CALIFORNIA STATE POLYTECHNIC UNIVERSITY, POMONA
COLLEGE OF ENGINEERING

ECE 3301L Fall 2024 Session 3

Microcontroller Lab **Felix Pinai**

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Grading:

Lab Assignments	85%
Lab Report	10%
Attendance	5%

Hardware:

You and a partner will form a group of two (maximum) to perform the experiments in the lab. Each group is required to acquire the following items:

1. **It is preferred that each group has at least a portable computer/laptop or desktop** available to load some free development software. I will be providing links to the software in the Software section below.

2. To program the code onto the microcontroller, you will need to buy the following piece of hardware:

   PICKit4: https://www.microchipdirect.com/product/search/all/PICKIT5

   There is a 25% discount if you register with that website and use your cpp.edu email when you do the checkout. from $25 to $35.

   Or, if you have a budget constraint, you can get the older version Pickit3 from – it is not a Microchip official version (which is discontinued) but it still does work:

   PICKit3: check with Amazon or any other website. The price range is

   Note: The PICKit3 will program slower than the PICKit4 depending how large your program is

I will be providing for each group a board that I have designed to be used in the debugging of the experiments. The board has on-board a Microchip processor PIC18F4620 (a better version of the PIC18F4321 used in the lecture) and a header to connect all the signals to a

breadboard. I am attaching a PDF file called 'lab_connector.pdf' that shows the pin definitions of that header for future reference. The board also has a USB port to be used for serial port debugging that I will go over in the class. Hence, I don't expect you to buy the microcontroller chip. In addition, you can get for yourself some free samples provided by the manufacturer of the microcontroller. I will send you the instructions on how to get those samples on a separate email. The samples can be used when the original microcontroller on the development is damaged and should be replaced.

Beside the development board, I will be providing to each group some other hardware needed for the rest of the semester. Each group will be responsible for any damage to any component on the board and the cost to replace any damage part. These items along with the development board are on loan from me and they must be returned back to me only at the end of the semester.

In addition, you will need to have the following items (Notes: The following links are for reference only and should not be treated as the exact items to be obtained):

a. Breadboard. Recommend to get a decent one like the following:

   https://www.amazon.com/1660-Point-Solderless-Breadboard-Prototyping-Classroom/dp/B00B8862FA/ref=sxin_7_ac_d_rm?ac_md=1-1-YnJlYWRib2FyZCBsYXJnZQ%3D%3D-ac_d_rm&cv_ct_cx=breadboard&dchild=1&keywords=breadboard&pd_rd_i=B00B8862FA&pd_rd_r=635d12d4-6e35-4f84-baf2-8b7a5587cac8&pd_rd_w=EpPSM&pd_rd_wg=DRVF9&pf_rd_p=54ae11ea-870e-480b-a70f-1f4a57c2e311&pf_rd_r=CBCRJRAHV4T5C2E36H4P&psc=1&qid=1596779328&sr=1-2-12d4272d-8adb-4121-8624-135149aa9081

   Make sure that the board has multiple common power bus lines indicated by either the blue color (to connect the ground) or the red color (to connect the power).

   Or you can get the better one:

   https://www.amazon.com/Makeronics-Tie-Points-Solderless-Breadboard-Prototyping/dp/B0824W99L2/ref=sr_1_27?crid=CS1MPW58LDH8&dchild=1&keywords=prototype+breadboard&qid=1597457805&s=industrial&sprefix=prototype+bread%2Cindustrial%2C219&sr=1-27

   This last one is better because it has a horizontal band on the top side that allows connections for the vertical ground and the power lines to be hooked up from that band thus to provide an overall distribution of the ground and power signals. I will go over this concept at the start of the semester.

