Syllabus, Spring Quarter, 2019

FRS 002, Sec. 032--Freshman Seminar

Join the Maker Revolution!

CRN 74372

Class Meeting: Friday, 1:10 - 3:00 p.m., 152 Roessler

First Class: April 5, 2019

Instructor: Shirley Chiang, 235 Physics/Geology, Tel. (530) 402-7113 (office),
FAX: (530) 752-4717; e-mail: chiang@physics.ucdavis.edu
Office hour: Friday 3:00 – 3:30 p.m. in 235 Physics/Geology; and by appointment

Class web page **http://chiang.physics.ucdavis.edu/FRS2_Maker.html**
OR http://chiang.physics.ucdavis.edu (Chiang group webpage), then click on **Teaching**; under 2018-2019, Spring 2019, **Freshman Seminar – Join the Maker Revolution**

Canvas site for class: **https://canvas.ucdavis.edu** Login with your UC Davis Kerberos ID and passphrase. Look for "**FRS 002 032 SQ 2019**". Supplementary information is posted under **Files**.

Description:

Have you ever dreamed of building a robot? Or using a 3D printer to bring an idea to life? A manufacturing revolution through the "maker culture" of do-it-yourself technology has been taking place in the last few years. The ability to prototype small objects using a 3D printer and to use small, inexpensive computers allows makes it possible for everyone to design, build, and control small machines, such as a simple robot or a garden watering system. We will discuss the tools that make this possible and learn to use some of them. We will learn some simple electronics and computer programming in order to use an Arduino microcontroller to get input from sensors (switches, thermometers, etc.) and control output to devices (LEDs, motors, etc.). We will also learn how to design an object that can be fabricated on a 3D printer. Students will work together in groups on a final project that incorporates these devices.

Seminar goals:

Students will learn elementary dc and ac electronics and simple programming in C in order to connect simple circuits to the Arduino microcontroller. (No background in either circuits or programming will be assumed.) This will allow the Arduino to acquire input signals from analog sensors and to control analog outputs. They will also learn how the Arduino can be used to control a piezoelectric buzzer and make music. In addition, they will learn how to use electronic measurement tools like an oscilloscope and multimeter to measure waveforms and to debug their electronic circuits. They will also learn how to use computer-aided design (CAD) software to design a 3D object, slice it, and transmit code to a 3D printer to fabricate it. Then they will discuss how to use these skills and work in groups to build final projects of their choice, given limitations in materials available in the laboratory. Examples of possible projects are a robot with wheels and sensors, a controllable lamp with varying colors, an alarm system, a temperature controller, a computer game, and a water irrigation system.

Assignments:

Students will read about how to use the Arduino microcontroller and write small programs weekly before they come to class. These programs will involve exercises such as reading input from switches, turning LEDs on and off, and using analog to digital and digital to analog converters. In the first half of the course, they will work in pairs during class time to wire up simple circuits to the Arduino and then to test their programs on the hardware in the lab. They will also use free 3D design software to design an object and then build it on the 3D printer in the lab. Students will form groups of 3 to 4 people to work together on the design and construction of a final project. The concept of the final project must be discussed with the professor for assessment of feasibility that will depend on the availability of components in the lab or additional parts that can be purchased quickly and inexpensively to build the project. Students will work on the designs outside of class and work together to build

the final projects during the class times in the last half of the course. At the final class, each group will present its project to the class and explain how they built it. Each student will be required to write a final report of about 5 double-spaced pages explaining the project and describing his/her role in designing and building it. The class will meet for 2 hours per week, and assignments are expected to take an additional 2 to 4 hours per week.

Grading:

Students will be evaluated on their participation in the programming and circuit lab exercises (1/3), on the quality of the final group project and presentation (1/3), and on their final paper of approximately 5 double-spaced pages (1/3).

Tentative Schedule:

Week	Class Dates	Topics	Assignment
1	Apr. 5	DC Circuits—using power supplies, breadboards, multimeters.	Download a book. Start reading about Arduinos and/or 3D printing.
2	Apr. 12	AC Circuits—using function generator, oscilloscope.	Start thinking about projects! Design an object for the 3D printer..
3	Apr. 19	Arduinos --Blinking LEDs, playing music.	Write programs for the Arduino.
4	**Apr. 26**	**Form groups to work on projects and decide on projects. Start working on projects.**	
5	May 3	Work on projects.	
6	May 10	Work on projects.	
7	May 17	Work on projects.	
8	May 24	Work on projects.	
9	May 31	Work on projects. Each group should present their project to the class.	
Paper Due Thursday, June 13, 2019, 11:59 p.m. Please e-mail a Word or PDF file to Professor Chiang.			

