

ESE 323 - Modern circuit board design and prototyping

Syllabus for Fall 2023

Bulletin Description: Design, fabricate, and test a prototype device using a custom-made circuit board, surface mount components, and a 3D printed enclosure. Topics include printed circuit design, active and passive component selection, signal integrity, design for testability, solid modeling, and 3D printing

Overview: ESE323 is a prototyping course intended to introduce students to modern circuit prototyping techniques and packaging. Students will demonstrate these techniques with laboratory experiments and by designing, building, and testing a project. The prototype device will be enclosed in a student-designed 3D printed enclosure.

ESE280 is a pre-requisite for this course. The Microchip Studio and MPLAB integrated development environments are installed on the lab computers and Microchip/Atmel programmers will be available in the lab.

We will use Autodesk Fusion 360 for schematic entry, circuit board design, and 3D mechanical design. This software may be downloaded at no cost for students who would like to work on their own computers. This software is also available in the CAD lab, the senior design lab (light 283B), and the prototyping lab (light 283A).

The CAD lab and the prototyping labs have open hours which are posted separately. Some labs (e.g. 3D printing) will require long run times on limited equipment and students urged to plan accordingly.

Required materials: You will be responsible for purchasing all of the parts for your project – circuit board, integrated circuits, displays, connectors, switches, battery holders, passive components, and whatever else you put in your design. As designer, you will have some control over the cost of your project, but you should plan on spending around \$100 on parts. The circuit board itself will cost a minimum of \$22 including shipping. The University will provide materials for the 3D printer.

Texts:

Peter Wilson, “The Circuit Designer’s Companion”, 4rd edition, Newnes, 2017.
(recommended)

Topics:

Week 1	Class procedures, design introduction
Week 2	Recurring and non-recurring costs, product design
Week 3	Data sheets, application notes, parts vendors, online catalogs
Week 4	Printed circuit board (PCB) anatomy and materials, EAGLE schematics
Week 5	Electrical rule checks, trace current capacity, surface mount packages,
Week 6	Fusion libraries, design for test, Fusion board view
Week 7	Fusion routing, copper pours, design rule checks,
Week 8	Design for manufacture, computer automated manufacturing (CAM), midterm exam
Week 9	Non-ideal components, thermal management
Week 10	Signal propagation, grounding, low voltage differential signaling (LVDS)
Week 11	3D modeling with Fusion 360, fundamentals of 3d printing
Week 12	Printed circuit waveguides: stripline and microstrip, equal length routing
Week 13	large scale circuit board production, probing surface mount boards
Week 14	Component failure mechanisms, Fusion trace classes, final review

Course Learning Outcomes: After completing this course, students will be able to:

- Independently design an electronic circuit
- Identify common surface mount electronic component packages
- Choose parts for the design and prepare a bill of materials
- Use software to design a printed circuit board to implement the circuit
- Work with vendors to have the board made and purchase parts
- Assemble the circuit using techniques appropriate for surface mounted electronics
- Understand the role of printed circuit boards in circuit thermal management
- Use 3d CAD software to design a project enclosure
- Use a 3d printer to prototype the enclosure
- Prepare engineering documentation for the project

Laboratory work: Each student will be making their own designs and performing their own labs. In addition, there are labs to develop familiarity with the concepts and tools you will be using later for your own design. You will not be working in groups.

Exams: There will be one midterm exam and a final exam. The midterm will be online, the final exam will take the form of a presentation. The final exam will be on Tuesday December 12th from 8:30 pm to 11:00 pm.

Grading: The final grade will be weighted as follows:

Preliminary design review paper:	20%
Lab assignments	20%
Midterm exam:	20%
Critical design review paper:	30%
Critical design review presentation:	10%

Schedule: The prototyping lab will be open for your use per a posted schedule. There are no assigned laboratory times – you can come in whenever the lab is open. The lab can only accommodate a handful of students at a time – plan ahead to avoid a crush.

Laboratories will be conducted in Light Engineering room 283A. Labs will begin meeting on the second week of the semester.

My office hours will be on Tuesday from 10:00 am until 11:30 am and on Wednesday from 7:00 pm until 8:30 pm in Light Engineering 143. I will be happy to meet with students at other times by appointment.

Contact Information: David Westerfeld: david.westerfeld@stonybrook.edu.

The University Senate has authorized that the following required statements appear in all teaching syllabi on the Stony Brook Campus.

Disability Support Services (DSS) Statement:

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room 128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: <http://www.stonybrook.edu/ehs/fire/disabilities>]

Academic Integrity Statement:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management Statement:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Document prepared by David Westerfeld on 28 August 2023.