

PHY 189.14 Introduction to Making (2 semester hours)

Format: One 1-hr lecture per week and one 3-hr lab per week.

Lecture: Tuesdays, 2:00 – 2:50 in MLT 309

Lab: Thursdays, 2:00 – 4:50 in MLT 304 or SLB 029 (Physics Model Shop)

Instructor: Dr. George Rutherford 8–2934 ghr@ilstu.edu

Shop Director: Jim Dunham 8–8727 judunha@ilstu.edu

TA: Bailey McNulty bmcnul2@ilstu.edu

No prerequisites. Materials Charge: \$50

Catalog description: Design principles and fabrication skills necessary for the creation of useful devices of reasonable complexity, including those requiring embedded electronics.

Course Overview: The maker movement takes advantage of the increasing sophistication of prototyping, fabrication, and consumer electronics equipment available to everyone at reasonable cost. These practical skills are used in higher education as a vehicle to tie together a number of areas considered valuable in our high-tech society: design, project planning, teamwork, innovative thinking, problem solving, and entrepreneurship, among others. This course introduces student makers to basic design principles, solid modeling software, traditional and modern fabrication tools and their safe operation, and enough electronic principles to allow the creation of a useful device as a semester-long project.

Student Outcomes: After successfully completing this course, students will

- Be familiar with the properties of soft materials (wood, plastic, etc) and how to join them
- Know how to safely use some common tools used to shape soft materials
- Be familiar with the properties of common metals and how to join them
- Know how to safely use some common tools used to shape metals
- Be able to use common solid modeling software to design simple parts
- Be able to use a 3D printer to create plastic parts
- Be able to use basic electronic components to create simple circuits
- Be able to program and use an Arduino microcontroller for simple electronic tasks
- Be familiar with the basics of intellectual property, small business formation, and how to perform a back-of-the-envelope feasibility calculation for a small business venture
- Be able to complete a semester-long project involving the elements above and culminating in a working, useful device
- Be able to work in small teams to complete common tasks necessary for the completion of each student's project
- Be able (in a small team) to create an “instructable”, a clear guide to allow others to re-create the student's project, safely perform a fabrication process, or safely use a tool necessary for the completion of the project

- Be able to keep a clear “maker’s journal” as a reliable record of their newly acquired knowledge and skills

Topical Schedule: The following presents a tentative weekly schedule of the lecture and lab topics in this course. Please remember that this schedule is tentative and subject to change at the instructor’s discretion as circumstances warrant. The instructor will make every effort to give ample advanced notice of any changes.

Week #	Lecture Topic	Makerspace Topic
1	Intro to course and semester project reveal and overview	SketchUp Pro (solid modeling software)
2	Woodworking tools and safety	General shop safety; basic woodworking skills (hand tools, saws, drills, sanders, routers)
3	Soft material properties; joining and fastening soft materials	SketchUp Pro: Designing the soft material parts of the semester project
4	Metal working tools and safety	Making the soft material parts of the semester project
5	Properties of metals; joining and fastening metals	Basic metalworking skills (lathe, mill, metal bandsaw)
6	Designing parts for 3D printing; materials and properties of 3D printed parts	Exam 1 SketchUp Pro: Designing the metal parts of the semester project
7	From Fusion 360 to 3D printer: exporting files and choosing the right parameters for 3D printing	Making the metal parts of the semester project
8	Basic electronics: voltage, current, and resistance; analog vs. digital	Building basic circuits: LEDs, switches, and voltage dividers
9	More electronics: batteries, power supplies, connectors, and breadboards	Breadboarding and troubleshooting the circuit for the semester project
10	The Arduino: getting a tiny computer to perform tasks for you	Exam 2 Putting the electronics into more permanent form for the semester project
11	Programming the Arduino	Creating the Arduino code for the semester project
12	Specialty electronics: sensors, communication, and special purpose integrated circuits	More coding if necessary; finishing all the electronic parts for the semester project
13	Protecting your ideas: intellectual property	Finishing the semester project and the instructable
14	Turning your idea into a business: forms of business organization	Finishing the semester project and the instructable

15	But can you turn a profit? Quick and dirty feasibility calculation	Finishing the semester project and the instructable
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Required Texts: There are no required texts for this course. Students will be directed toward free online material in addition to the material presented in lecture and pre-lab discussions.

Required Student Tasks/Assignments:

- There will be two short exams, one each at the beginning of the 6th and 10th lab sessions.
- Each student will keep a maker's journal, either in hardcopy (bound, but not spiral bound) or electronic (GoogleDrive or equivalent – the instructor must have read access) in which they record not only what they learn in lecture and lab, but what they learn by their own investigation outside of class.
- Each student will complete a semester-long project, culminating in a useful, working device. The device becomes the student's property at the end of the semester.
- Each student will, either individually or as a member of a group no larger than three members, create an "instructable". An instructable is a clear guide to making the project or safely performing a process or using a tool used in making the project. It may take the form of a webpage, video, or similar format capable of multimedia content and easy dissemination. The instructable topic must be approved by the instructor.

Student Performance Evaluation:

Each student's performance will be evaluated as follows (relative weights are indicated):

- Exam scores (10% each, for a total of 20%)
- Maker Journal (20%) – Instructor will give at least four evaluations per semester with feedback. The top three evaluation scores will be averaged.
- Semester Project (35%) – Criteria include quality of workmanship including appearance, device performance, with possible extra credit for additions or improvements initiated by the student.
- Instructable (25%) – Criteria include accuracy, clarity, and ability to catch and hold the viewer's attention.
- In addition, the course letter grade determined below may be lowered due to unjustified student absence from lecture or lab, or by unsafe or disruptive behavior in the classroom or makerspace. Plagiarism or cheating may result in receiving a zero grade for that assignment, a lower letter grade for the course, failure in the course, and/or disciplinary action by the university.

Grading Scale: Each performance evaluation category above will be scored on a 100 point scale and the average in each category will be combined with the weights indicated. The final letter grade will be determined via the following scale. The instructor reserves the right to make the grading scale more lenient, but not more stringent.

- A: $\geq 90\%$
- B: 80 – 89%
- C: 70 – 79%
- D: 60 – 69%

- F: $\leq 59\%$

Attendance Policy: Attendance is strongly recommended for both lecture and lab (makerspace) sessions. If a session is missed due to illness, death in the family, university-sponsored activities, or other justifiable or unforeseeable cause, the instructor will work with the student to arrange a make-up session (for makerspace sessions) or one-on-one meeting (for missed lecture sessions). The student should attempt to get the notes from a friend. Advanced notice is required for absences resulting from foreseeable causes. Absences without justifiable cause may be grounds for lowering the final course grade below the level indicated by the numerical score calculated above.

Any student needing to arrange a reasonable accommodation for a documented disability and/or medical/mental health condition should contact Student Access and Accommodation Services at 350 Fell Hall, (309) 438-5853, or visit the website at StudentAccess.IllinoisState.edu.