PHYSCI 70: Introduction to Digital Fabrication

Harvard Physical Sciences
Spring 2020: Tues & Thurs 3:00 - 4:15pm Room: SC102
Instructors: Rob Hart and Nathan Melenbrink
TF: Victoria Shen

Description: A hands-on introduction to rapid prototyping, integrating physics and engineering, design, computer science and art. Students will learn to safely use software and hardware to fabricate programmable projects. Tools and topics will include shop safety, hand tools, laser cutting, 3D printing, computer-controlled milling, electronic circuit design, programmable microcontrollers, and molding and casting. Applications may include personal fabrication, product prototyping, fine arts and the creation of scientific research tools. The course will culminate with an individual final project, integrating as many of the topics as possible. Each student will document work on each weekly topic in a personal website, thereby finishing the course with an online portfolio that not only illustrates their new skill sets, but also contributes to a collective repository of knowledge that serves as a foundation for continued learning.

Course Notes: Attendance is mandatory since lab safety training will occur during class times. Class will meet twice each week. The first meeting will consist of a discussion of the previous week's assignment, with each student reporting on progress, followed by a short introduction to the current week's topic and assignment. The second meeting may include a short lecture but will primarily focus on a hands-on training session for the accompanying assignment. Meetings may also include appearances by local experts and field trips
Course website: https://tinyurl.com/tasr7b6

Recommended Prep: There are no formal prerequisites for this course. Students are expected to bring their own laptop computer (tablets and Chromebooks are not sufficient for some of the software required for this course, though students will have access to lab computers).

Related Sections: Coursework will mostly be conducted independently through open lab time. Lab access will be 24/7 once online lab safety training is complete. TFs will be available during flexibly scheduled lab times. For some topics, supervision will be needed as students learn to operate machines safely.

Assessment: Students will be assessed on the basis of website documentation (60%), the documentation and presentation of the final project (20%) and attendance and participation (20%). Only work that is documented on the personal page will be considered for grading.

Documentation: Thorough documentation on your personal page is required in order to earn full credit for assignments (60% of total grade). A well-documented assignment is one that provides sufficient information for someone else to fully recreate your project. At a minimum this requires photographs, screenshots, and a thorough written description of the steps taken, and

may also require code snippets, movies, 3D models and/or links to outside resources. Here is an example of a well-documented assignment. Instructors will provide examples and precedents for each assignment. Documentation will be assessed throughout the semester, and instructors will provide mid-term feedback.

Final Project: Students are asked to present an idea for a final project at the start of the semester, which is expected to evolve over the duration of the course. Students will have weekly opportunities for advising on final project ideation. Final projects should integrate most of the skills covered over the semester, including at a minimum:

- 3D design and fabrication (either mold/cast, 3D print, lasercut, etc.)
- Electronics (input and output)
- Microcontroller programming

WEEK	TOPIC	ASSIGNMENT	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
			1/27	1/28	1/29	1/30	1/31
1	**Lab, safety, documentation, software.**	Tuesday: Submit application. Download Arduino + boards Thursday: Make a website, upload a sketch of your final project idea. Build a circuit and use a DMM.	First day of classes (no meeting)	Intro presentation, talk about final projects. Overview GitHub + pages		Lab, safety, documentation, software. Intro to electronics. Arduino Blink sketch. HTML + CSS	
			2/3	2/4	2/5	2/6	2/7
2	**2D Design and Cutting**	Make a vinyl sticker. Make a press-fit kit on the laser cutter.		Review circuits, final project ideas.		Loose ends, Introduce vinyl cutter / laser cutter	
			2/10	2/11	2/12	2/13	2/14
3	**Hand tools and fabrication. Making things move. Mechanical design.**	Make and document a kinetic sculpture.		Review documentation from past week		Saws, drills, taps, materials, power tools,	
			2/17	2/18	2/19	2/20	2/21
4	**Programming (Arduino)**	Program an Arduino board to do something.		Review documentation from past week		Workshop on Arduino programming	
			2/24	2/25	2/26	2/27	2/28
5	**3D design. 3D scanning and printing.**	Design and print an object. Scan something.		Review documentation from past week		Modeling with Fusion 360, 3D Scan and 3D print demos	
			3/2	3/3	3/4	3/5	3/6
6	**Sensors. Electronic input devices.**	Make a sensor to measure a physical quantity with the Arduino.		Review documentation from past week		Sensor fabrication workshop	
			3/9	3/10	3/11	3/12	3/13
7	**CNC milling. Toolpaths in 2D and 2.5D**	Make something useful.		Review documentation from past week		VCarve and Shopbot CNC	
			3/16	3/17	3/18	3/19	3/20
	Spring Break						
			3/23	3/24	3/25	3/26	3/27
8	**Electronic output devices.**	Use a microcontroller to drive an output device.		Review documentation from past week		Output device workshop: motors, speakers, LEDs, etc.	
			3/30	3/31	4/1	4/2	4/3
9	**Molding and casting: 3D toolpaths. Composites and sewing.**	Design a 3D mold, machine it, and cast material in it.		Review documentation from past week		Molding and casting demos	
			4/6	4/7	4/8	4/9	4/10

10	**Networking and communication (IoT)**	Demonstrate 2 microcontrollers communicating over wired or wireless connection.		Review documentation from past week			Demo Bluetooth/radio connections	
			4/13	4/14	4/15		4/16	4/17
11	**Interfacing projects with computers. Computer programming.**	Send data to a computer and write code to display results.	Easter Monday	Review documentation from past week			Circuit board design and fabrication demo	
			4/20	4/21	4/22		4/23	4/25
12	**Machine building. End effectors.**	Work collectively to design and build a novel machine.		Review documentation from past week			Machine fabrication and assembly	
			4/27	4/28	4/29		4/30	5/1
13	**Circuit board fabrication. Project integration.**	Integrate multiple project components into a compact package. Sketch housing for final project.		Machine Demo Day			Reading Period begins	
			5/4	5/5	5/6		5/7	5/8
14	**Project development.**	Document progress on a project integrating several capabilities.			Reading period ends			
			5/11	5/12	5/13		5/14	5/15
	Finals Week						**Final Presentations**	