b. A Digital voltmeter (DVM) to make measurements for voltage and resistance. There are plenty of varieties of DVM in the market. Here is a low cost one in Amazon:

   https://www.amazon.com/AstroAI-Digital-Multimeter-Voltage-Tester/dp/B01ISAMUA6/ref=sr_1_1_sspa?dib=eyJ2IjoiMSJ9.H3oCqTVL6Jss1rnlQCmsAVFx8vioXUHWKz8WqoQRqWwmZsUJZnOf57r8NnhdDE6XfSJItq-T7hTSi0MgQ6m-AzkPm-tCkqsS-Rzw4f38PzYyDYNbbjR69Mh8onJ-dI7JWENH3q3_qogLD2XoPpJJ1v-_8B03xsVuHCRLxTmWa2h607LR_jP8fr8yaLNYw6X6um8Zj255Uz3rOM1NQt43bicH5GXZuo2KI5nKGcnNDoQIJJtD6bwFeGi03YGKQzwp1de7JqawT0xUyiKgn_g1b4AHV6YM3wTSWykP5uzqyUA.HrZBbAAVH36Bz78EV10EQKKpc6p-GjRT3wAYktLFAmI&dib_tag=se&keywords=dvm&qid=1723608050&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1

c. A low-cost logic analyzer

   https://www.amazon.com/HiLetgo-Analyzer-Ferrite-Channel-Arduino/dp/B077LSG5P2/ref=sr_1_4_pp?keywords=logic+analyzer&qid=1705976377&sr=8-4

d. A low cost USB hub:

   https://www.amazon.com/dp/B00JX1ZS5O?ref=ppx_yo2ov_dt_b_product_details&th=1

This hub is practical for the purpose of powering up and down the prototype board without plugging in and out the USB cable. In addition, if you have the Surface tablet, you will need a hub to provide two USB ports, one for the programmer and one for the development board.

e. Wires. Recommend to get the following set:

   https://www.amazon.com/IZOKEE-Solderless-Breadboard-Arduino-Project/dp/B08151TQHG/ref=sr_1_11?crid=5KJH8WWEH6VG&keywords=Breadboard+Jumper&qid=1641933992&sprefix=breadboard+jumper+%2Caps%2C166&sr=8-11

   Make sure to have three types of wires – Male-to-Male, Male-to-Female and Female-to-Female

f. Alligator clips:

   https://www.amazon.com/WGGE-WG-026-Pieces-Colors-Alligator/dp/B06XX25HFX/ref=sr_1_2_sspa?crid=3IER8Y0AMS7YJ&keywords=alligator+clips+electrical&qid=1641934063&sprefix=alli%2Caps%2C158&sr=8-2-

spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEySVcwMFpZMU5RU1g5JmVuY3J5cHRlZElkPUEwNjM3MDUzMUlIUzFYMlE2RTFPMSZlbmNyeXB0ZWRBZElkPUEwMDA0MjI5M0pSSzYyUVpPQklWRCZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=

g. BNC Cables:

https://www.amazon.com/Proster-Dual-Head-Alligator-Universial-Oscilloscope/dp/B07K2MVB2D/ref=sxin_16_pa_sp_search_thematic_sspa?content-id=amzn1.sym.52245a2c-8c16-4000-bf4a-60168de07fe4%3Aamzn1.sym.52245a2c-8c16-4000-bf4a-60168de07fe4&crid=HE51MXPA3FEH&cv_ct_cx=bnc+to+alligator+clip+cable+thick&keywords=bnc+to+alligator+clip+cable+thick&pd_rd_i=B07K2MVB2D&pd_rd_r=196287ee-4a05-4c7c-9e4c-faecbed41246&pd_rd_w=1Fh9R&pd_rd_wg=Yps0j&pf_rd_p=52245a2c-8c16-4000-bf4a-60168de07fe4&pf_rd_r=8PCV75Y5YF6XVZGHJAJW&qid=1692154352&s=electronics&sbo=RZvfv%2F%2FHxDF%2BO5021pAnSA%3D%3D&sprefix=%2Celectronics%2C267&sr=1-3-b6abdd27-62b8-4289-b410-d963a80e3e5e-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9zZWFyY2hfdGhlbWF0aWM&psc=1

h. Items that you can get from the stockroom (5th floor):

    a. Dip-Switches

    b. Red, Yellow, Green LEDs

    c. Dual 7-segment display (instructor may provide)

    d. Potentiometers

i. Various resistors:

* 1 (22 ohm)
* 1 (100 ohm)
* 10 (220 ohm0
* 1 (470 ohm)
* 2 (1Kohm)
* 1 (2.2Kohm)
* 1 (10Kohm)
* 1 (22Kohm)
* 3 (33Kohm)
* 1 (47Kohm)
* 2 (100Kohm)

All the above items should be available with you or your team on every lab session even though we might not be used every item.

Software:

We will use free software provided by Microchip & TeraTerm

Step 1) Download MPLAB X IDE software - MPLABX IDE V6.20:

https://ww1.microchip.com/downloads/aemDocuments/documents/DEV/ProductDocuments/SoftwareTools/MPLABX-v6.20-windows-installer.exe

Install this piece of software first.

At the end of the installation, the software will ask whether you want to install some additional software like XC8 compiler, MCC, etc… I do suggest that you deselect the choices (not to install) because we will use another XC8 compiler version (see below) or we don't need to use the additional software (MCC, Harmony).

Step 2) Download MPLAB XC8 compiler version 1.34(Make sure to install this compiler after the MPLAB software is installed)

http://ww1.microchip.com/downloads/en/DeviceDoc/xc8-v1.34-full-install-windows-installer.exe

Note: This is an older version of the XC8 compiler and there are newer versions available on the website. Don't use them because of the non-compatible setup that I have in this lab.

Install the second piece of software onto your computer.

Step 3) Download the software for the logic analyzer:

https://discuss.saleae.com/t/logic-2-4-13/2563

Install the Windows version

Step 4) Download one of the TeraTerm software (version 4.106):

https://github.com/TeraTermProject/teraterm/releases/download/v4.108/teraterm-4.108.exe

At the end of the installation of this TeraTerm software, do not install the other options.

Step 5) This step might not be needed. Only apply it if your computer does not detect the USB_COM port with my board.

Download the following driver needed for my development board:

Go to the link:

http://www.ftdichip.com/Drivers/VCP.htm

Choose the version 2.12.28:

http://www.ftdichip.com/Drivers/CDM/CDM%20v2.12.28%20WHQL%20Certified.zip

When your team has the possession of my development board, plug in the USB cable and go to 'Device Manager' and check whether the 'Ports (COM & LPT)' is on the list. If so, expand that item and check that the item 'USB Serial Port (COMxx)' where xx will show a number. If positive, then your computer has detected the virtual PORT from the development board. If nothing is detected, then you will need to install the driver downloaded above.

Next, there is a tutorial that you will need to perform to get used to all the software. That tutorial will be part of Lab #1 (to be sent later).

EXPERIMENTS:

Below is a list of the usual experiments. However, I may make some modifications/adjustments to the contents of the labs or to the schedule:

Week 1 - 8/22:	First class meeting – Group assignment
Week 2 - 8/29:	Lab #1 - Introduction to Microcontroller programming using PIC microcontroller/Tutorial
Week 3 - 9/05:	Lab #2 - Input / Output Control using C Language
Week 4 - 9/12:	Lab #3 - Introduction to Assembly Program
Week 5 - 9/19:	Lab #4 - Assembly Program
Week 6 - 9/26:	Lab #5 - A/D converter, Temperature Sensor & Light Sensor
Week 7 - 10/03:	Lab #6 - Digital Voltage & Ohm Meters
Week 8 - 10/10:	Lab #7 - Traffic Light Controller with use of System Timer
Week 9 - 10/17:	Lab #8 - Implementation of LCD Panel with SPI bus
Week 10 - 10/24:	Lab #9 - External Interrupt
Week 11 - 10/31:	Lab #10 - IR Receiver
Week 12 - 11/07:	Lab #11 - Hardware and Soft I2C with Real-Time Clock
Week 13 - 11/14:	Lab #12 - PWM
Week 14 - 11/21:	Lab #13 - Special Final Integration Project
Week 15- 11/28:	No class - Thanksgiving
Week 16 - 12/05:	Final Project Demo