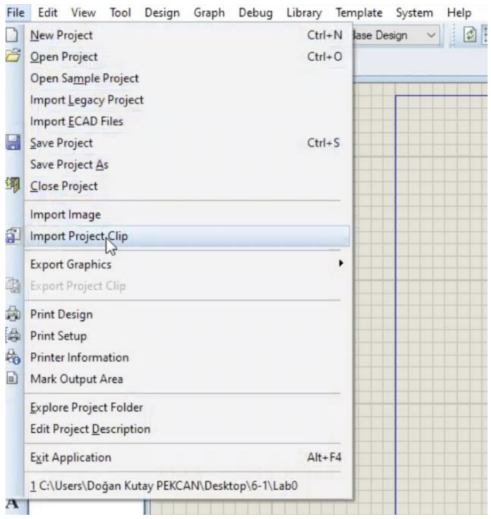

Figure 11: How to find the Import Project Clip section.

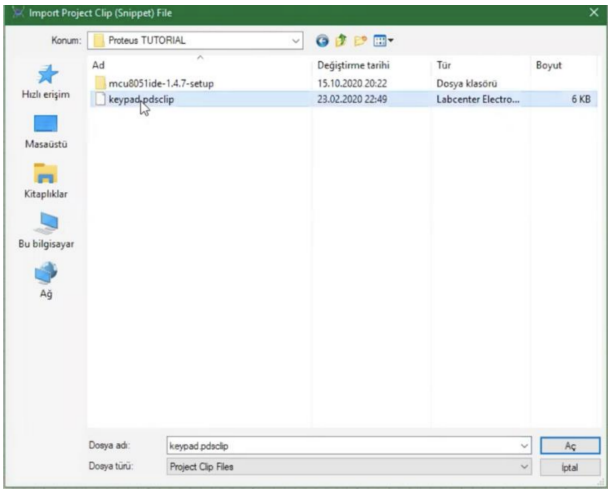

Figure 12: In the 'Import Project Clip' section, select the "keypad.pdsclip" file to add the keypad to your Proteus project.

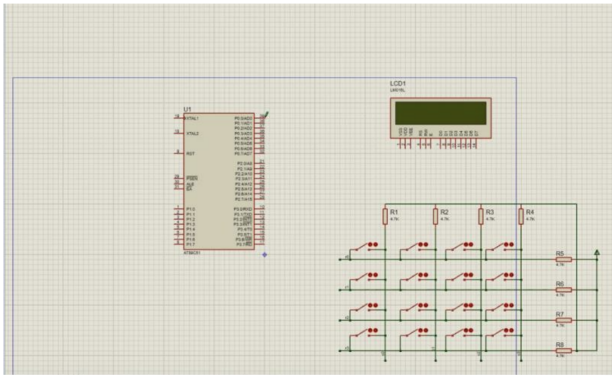

Figure 13: You can see that keypad is added to your project.

6. **IMPORTANT STEPS!** Now, we are going to connect the keypad to the LCD screen. **To use the keypad code properly, you need to connect the same keypad ports to the same LCD ports given in Figures 14 and 15**. Connections will be made based on *'Proteus_Tutorial.mp4'* video or you can find the connections given in Figures 14 and 15. Check the video thoroughly or check the figures below to name the wire connections of the keypad and 8051.

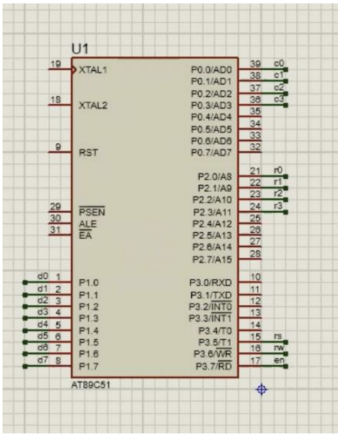

Figure 14: The assigned name of the ports.

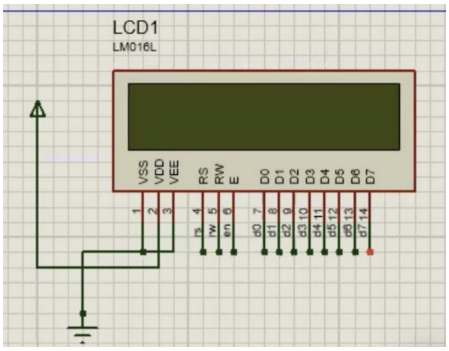

Figure 15: The assigned name of the ports should be connected to LCD screen EXACTLY.

Assign names to ports so you can easily connect them later using the designated names. To assign names to ports, simply click on the port and select 'Place Wire Label' (Figure 16). Then, enter the appropriate wire name and click 'OK' to complete the process (Figure 17).