Group Project, Presentation, and Paper:

You will work in groups of 3-4 students to build a final project. Start thinking early about what type of project you want to build, because the instructor may need to order some parts for you.

April 26. Decisions on projects and which groups will work together must be made by the fourth week of class. Earlier decisions are encouraged if additional parts need to be purchased

Each student will be required to write a final report of about 5 double-spaced pages explaining the project and describing his/her role in designing and building it, as well as how the final project operated and what results, if any, were obtained. Your paper will be graded both on exposition and content. The instructor will be happy to read a draft of your paper at any time and offer suggestions for improvement. The final paper is due **Thurs. June 13, 2019, 11:59 p.m. Please e-mail a Word or PDF file to Professor Chiang.**

Useful websites for reference. Download software as needed.
www.arduino.org You can download the Arduino IDE here.
www.openscad.org Software for creating 3D solid CAD objects. Tutorial on class Canvas site under files, “Open Scad Info”. Creates “.stl” files that can be converted to gcode by Cura, Slic3r, etc.
www.reprap.org Self-replicating manufacturing machine, i.e., 3D printer.
www.allaboutcircuits.com/textbook/ has chapters on direct current and alternating current circuits.

http://www.thingiverse.com/ Objects designed by other people for fabrication on 3D printer.
Windows slicing software for the 3D printer in the lab is available on the Canvas site under File, "3D Printer Software/IIIP-i3.exe"

Websites with ideas for projects:

- www.arduino.cc/projecthub/
- www.hackster.io/arduino/projects
- www.instructables.com/id/Arduino-Projects/
- www.makezine.com -- Make Magazine site, subtitle DIY Projects and Ideas for Makers
- www.adafruit.com -- sells parts for projects, Unique and fun DIY Electronics and Kits
- www.sparkfun.com -- also sells microcontroller boards, breakout boards, electronics parts for projects and kits
- www.jameco.com -- electronics distributor, also has lots of electronic kits and projects

Books on Arduinos available online as PDF files from UC Davis Library:

1. Rick Anderson and Dan Cervo, Pro Arduino.
2. Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi
3. Mike Cook, Arduino Music and Audio Projects
4. Alexandros Drymonitis, Digital Electronics for Musicians
5. Brian Evans, Beginning Arduino Programming
6. Joan Horvath and Rich Cameron, The New Shop Class: Getting Started with 3D Printing, Arduino, and Wearable Tech
7. Michael McRoberts, Beginning Arduino
8. Tony Olsson, Arduino Wearables
9. Steven Osborn, Makers at Work
10. Jonathan Oxer and Hugh Blemings, Practical Arduino: Cool Projects for Open Source Hardware
11. Jack Purdum, Beginning C for Arduino, Second Edition: Learn C Programming for the Arduino
12. David J. Russell, Introduction to Embedded Systems Using ANSI C and the Arduino Development Environment
13. Alan Trevennor, Practical AVR Microcontrollers: Games, Gadgets, and Home Automation with the Microcontroller Used in the Arduino
14. John-David Warner, Josh Adams, and Harald Molle, Arduino Robotics
15. Don Wilcher, Learn Electronics with Arduino

Books on 3D Printers available online as PDF files from UC Davis Library:

1. Joan Horvath, Mastering 3D Printing: Modeling, Printing, and Prototyping with Reprap Style 3D Printers
2. Brian Evans, Practical 3D Printing: The Science and Art of 3D Printing
3. Joan Horvath and Rich Cameron, 3D Printing with Matter Control

About the Instructor: Professor Chiang is a condensed matter experimental physicist who specializes in surface physics studies using high resolution microscopy techniques. She received her Ph.D. degree from U.C. Berkeley and was a Research Staff Member at the IBM Almaden Research Center before coming to U.C. Davis in 1994. Her current research interests include the surface structures of metals on semiconductors. She enjoys building things, including computers, machines, and experimental apparatus.