**EE 175AB: Senior Design Project**

Fall-Winter 2017-2018

**Instructors**

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**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 specification, 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 were 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, and budgeting, gain 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 and analyze data
7. Understanding of professional and ethical responsibility
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
11. **Student Outcomes Addressed**



A. Ability to apply knowledge of mathematics, science and engineering

B. Ability to design and conduct experiments, as well as, analyze and interpret data.

C. Ability to design a system, component, or process to meet desired needs.

D. Ability to function on multidisciplinary teams.

E. Ability to identify, formulate and solve engineering problems.

F. Understanding of professional and ethical responsibility.

G. Ability to communicate effectively.

H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.

I. Recognition of the need for and an ability to engage in lifelong learning.

J. Knowledge of contemporary issues.

K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

**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 entire class of EE 175A and EE 175B will meet once each week for one hour. 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 a 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. If you miss more than 3 lectures, your final grade will be deducted one grade level regardless whether you submitted the essays.**

In addition, it is expected that each project team meet with their session 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 the lectures and weekly meetings are mandatory.

**Project Topics**

Projects span the main electrical engineering areas of the ECE department. You can pick a project suggested by the instructors or you can propose your own topic but it must be approved. In addition, joint projects with other departments may be arranged. Topics that each section professor will supervise are presented to the students in an information meeting held in the spring quarter and are available online.

## Project Participants

Projects will be completed in small teams with shared responsibility. Each team should have 2 to 3 students. Single student team and team with more than 3 students are not generally not 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)?

1. **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.
2. **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).
3. **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.
4. **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.
5. **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).
6. **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.
7. **Working Demo and Draft Final Report:** A preliminary working demo is required at week 8 of the winter quarter. First complete draft of the final report also due in week 8 of the winter quarter. Your section professor will review and marked up draft of your final reports and send it back for improvement and re-write.
8. **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.
9. **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.
10. **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.

**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** | **Lecturer** | **Lecture Content** |
| 9/29 | Week 00 | All | Introduction, course outline, preliminary issues, requirements and expectations |
| 10/6 | Week 01 | KK | Introduction to product specification process, engineering design process, understanding prior art, laboratory notebooks, library techniques, literature and information search |
| 10/13 | Week 02 | RC | Design methodologies, functional block diagram and hardware block diagrams, evaluation of feasibility, problem solving and debug approaches |
| 10/20 | Week 03 | PL | Lab skills, exam for equipment use and lab safety for gaining lab access |
| 10/27 | Week 04 | KK | Experiment design, developing a test plan, collecting data, and evaluation. Realistic design constraints and considerations. |
| 11/3 | Week 05 | RC | System engineering |
| 11/10 | Week 06 | Holiday | No lecture |
| 11/17 | Week 07 | RC | Implementation and debugging of microcontroller interfaces: RS232, I2C and SPI  Each section to hold first design review in or before this week |
| 11/24 | Week 08 | Holiday | No lecture |
| 12/1 | Week 09 | MB | Data analysis techniques (statistical and time series analysis, curve fitting, regression, etc.)  Project management: organization, teamwork, scheduling, budgeting, etc. |
| 12/8 | Week 10 | PL | Printed circuit board design, layout, and fabrication  Each section to hold second design review in or before this week. |
|  |  |  | **Winter Quarter** |
| 1/12 | Week 01 | MB | Career choices and strategies, job searches, how to write resumes |
| 1/19 | Week 02 | RC | Debugging workshop: Debug case study, including cases for hardware and software |
| 1/26 | Week 03 | 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) |
| 2/2 | Week 04 | MB | 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. |
| 2/9 | Week 05 | MB | Writing Technical reports I. Go over the Final Report Template section by section, with instruction on what to write in each section. |
| 2/16 | Week 06 | MB | Writing Technical reports II. Use well-written Technical Reports as examples. |
| 2/23 | Week 07 | KK | 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 |
| 3/2 | Week 08 | KK | 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 |
| 3/9 | Week 09 | KK | Marketing engineering products, entrepreneurship, venture capital and startups |
| 3/16 | Week 10 | Open House | Work with section 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. |

**RC –** Roman Chomko, **MB** – Matt Barth, **KK** – Konstantinos Karydis, **PL** – Ping Liang

**Poster Presentation and Working Demo**

At week 8 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 are required. If you miss a lecture, you will be required to submit a >500 words essay on the topic of the lecture and submit it before the next lecture. If you miss more than 3 lectures, your final grade will be deducted one grade level and one more grade level for two more lectures you miss, and you are still required to submit the essays. 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 2 or 3 students. Exceptions are approved only on rare cases with strong justifications. No single member team 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 lab 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 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 of the winter quarter. A complete draft final report due week 8 of winter quarter, final version of final report due week 10 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 2016/2017**

EE 175 Senior Design

**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:

**Department of Electrical Engineering, UCR, Fall/Winter 2016/2017**

EE 175 Senior Design

**Professional Ethics and Responsibility Outcome**

**Instructor’s Name:** \_**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Section:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**INSTRUCTOR’S 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 |