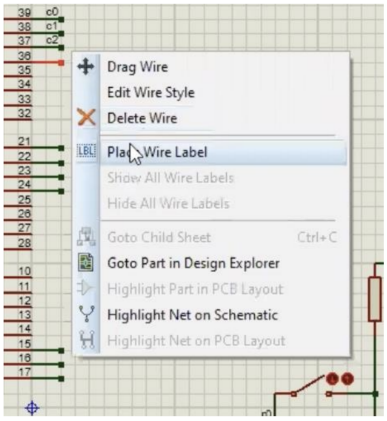

Figure 16: To assign names to ports, simply click on the port and select 'Place Wire Label'.

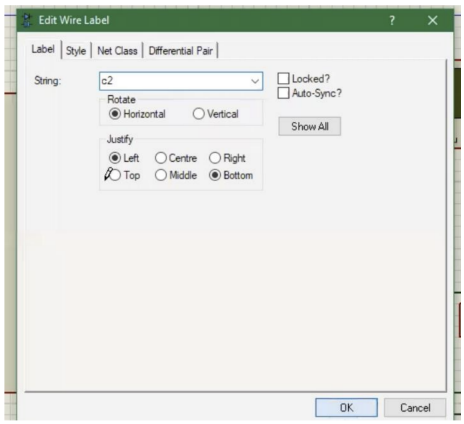

Figure 17: Enter the appropriate wire name and click 'OK' to complete the process.

7. Make sure to connect ground and VCC ports to the LCD. You need to connect VDD port of LCD to VCC and you need to connect VSS and VEE port of LCD to the ground as shown in Figure 18. To find voltage and ground, go to the left of the page and click on **TERMINALS** button to find VCC and ground pins, then click on them and drag them to the project as shown in Figure 19. From the left side as shown in Figure 19, you also can find other objects as well such as virtual oscilloscopes, serial ports, resistors etc.

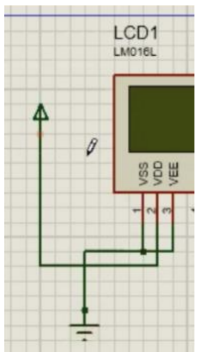

Figure 18: You need to connect VDD port of LCD to VCC and you need to connect VSS and VEE port of LCD to the ground.

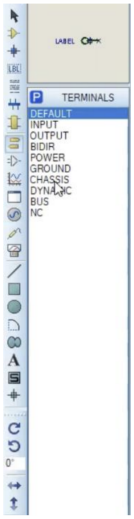

Figure 19: To find voltage and ground, go to the left of the page and click on **TERMINALS** button to find VCC and ground pins, then click on them and drag them to the project.

8. Now, switch to **MCU 8051 IDE** and compile the test program file 'TEST.asm' provided in the folder. If it successfully runs, the '.hex' file is successfully created. Then switch again to Proteus, and click on the microprocessor as shown in Figure 20. You can upload the .hex file to your virtual microprocessor as shown in Figure 21. To do that, choose the '.hex' file after compilation. Please, follow the following Figures 20, 21, 22, 23 for better understanding.

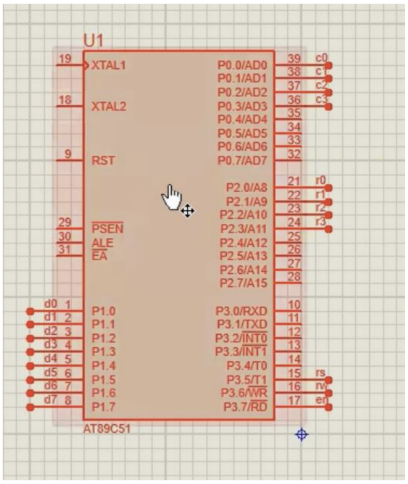

Figure 20: Click on the microprocessor.

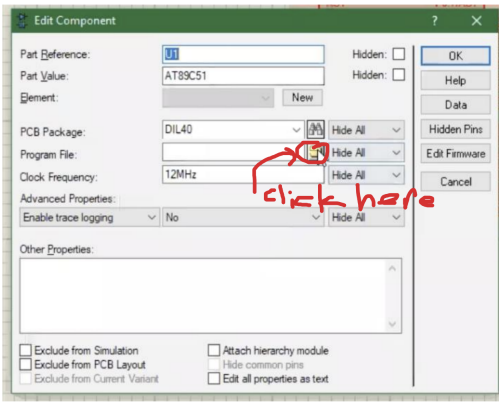

Figure 21: You can upload the .hex file to your virtual microprocessor.

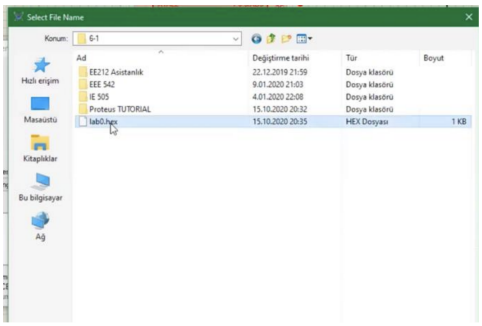

Figure 22: Choose your appropriate .hex file.

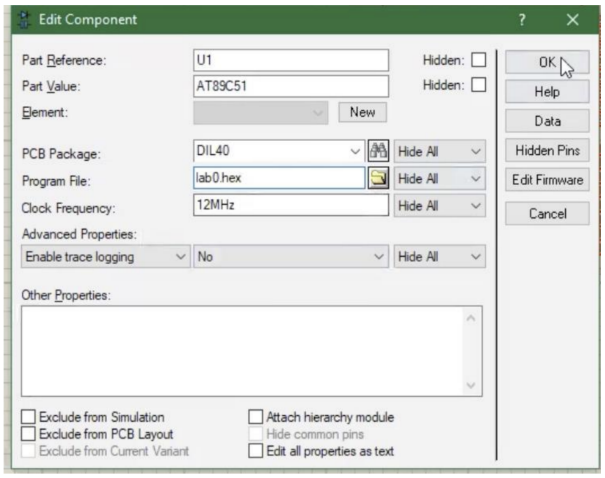

Figure 23: Your .hex file is uploaded on the microprocessor and microprocessor is ready to run your code.

9. Click the run button in the bottom left of the Proteus screen to start your demo. To start your demos after uploading your .hex files, you must click that button. (Figure 24).

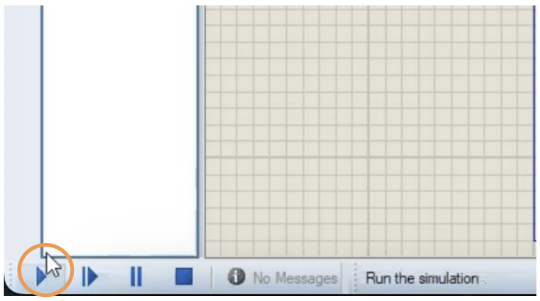

Figure 24: Click the run button in the bottom left of the Proteus screen to start your demo

10. If your code works properly, you observe that

    (a) LCD screen displays 'LCD IS OK!, and

    (b) click a key on the virtual keypad and see the pressed key displayed on the LCD screen immediately. As you press new keys, it will be displayed immediately. In Figure 25, we press '2' in the keypad and observe it is written on LCD.

    To click a key on the virtual keypad, you need to first close, and then open the related gate. If you do not open the gate back, it will not take the next input.

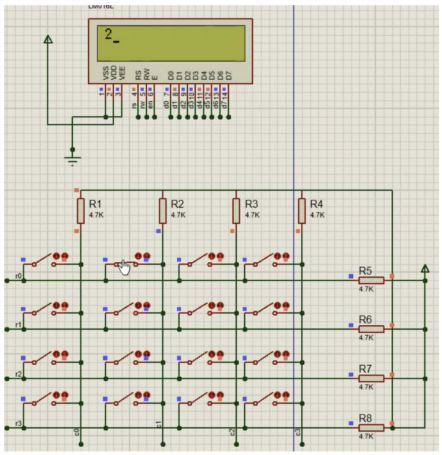

Figure 25: We press '2' in the keypad and observe it is written on LCD.

11. To terminate the code, click the stop button in the bottom left.

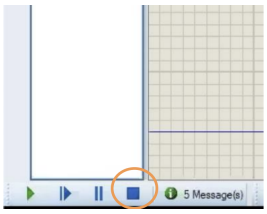

Figure 26: The stop button in the bottom left.

4 Implementation Notes

- You need to copy the subroutines provided in the 'keypad.asm.txt' file to use the keypad and LCD. Subroutines are similar to functions in high-level programming languages and you will see them in detail in a few weeks. The questions shouldn't require any more information given here and information regarding knowledge of subroutines. These subroutines play a crucial role in printing results in LCD or getting inputs from the keypad.
  - For example, you need to start 'ACALL CONFIGURE_LCD' line to start the LCD of Proteus. 'CONFIGURE_LCD 'sends initialization commands to the LCD.
  - 'KEYBOARD' subroutine waits for the user to enter an input through the keypad. Entered number is stored on accumulator register (A) of 8051 in an ASCII format.
  - 'SEND_DATA' subroutine sends what is stored on accumulator register(A) to LCD for displaying. An example is that, if A = 32h (32h means ASCII of number 2), then LCD prints 2 after the 'ACALL SEND_DATA' code line. Similarly, if A = '!', then LCD prints '!'. Please refer to this link if you need further questions regarding the ASCII representation of characters.
  - 'SEND_COMMAND' sends what is stored on register A to LCD for LCD commands. An example is that, if A = 10h, then cursor position of LCD is shifted to left after the 'ACALL SEND_COMMAND' code line. Please refer to this link for further information about LCD commands that can be useful.