EE 175AB: Senior Design

Fall-Winter 2019-2020

Instructors

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Electrical Engineer

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Meeting Times

Fall 2019
Lectures: F 10:00 am – 10:50 am, Spieth Hall 2200 or virtual (live) online, or pre-recorded
Section 021: T 9:00 am – 11:50 am, Chung TBD
Section 022: F 6:00 pm – 8:50 pm, Chung TBD
Section 023: M 5:00 pm – 7:50 pm, Chung TBD

Winter 2020
Lectures: M 7:00 pm – 7:50 pm, PHYS 2000
Section 021 (AKRC, KK): F 9:00 am – 11:50 am, Chung TBD
Section 022 (RC): F 6:00 pm – 8:50 pm, Chung TBD, moved to M 4 pm – 6:50 pm, Chung 128
Section 023 (SC): F 2:00 pm – 4:50 pm, Chung TBD

Textbook and Related Materials

No textbook required. All course materials are posted on iLearn.

ENGR 181W

All students in EE175AB are **should take the ENGR 181W** technical writing course (DO NOT take the ENGR 180W alternative). For EE majors, ENGR 181W is the required course and ENGR180W will not be accepted for graduation. ENGR 181W is specifically designed to help you learn how to write professional technical specifications, design documents and test reports. It will start with your final report from EE175AB and help you produce a polished and enhanced final report that you can be proud of when presenting to future employers as evidence of your good work and technical communication capabilities. This can be of great value in your job search and career development. The Board of Industrial Advisors and faculty of the ECE department felt the final reports in past years were not meeting the standard, and ENGR 180W was not sufficient in meeting the needs of EE students and the EE program objectives. ENGR 181W was specifically designed to improve it.

Specific Course Information

A. Course Objectives

1. Ability to understand the engineering design process.
2. Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses.

3. Develop skills in project management including organization, teamwork, planning, scheduling, budgeting, and gaining teamwork experience.
4. Develop skills in background research and library techniques such as literature and information searching.
5. Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations.
6. Ability to design and conduct experiments, as well as analyze data.
7. Understanding of professional and ethical responsibilities.
8. Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation.
9. Understand the impact of engineering solutions in a global and societal context.
10. Knowledge of contemporary engineering issues.

B. Student Outcomes Addressed

1. Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. Ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. Ability to communicate effectively with a range of audiences.
4. Ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. Ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

List of Topics

The Senior Design Project is the culmination of coursework in the bachelor's degree program in electrical engineering or computer engineering. In this comprehensive two-quarter course, students are expected to apply the concepts and theories of electrical engineering or computer engineering to an engineering design project. Detailed written reports, working demonstration, and oral presentations are required.

Eight quarter units of engineering design credit will be granted for the completed project and other required components listed here. It is expected that approximately twelve hours of laboratory (or field) work will be required weekly for satisfactory completion of the project. The design value of these units has been accounted for in the total number of required science and design units necessary for graduation.

Weekly Class Lectures and Meetings

The format of EE 175A,B one hour lectures will be either in person in class, or virtual (live) online at scheduled times, or pre-recorded. These lectures are intended to provide instruction in topics common to all design projects (design process, technical documentation, engineering economics, ethics, etc.). **If you miss an in person or a virtual online lecture, you will be required to submit a 500-words essay on the topic of the lecture and turn it in at the next lecture. Pre-recorded lectures will require a completion**

of a few short quizzes. If you miss more than 3 lectures, your final grade will be deducted one letter grade (regardless whether you submitted the essays for missed in person or virtual lectures).

In addition, it is expected that each project team meet with the instructor on a weekly basis to report and discuss the progress of the project. The weekly meetings may include progress reports, discussions of difficulties, problem solving, brief presentations by each team aimed at improving technical presentation skills. Attendance of weekly meetings is mandatory.

Project Topics
Projects span the main electrical engineering areas of the ECE department. You can pick a project suggested by the instructor or you can propose your own topic but it must be approved. In addition, joint projects with other departments may be arranged.

Project Participants
Projects will be completed in small teams with shared responsibility. Each team should have 3 or 4 students. Single student team and team with more than 4 students are not generally allowed. Exceptions require approval by the ECE department. Team projects need to be sufficiently complex to allow for an appropriate workload for all team members. Each student will be held responsible for a distinct component of the total team effort.

