ELEC 4000 - SENIOR DESIGN PROJECTS  
Spring Semester, 2014    Dr. Dean

2011 Catalog Data:    ELEC 4000. SENIOR DESIGN PROJECTS (3). Pr. ELEC 3040 or ELEC 3050 or ELEC 3060, and departmental approval. A capstone design project which draws on the accumulated curricular experience. Particular project sections may have additional prerequisites.

References:          1. Textbooks and lab manuals from previous courses  
                              2. References available from the library and on-line  
                              3. Manufacturer’s data sheets

Instructor:   Dr. Robert Dean, deanron@auburn.edu, www.eng.auburn.edu/~deanron/SeniorDesign.html

Class Meetings:    2:00 – 2:50, Monday, Wednesday, Friday, Broun 235

COURSE OBJECTIVES:

Over the course of this class, you will demonstrate your ability to participate in large electrical system design projects using disciplined, hardware and software engineering techniques. In particular, this will manifest in your ability to:

1. Design, implement, and test nontrivial, commercial quality systems.
2. Work effectively as members of a system design and development team.
3. Communicate technical information in oral and written form.

Background

Engineering draws heavily on the ability to design. The International Technology Education Association (ITEA) defines engineering design as “The systematic and creative application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.”

The purpose of the Senior Design Project is to provide you with a capstone design experience. To earn accreditation from the Accreditation Board for Engineering and Technology (ABET), an engineering program must satisfy ABET Engineering Criteria 2000 (EC2000), Criterion 4, which states:

* Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and multiple realistic constraints, which might include the following considerations:
  * economic  
  * manufacturability  
  * ethical  
  * environmental  
  * health and safety  
  * political  
  * sustainability  
  * social

Criterion 3 of EC2000 further specifies a set of educational outcomes that all students must achieve by the time of graduation. Every engineering program must assess and document the degree to which its students have achieved these outcomes and show how assessment results are used for program improvement. In our wireless engineering program, as in many other programs, a number of the student outcomes are assessed in the capstone design project, where students demonstrate and apply what they have learned in the curriculum. Accordingly, project grades will be, in part, based on the electrical/computer/wireless engineering program outcomes listed below. Each student will be expected to demonstrate achievement of most of these outcomes during this capstone project course, and thereby demonstrate preparation for the professional practice of electrical/computer/wireless engineering.

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1 http://www.iteawww.org/TAA/Glossary.htm
2 Criteria for Accrediting Engineering Programs, ABET Engineering Accreditation Commission, Nov. 2002
<table>
<thead>
<tr>
<th>#</th>
<th>Formal Statement of Course Objective</th>
<th>Short Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing ELEC: the seven fundamental areas of electrical engineering (circuits and systems, electronics, digital systems, electromagnetics, communications and signal processing, control systems, and power engineering). ECPE: the fundamental areas of computer engineering (circuits and systems, electronics, digital systems, software design, operating systems, and computer system design). Wireless Majors: Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing fundamental areas of wireless communications, with greatest emphasis by option as follows: WIRE: electrical engineering key to the practice of wireless engineering (circuits and systems, electronics, digital systems, electromagnetics, and communication systems). WIRS: software-oriented wireless engineering (digital systems, systems software, communication systems, communication networks, wireless applications, and human-computer interaction).</td>
<td>Apply basic knowledge to solve problems.</td>
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<tr>
<td>2</td>
<td>Ability to apply in-depth knowledge of ELEC: one or more disciplines within electrical engineering to the solution of engineering problems. ECPE: one or more disciplines within computer engineering to the solution of engineering problems. Wireless Majors: wireless communications principles, systems, and networks to the solution of wireless engineering problems, with emphasis on WIRE: RF electronics, digital signal processing, antenna design, and network design. WIRS: software engineering, network design, security, and quality assurance.</td>
<td>Apply advanced knowledge to solve problems.</td>
</tr>
<tr>
<td>3</td>
<td>Ability to design and evaluate a component or system to meet desired needs within the field of electrical/computer/wireless engineering.</td>
<td>Design a circuit and/or software that solves a problem.</td>
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<td>4</td>
<td>Ability to identify and formulate a problem when faced with a situation that calls for an engineering solution.</td>
<td>Formulate problems.</td>
</tr>
<tr>
<td>5</td>
<td>Ability to design and conduct experiments to acquire needed data, and to analyze and interpret data to solve engineering problems.</td>
<td>Design experiments to get needed data.</td>
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<tr>
<td>6</td>
<td>Proficiency in the use of computers and other modern tools and skills to solve engineering problems.</td>
<td>Modern tools.</td>
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<tr>
<td>7</td>
<td>Ability to function as a member of a multidisciplinary team in the solution of engineering problems.</td>
<td>Teamwork.</td>
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<tr>
<td>8</td>
<td>Proficiency in communicating ideas and information orally and in writing.</td>
<td>Oral and written communication.</td>
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<td>9</td>
<td>Appreciation of the need for, and an ability to learn new concepts as required for the continuing practice of electrical/computer/wireless engineering.</td>
<td>Self-teaching / Lifelong learning.</td>
</tr>
<tr>
<td>10</td>
<td>Understanding of ethical responsibility and professional integrity issues related to the practice of electrical/computer/wireless engineering.</td>
<td>Ethical/professional behavior</td>
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<tr>
<td>11</td>
<td>Understanding of contemporary engineering and societal issues, and the impact of engineering decisions on society in both a local and global context.</td>
<td>Contemporary issues</td>
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Project Teams

In this class, you will work as a team, and the entire team is responsible for the specific project. It will be up to the team to plan, partition, and execute the tasks required to achieve success in the project. All team members are expected to participate equally in all aspects of the class objectives, product demonstrations, etc. Each student will be accountable for an average of nine hours per week on course related activities, in addition to the regular class meetings.

At selected times during the semester, the weekly reports will include evaluations of teammate performance (peer reviews). Poor personal effort indicates that your fellow team members did your work for you, or that you otherwise did not contribute adequately to the project; hence your grade will be adjusted accordingly. Peer reviews shall also be used to identify quickly conflicts within project teams. Significant instructor intervention in team conflicts is a last resort and is undesirable. However, should conflicts arise that require outside arbitration/discussion, feel free to contact the instructor and discuss options.

The engineering design process will be described to you in the first several class sessions. There is no textbook for this course. Some course material will be made available to you through the class “Blackboard” page; however, you are also expected to locate resources and materials pertinent to your project on an independent basis. Do not rely on material from previous ELEC 4000 offerings.

Introduction To The Design Process

You will be instructed in the hardware and software design process and procedures of Senior Design. You will be shown a variety of template forms your team will use to produce standardized status reports, test logs, design reviews, etc. The time allowed for these discussions is short and will be insufficient for you to fully comprehend the details of the course. You are not, however, excused from learning these details, so discussions must remain open and scheduled regularly by each team.

Project Proposal Phase

The team must develop an initial implementation of its assigned project. We call this phase the proposal phase. The primary stipulations are:

1. The team should accomplish as much as possible.
2. Overall project cost should be considered and documented, including nonrecurring and recurring costs, assuming that your product will eventually be manufactured and some number of units sold.
3. All work must have some deliverable form (e.g., it cannot be stated that “serial interface programming was learned”; rather, data demonstrating those concepts learned must be presented (e.g. a program that successfully sends a character to serial port is demonstrated).

The intent of the proposal phase is to allow each team to immerse itself in the project without regard to formal documentation and to provide opportunity to focus on what project risks face them. A written proposal that is not backed up with a preliminary design is not of much value. This will afford insights that might otherwise be undiscovered until later in the semester, requiring radical redesign late in the semester. The design will be summarized in a written report and oral presentation outlining the team's design decisions and describing their product’s function, feature, structure, and any other relevant features.

The proposal must include the following:

- Project Description
- Technical Approach (some Pugh charts may be appropriate here)
- Management Approach
- Budget (including parts and costs, and how funds will be obtained)
- Timeline (Gantt chart)
- Facilities to be used
- Disposition agreement signed by each team member, describing what will be done with the finished product at the end of the semester.