Project Elements
The senior design projects will include proposal and report writing, experiment design, hardware and software design, test plan and test, analysis of broad impact and ethical issues, among other things. Remember that this is a design course and students must define a ***design*** project, not a research, nor an evaluation or fabrication project. Each design project must include the following components:

1. **A Clear Technical Design Objective**: Each group must decide upon a design project and get the approval by their section professor by the time of the second lecture. If a team wishes to propose its own project, they must obtain the endorsement of the section professor. Each team should assess the following:
   - Is the design project doable within two quarters?
   - Does the group have the expertise to complete the design, prototype, and testing?
   - Does the group have sufficient funding for the project?
   - Does the group have access to the required test equipment?
   - Is this a design problem (not research, nor fabrication)?
   - Is the project significant enough to be worthy of eight credits (>12 hours/week/person)?

2. **Experiment Design and Feasibility Study** (Required section in Final Report, 5% of final grade) Design and carry out experiments to evaluate the feasibility of project ideas, alternatives, trade-offs and realistic engineering constraints. Analyze the experimental results to prove the feasibility of your project idea and select the best solution to be further developed in the design project.

3. **A Detailed Design Specification**: Describes the functions and quantitatively measurable design objectives, design methods, hardware and software architecture and interfaces, user interface, realistic constraints in terms of time, cost, safety, reliability, social impact, ethics, etc. It must also list and consider the industry standards related to your project, including hardware, protocols, software and tools (e.g., 802.11, RS232, USB, PCI, 3G, API, device drivers, VHDL).

4. **Test Plan** (Required section in Final Report, 5% of final grade)**:** A detailed description of your design of experiments to test and measure whether the final product and each of its components meet the design specifications, and, if not, to test and measure the errors and deviations from specifications.

5. **Design Review Presentation** (Week 10 of the fall quarter, 5% of final grade): Each group must make a Power Point presentation of their design specification and progress to faculty and other students. Requirements of design review presentation will be provided.

6. **Detailed Quantitative Design and Prototype** (To be completed by week 10 of the winter quarter. See the Grading section) Each component of the selected solution and the overall system should be designed and implemented. In most cases, it is necessary to construct a system prototype (or component prototype).

7. **Test Report** (5% of final grade): Carry out the Test Plan you developed to identify how well your final design meet the specifications under the defined constraints, and present the results in this report.

8. **Working Demo and Draft Final Report:** A preliminary working demo is required at week 8 of the winter quarter or at the time required by your section instructor. First complete draft of the final report is due in week 9 of the winter quarter or at the time required by your section instructor. Your professor will review and mark up draft of your final reports and send it back for improvement and re-write.

9. **Poster Presentation and Working Demo** (Week 9 of the Winter quarter, 5% of final grade): Each group must make a poster presentation of the final design and show a working demo to their section instructor and other students. Requirements of final presentation will be provided.

10. **Final Report and Final Demo** (Final version of the final report and final demo due in week 10 of winter quarter.): The final report must include all the required sections and appendices in a template file, final presentation poster file and video or data of a working demo must be uploaded on the iLearn website for the course. A working demo of the completed design is critical and required. The demo should show whether and how design specifications are met.

11. **Open Demo Day**: Each section professor will select a number of projects from his section to participate in the Open Demo Day, most likely in the open areas of WCH. Members of the department's Industrial Board of Advisors, representatives from local industries, all professors in ECE and other departments in the college, and all ECE students will be invited. The projects selected need to be well designed, well presented and have a robust working demo. On this day you will demonstrate your ability to communicate with a range of audiences.

Four Required Essays (Submitted separately from Final Report)

1. **Contemporary Engineering Issues** (2% of final grade) Write an essay (500 or more words) on the contemporary engineering issues related to the project. Everyone on the team must contribute to this essay. Potential contemporary engineering issues related to your project are new technologies, new industry standards, new design methods, new materials, new trends in manufacturing, etc.

2. **Global, Economic, Environmental and Societal Impact** (Required essay, 2% of final grade): Each team must write an essay (500 or more words) providing an analysis of the potential global, economic, societal, and environmental impact of the project. Everyone on the team must contribute to this essay. You do not need to address every aspect, just focus on a couple of aspects that are related to your project. For example, if your project is made into a product, how will it improve quality of life, affect the

environment, enhance entertainment, education, globalization etc.? Are there any ethical or political debates, laws and regulations that are related to your project?

3. **Understanding of Professional and Ethical Responsibility** (Required essay, will be a part of the 7.5% of the grades assigned to Professional and Ethical Responsibility. See 2 in the Grading section) Write an essay (500 or more words) on (a) what are the ethical considerations or implications of your project, (b) how you addressed them, and (c) what you learned through this design project about professional and ethical responsibility. Everyone on the team must contribute to this essay.

4. **Recognition of the need for and an ability to engage in lifelong learning** (2% of final grade) Write an essay (200 or more words) on how doing this design project helped you (a) recognize the need and (b) developed the ability in lifelong learning. Everyone on the team must contribute to this essay.

Grading

In addition to the deliverables listed above, each project will also be graded on the following:

1. **Design Notes or Project Wiki, Weekly Progress and Lecture Attendance:** Each student team need to maintain a design notebook and/or project wiki for the duration of their projects and report progress to the section instructor at least weekly. Each week, you must show evidence of amount of work done and progress in the design, implementation and/or testing. Attendance of the lectures is mandatory. Everyone must sign in at each lecture. (This portion accounts for 7.5% of grade, but each absence from lecture must be made up with an essay and excessive absence will result in punitive grade deductions.)

2. **Professional Ethics and Responsibility** (7.5% of the final grade but unethical behavior will result in punitive grade deductions): You will be evaluated by your team member(s) and by your section instructor. See the attached evaluation forms on how this is graded.

3. The remaining percentage of the grade are based on the technical and design capability and problem solving skills you demonstrated in the design, prototype building, testing, presentation and final report writing.

NOTE: EE 175AB do not have exams.

Grading will be determined by all of the section professors conferring on each project and student. Please note that grades are assigned to each individual student, not to a project team. That is, for a successful project, a student who contributed most to the success may get an A while another student on the same team who barely did any complex technical work may get a D or F.

Weekly Schedule

Date	Week	Lecture Type	Lecturer	Lecture Content
9/27	Week 00	In person	All	Introduction, course outline, preliminary issues, requirements and expectations
10/4	Week 01	Online	RC	Introduction to product specification process, engineering design process, understanding prior art, laboratory notebooks, library techniques, literature and information search
10/11	Week 02	Online	RC	Design methodologies, functional block diagram and hardware block diagrams, evaluation of feasibility, problem solving and debug approaches
10/18	Week 03		RC, MZ	Lab skills, exam for equipment use and lab safety for gaining lab access

10/25	Week 04	Online	RC	Experiment design, developing a test plan, collecting data, and evaluation. Realistic design constraints and considerations.
11/1	Week 05	Online	RC, TBD	System engineering
11/8	Week 06	Online	RC	Implementation and debugging of microcontroller interfaces: RS232, I2C and SPI Each section to hold first design review in or before this week
11/15	Week 07	In person	RC, MZ	Printed circuit board design, layout, and fabrication Each section to hold second design review in or before this week.
11/22	Week 08	Online	RC	Data analysis techniques (statistical and time series analysis, curve fitting, regression, etc.)
11/29	Week 09		Holiday	No lecture
12/6	Week 10	Online		Project management, organization, teamwork, scheduling, budgeting, etc.
				Winter Quarter
1/10	Week 11	In Person	RC	Career choices and strategies, job searches, how to write resumes
1/17	Week 12	In Person	RC	Debugging workshop: Debug case study, including cases for hardware and software
1/24	Week 13	In Person	RC	Engineering product testing requirements, test report requirements. Introduction to and use of industry standards. What is and is not an industry standard. Industry standards vs. de facto standards. Review the important sections of at least two actual industry standards, e.g., 802.11 (standard), SPI or I2C (de facto standard)
1/31	Week 14	In Person	RC	Understanding professional and ethical responsibility. IEEE Code of Ethics. A required ethics exam will be given at the lecture. Each section to hold third design review in or before this week.
2/07	Week 15	TBD	RC, TBD	Writing Technical reports I. Go over the Final Report Template section by section, with instruction on what to write in each section.
2/14	Week 16	TBD	RC, TBD	Writing Technical reports II. Use well-written Technical Reports as examples.
2/21	Week 17	In Person	RC	Contemporary engineering issues; understanding global, economic, environmental and societal impact; recognition of the need for and an ability to engage in lifelong learning. Preparation for the final poster presentation
2/28	Week 18	In Person	RC	Patents and intellectual properties: how to apply for a patent, protection of IP. Final poster presentations and Demo each section Completed draft final report due, all 4 essays due
3/06	Week 19	In Person	RC, TBD	Marketing engineering products, entrepreneurship, venture capital and startups
3/13	Week 20	N/A	Open House	Work with section the instructor to improve final report and essays. Final version of final report and essays due **Senior Design Open House** (show your project to the world!) May be on Thursday to be held together with UCR EE Day to attract industry attendance.
Tue, 3/17	Finals week			Final version of final report and essays due

RC – Roman Chomko, **MZ** – Manglai Zhou, **TBD** – to be determined

Poster Presentation and Working Demo

At week 8 or 9, per your section instructor requirement, of the winter quarter, each project group is required to make a poster presentation and demo in their section.

Each group has 15 minutes for presentation. Every member of a team must do a part of the presentation. Below is the template for the powerpoint slides on the poster. Your final presentation MUST contain the info listed below and it MUST include a real-time demo.

Slide 1: Title, group members, date, contact info
Slide 2: Concept and application of the design: What did you design, technical principles, why this is a meaningful project, what are the intended applications, how is it related to subjects in electrical engineering.
Slide 3: Technical design objectives, be specific and should be measurable (numerical), e.g., response time, frequency or transmission range, SNR, accuracy, false alarm rate, power consumption, capacity, etc.
Slide 4: Final high-level design, show block diagram of the system.
Slide 5: Technical challenges, what are the difficult electrical engineering related technical problems you encountered and solved, was there any difficulty that you were unable to solve, and how have you changed your design to get around it?
Slide 6: Major components of the design and implementation, and who contributed to what. Include circuit schematics and program flowcharts on separate slides.
Slide 7: Design considerations:
* Realistic constraints (time, skill, power consumption, weight, size, microcontroller speed, memory size, sampling rate, data rate, costs (this is for weighing the costs of different design decisions. Do NOT simply show a list of parts and their costs), etc.
* What industry standards did your project involve? e.g., 802.11, Bluetooth, I2C, USB, RS232, Zigbee, etc. How using the industry standards affected/constrained your design? (e.g., data rate, voltages, connectors, compatibility with other devices, etc.)
Slide 8: Test report: how did you test the system, what are the test results (in quantitative measures), how close did you come to your design specification?
Slide 9: A real demo or a demo video is required. If your design cannot be demoed at the presentation, you should schedule a demo after the presentation and invite the class to visit
Slide 10: Summary
Slide 11: Acknowledgment of people helped you or provided you with the design concept or ideas

Technical Merits of the Project and the Final Report

The evaluation of technical merits of your project and final report will be based on the reproducibility of your projects, that is, on the clarity of the following:

1. ***What the project is all about?*** (Provide a clear and brief Executive Summary of your system, a well-annotated and well-explained photo of the system, etc)

2. ***Theoretical basis for the project*** (provide the theoretical analysis and associated experiment designs which, when implemented, will confirm the theory of operation)

3. ***Design Specifications*** (provide a clear outline of features to be expected from the system, expected performance requirements. They must follow from the overall system objectives and goals and the theoretical analysis and/or other considerations)

4. ***Implementation Strategy*** (describe the System Architecture, show the high-level design, *aka* SBD, etc.)

5. ***Actual Implementation*** (describe in great detail the low-level design in terms of both hardware and software. Make sure to provide and explain the schematics of all circuits used, show the program and data flow-charts, etc.)

6. ***Validation/Verification of Functionality*** (provide test results against design specifications, clearly outline conditions for both Pass and Fail, etc)

7. ***Future Improvements*** (suggest changes, updates and/or alternatives in design in the whole or in parts based on your experiences implementing the project)

Notes of first lecture

1. Projects must be design projects with clearly defined design objectives, not research, experimentation or data collection and analysis.
2. Syllabus with course requirements and final report template in iLearn. Use it to check if you covered everything.
3. Attendance of lectures and weekly lab sessions is required. See details above. EE 175AB do not have textbooks nor exams.
4. You can pick a project suggested by the instructors or you can propose your own topic but it must be approved. All students must have decided upon a project by the time of the third lecture.
5. Each project team must be 3 or 4 students. Exceptions are approved only on rare cases with strong justifications. No single member teams as teamwork experience is a requirement.
6. We will move you to the right lab section based on your project topic and **all members on the same team will be moved to the same section**.
7. Everyone on the team needs to do approximately equal amount of technical work. The design review, final presentation and final report must clearly indicate who did what. Cannot have one person do all administrative work, e.g., ordering parts, keeping notes. Each student is graded individually based on his/her contribution.
8. Be a good team player. Teamwork is part of your grade. Everyone must be a reliable and helpful team member. Each member will be evaluated by all other team members.
9. Design specifications and test plans must be **numerical and measurable**.
10. Must do prior art study. Find out what has been done, how other people have done it and what are their advantages and shortcomings. How does your design compare with theirs?
11. Focus is on design using electrical engineering knowledge. Don't spend more than 10% of your effort on mechanical designs.
12. You will be given access to ECE teaching labs (Chung 126, Chung 128) to work on your project after you pass a lab skills and lab safety exam. You must follow lab rules or your lab access may be revoked.
13. Mr. Manglai Zhou is ECE dept's Research Engineer, he manages the ECE lab and can provide some parts. He is a very experienced engineer and is available to help you.
14. Instructors will guide you and point you to the right direction, but you must do your own work. Systematic problem solving is a major part of this course. You will be evaluated on how you identify problems, approach them and find solutions.
15. When you are stuck on a problem for too long even after guidance from your section instructor, he may provide a solution to you because we want you to work through the process of getting a design to a functional prototype. But if your section instructor provides a solution to a problem you are stuck on, points will be deducted from your grade.
16. Parts of final reports due throughout the fall and winter quarters, as specified by each section instructor.
17. Document your design process, the alternatives you experimented with, the problems you encountered, how they were solved, and who did what. These all should go into your final report. Do not wait until the end to start writing the final report. Use the Final Report Template as a guide and to document your progress right from the beginning.
18. Final presentation and demo at week 8 or 9 of the winter quarter per your section instructor requirement. A complete draft final report due week 8 or 9 of winter quarter, final version of final report due week 10 or during finals week of winter quarter. Senior Design Open House in week 10 of winter quarter. You must demo a working design to get a grade better than D.

Department of Electrical Engineering, UCR, Fall/Winter 2019/2020

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Professional Ethics and Responsibility Outcomes

Instructor's Name: _____

Section: _____

TEAM MEMBER EVALUATION FORM

Project Team (name of project) _____

Name of Student Being Evaluated _____

Name of Team Member Evaluating the Student _____

For each attribute, circle the number that best corresponds to how much you feel the attribute was met (1 = very poorly, 5 = very well)

	Attribute	Very Poorly				Very Well
1	Responsibility for performing project duties in a timely manner	1	2	3	4	5
2	Timely response to e-mails, and /or answering phone calls, and/or team meetings regarding the project status and /or project design decisions	1	2	3	4	5
3	Use of proper language	1	2	3	4	5
4	Respect of other team members	1	2	3	4	5
5	Honesty in stating claims or estimates based on the conducted project research information and/or available data	1	2	3	4	5
6	Honesty in claiming ability and/or willingness to perform parts of a project	1	2	3	4	5
7	Honesty in promptly bringing up to attention of other team members factors that may affect individual safety, and/or overall safety of the project, and/or safety, health and welfare of the public, and other factors that might endanger the public or the environment	1	2	3	4	5
8	Ability to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others	1	2	3	4	5
9	Helpfulness to team members, and willingness to assist colleagues in their professional development	1	2	3	4	5

Written Comments:

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Professional Ethics and Responsibility Outcome

Instructor's Name: _____

Section: _____

STUDENT EVALUATION FORM

Project Team (name of project) _____

Student's Name (to be evaluated) _____

For each attribute, circle the number that best corresponds to how much you feel the course helped students develop that attribute (1 = very poorly, 5 = very well)

INSTRUCTOR'S USE ONLY (please ***do not*** evaluate the attributes in this table)

	Attribute	Very Poorly				Very Well
1	Responsibility for performing project duties in a timely manner	1	2	3	4	5
2	Prompt response to comments, remarks and/or requests for information	1	2	3	4	5
3	Results of the Ethics Test given after a lecture on Engineering Ethics	1	2	3	4	5
4	Ethics essay in the Final Report	1	2	3	4	5
5	Responsibility and faithfulness in project status reporting	1	2	3	4	5
6	Being a good team player, responsive to teammate requests, being helpful to teammate	1	2	3	4	5