The proposal phase will account for 20% of your total grade, broken down as follows:

- 7% team – Written report (M.S. Word) sections to be written by individuals, with authors identified
- 3% team – Oral presentation (M.S. PowerPoint), author’s name at bottom of each slide (except title)
- 10% individual – Peer evaluation (7 % of you and 3 % by you)

Deliverables:
• Written proposal and oral presentation slides must be emailed to the professor. Each team will elect a Team Captain that will email the proposal and the presentation to the professor. He/she is *NOT* solely responsible for preparing them: just for emailing them to the professor all Team Member will participate in preparing them.

• The Team will present the, nominally 20min, Proposal Presentation to the professor on Friday, 1/24. The Team Captain will present the Introduction and Conclusion slides. EVERY team member shall present one of more slides on their part of the project. The Team Captain shall email the professor a draft of the presentation by Wednesday 1/22, for feedback from the professor.

• The Team Captain shall email the professor the proposal and the final presentation by 5:00 pm Friday, 1/24.

• Each Team Member shall email the professor her/his peer evaluations, as an email, by 5:00 pm Friday 1/24. Each Team Member shall evaluate themselves and every other Team Member.

**Development Cycles**

Following the proposal phase, you will participate in two iterative **Development Cycles**, each of which will count for 40% of the overall grade. During the cycles, the team is expected to meet each scheduled class period with the course instructors to report on project status, present implementation or design concepts, seek feedback, etc. Additionally, the team is expected to meet with the professor regularly for detailed discussion, demonstrations, etc. to ensure the product and plans will actually meet the Cycle Intent.

The Team Captain must email the professor a formal electronic copy of a team status report (M.S. Word) no later than 5pm each Tuesday. The entire team is responsible for preparing the team status report.

**Deliverables**

**Cycle 1**

At the end of each cycle (Friday, February 28), the team will deliver

- Written report (MS Word), due 5:00 pm Friday 2/28 – by email
- Draft oral presentation PowerPoint file due Wednesday 2/26 – by email
- Oral presentation (M.S PowerPoint) with working demonstration of product – Friday 2/28
- Final copy of oral presentation PowerPoint file due 5:00 pm Friday 2/28 – by email
- Peer evaluation from each Team Member due 5:00 pm Friday 2/28 – by email

**Cycle 2**

At the end of each cycle (Wednesday, April 23), the team will deliver

- Written report (MS Word), due 5:00 pm Wednesday 4/23 – by email
- Draft oral presentation PowerPoint file due Monday 4/21 – by email
- Oral presentation (M.S PowerPoint) with working demonstration of product – Wednesday 4/23
- Final copy of oral presentation PowerPoint file due 5:00 pm Wednesday 4/23 – by email
- Peer evaluation from each Team Member due 5:00 pm Wednesday 4/23 – by email

The grade for *each* cycle will be broken down as follows:

- 20% individual – Written report (sections to be written by individuals, with authors identified)
- 5% individual – Oral presentation (weekly status reports and cycle presentation)
- 15% individual – Evaluation by peers (10 % of you and 5 % by you)

**Customer Evaluation**

A. Customer Demonstration

As part of the Development Cycle 2 oral presentation, the team will demonstrate there working device. Details on the demonstration will be given at a later time.

B. Senior Design Fair

At the end of the last development cycle, the final product will be displayed at Senior Design Fair (Friday, April 25). These activities are included in Cycle 2 Oral Presentation part of the course grade.
**Team Grades**
Many of the grade components listed above are graded at the team level. This means that each team member will receive the same grade for each such element. However, if a student does not perform at the team level for a given element, that student should NOT expect the same grade as the other team members. This includes both students who choose not to participate to an appropriate degree and those who choose to be “team hero”.

**Attendance**
Class attendance is mandatory. Failure to attend class regularly may sacrifice a substantial portion of a student's individual and team grades. The class will not meet every Monday, Wednesday and Friday: the professor will decide which class days to actually meet.
PROJECT DELIVERABLES:

**Project Proposal:** The team is to develop and submit a project proposal during the proposal phase. This proposal is to define the project goals and implementation plan, including a timeline for accomplishing these goals. This will be both a written document and an oral presentation. The project will be evaluated for viability as well as functionality: are the hardware and software components you select available at reasonable cost and will they interoperate? Experimental results of trials you have done are more convincing than paper arguments that things “should work”.

**Weekly Status Report:** The team will submit a weekly status report during design cycles 1 and 2, using the Excel spreadsheet template provided (emailed to the professor by the Team Captain). This report is to summarize key activities and results. There are 3 sections to the spreadsheet. The first itemizes tasks/features of the system in development and outlines the status of each one. The second summarizes how time has been spent by team members in the past week. The third highlights achievements, obstacles, and risks encountered in the last week. ALL Team Members will help write this document.

**Oral presentations:** The team will give an oral proposal report and two end-of-development-cycle oral project reports during the semester. At the end of the semester, each team will also prepare and present an exhibit in the “Senior Design Fair”, to be attended by faculty and industrial guests. The main objective of these reports is to communicate technical information about the team's progress to the class and instructor. However, an important adjunct objective is for each individual to refine his or her oral presentation skills, just as the written reports provide opportunities to refine writing skills. Therefore, the oral reports, or portions of the reports, should be divided among the team members during the course of the semester so that each person will have made at least two presentations. The final presentations will be judged by the instructor and a panel of other evaluators.

**Written Cycle Reports:** The team will provide a written report at the end of each design cycle. Within this report, each student is required to contribute one or more individually-written sections, with each author clearly identified. The detailed format will be specified separately. This report should be a summary of the information already provided in the weekly memos, including all pertinent design specifications, justification for engineering decisions, simulation results and evaluation, cost (budget), etc. Documentation is to be made available to the course instructor at least one class period before the end-of-cycle presentations (this is a different deadline than the due date for the final written report). Also include on a CD all reports and any source code or other electronic files necessary to build the project.

**Project Notebook:** The team will provide a project notebook at the end of each design cycle, containing the cycle report and all other project documents, including presentation slides, customer requirements, system specifications, management plan, test documentation, status reports, email communications, meeting notes, source code printouts, schematics, and a section on “lessons learned” during the cycle. Documents should be added to the notebook during each cycle, so that by the end of the course, the notebook contains the project proposal and all documents from both design cycles.

**Peer Review:** Teamwork is an important engineering skill. Part of each student’s teamwork grade will be derived from an assessment of his/her participation on the team, submitted anonymously by the other team members, and on the quality of assessment of his/her peers.

**Professionalism:** Determined separately for each individual, this includes items such as: (1) Arriving at class meetings on time, (2) Participating materially in class discussions, (3) Attending and participating in team meetings, (4) Demonstrating good teamwork skills, (5) Effective use of outside resources in problem solving.
Grading Summary

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<thead>
<tr>
<th>Item</th>
<th>Weight (%)</th>
<th>Date</th>
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<tbody>
<tr>
<td>Project Proposal</td>
<td>20</td>
<td>Fri., September 6</td>
</tr>
<tr>
<td>First Dev. Cycle</td>
<td>40</td>
<td>Fri., October 11</td>
</tr>
<tr>
<td>Customer Evaluation*</td>
<td></td>
<td>Fri., October 11</td>
</tr>
<tr>
<td>Second Dev. Cycle</td>
<td>40</td>
<td>Wed., December 4</td>
</tr>
<tr>
<td>Senior Design Fair*</td>
<td></td>
<td>Fri. 12/6, 2:00 – 4:00 p.m.</td>
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* Included in Cycle 2 for grading purposes.

Special Accommodations:

Students who need accommodations are asked to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by E-mail. Bring a copy of your Accommodation Memo and an Instructor Verification Form to the meeting. If you do not have an Accommodation Memo but need accommodations, make an appointment with The Program for Students with Disabilities, 1244 Haley Center, 844-2096 (V/TT).

Academic Honesty Policy:

All portions of the Auburn University student academic honesty code (Title XII) found in the Tiger Cub will apply to this class. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee.