2007 Catalog Data: ELEC 4000. SENIOR DESIGN PROJECTS (3). Pr. ELEC 3040, 3320, 3400, 3500, 3600, 3700 and departmental approval; or ELEC 3050, 3700, 4200, COMP 3500, COMP 3270 and departmental approval. One of ELEC 320, 3400, 3500, 3600, 3700, 4200, COMP 3500, or COMP 3270 may be taken concurrently. 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

Coordinator: Victor P. Nelson, Professor, Electrical & Computer Engineering

Class Meetings: 2:00 – 2:50, Monday, Wednesday, Friday, Broun 306 (see schedule below)

COURSE OBJECTIVES:

Over the course of this class, you will demonstrate your ability to participate in large wireless 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 wireless systems.
2. Work effectively as members of a wireless system 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 Wireless 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 realistic constraints that include most of the following considerations:

* economic
* environmental
* sustainability
* manufacturability
* health and safety
* ethical
* political
* 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 program 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, or wireless

---

1 [http://www.iteawww.org/TAA/Glossary.htm](http://www.iteawww.org/TAA/Glossary.htm)
2 Criteria for Accrediting Engineering Programs, ABET Engineering Accreditation Commission, Nov. 2002
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, and wireless engineering.

### Electrical, Computer, and Wireless Engineering Program Outcomes

<table>
<thead>
<tr>
<th>#</th>
<th>Formal Statement of Course Objective</th>
<th>Short Form</th>
</tr>
</thead>
</table>
| 1  | 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, electromagnetics, electronics, digital systems, 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: 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). | Apply basic knowledge to solve problems.         |
| 2  | 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: wireless communications principles, systems, and networks to the solution of wireless engineering problems, with emphasis by option as follows:  
WIRE: RF electronics, digital signal processing, antenna design, and network design.  
WIRS: software engineering, network design, security, and quality assurance. | Apply advanced knowledge to solve problems.         |
| 3  | Ability to design and evaluate a component or system to meet desired needs within the field of electrical, computer, or wireless engineering. | Build a circuit or computer program that works. |
| 4  | Ability to identify and formulate a problem when faced with a situation that calls for an engineering solution. | Formulate problems.                             |
| 5  | Ability to design and conduct experiments to acquire needed data, and to analyze and interpret data to solve engineering problems. | Design experiments to get needed data.           |
| 6  | Proficiency in the use of computers and other modern tools and skills to solve engineering problems. | Modern tools.                                   |
| 7  | Ability to function as a member of a team in the solution of electrical, computer, or wireless engineering problems. | Teamwork.                                       |
| 8  | Proficiency in communicating ideas and information orally and in writing. | Oral and written communication.                  |
| 9  | Appreciation of the need for, and an ability to learn new concepts as required for the continuing practice of electrical, computer, or wireless engineering. | Self-teaching / Lifelong learning.               |
| 10 | Understanding of ethical responsibility and professional integrity issues related to the practice of electrical, computer, or wireless engineering. | Ethical/professional behavior                    |
| 11 | Understanding of contemporary engineering and societal issues, and the impact of engineering decisions on society in both a local and global context. | Contemporary issues                             |
Project Teams

In this class, you will work in teams of three to six students, each team responsible for a specific project. It will be up to each 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.

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; 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, code 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

In parallel with the “Introduction to Process” lectures during the first three weeks (see schedule), each team must develop an initial implementation of its assigned project… in its entirety. We call this phase the proposal phase. The primary stipulations are:

1. The team should accomplish as much as possible.
2. All work can be mapped to the vision of the customer (you only do what the customer asks you to).
3. Each element of the customer vision can be mapped to some work (you do all that the customer asks you to).
4. 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.
5. 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 demo’ed).

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 worth the paper on which it is printed (remember that later in your career, when you are on the other side of the table, evaluating proposals). 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 outlining the teams design decisions and describing their product’s function, feature, structure, and any other relevant features.

The proposal phase will account for 15% of your total grade, broken down as follows:
- 5% team – All aspects of the project were addressed (2 and 3 above)
- 5% team – Work was implemented, presented, and demonstrated adequately within time constraints
- 3% team – Written report
- 2% individual – Peer evaluation
Development Cycles
Following the proposal phase, you will participate in two iterative Cycles, each of which will count for 25% 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, teams are expected to meet with the instructors/customers regularly for detailed discussion, demonstrations, etc. to ensure the product and plans will actually meet the Cycle Intent. Each team must post a formal electronic copy of a team status report to the course Blackboard page no later than 5pm each Monday. At the end of each cycle, the team will deliver the product of that cycle, written documentation (as outlined in class discussions), an oral presentation, and one peer evaluation from each team member. End of cycle products must be “build-able”, device installable, and have an up to date user manual.

The grade for each cycle will be broken down as follows:
- 5% team – Quality and adherence to course, process, and team standards
- 5% team – Quality of design and demonstration of working product consistent with Cycle Intent and customer vision
- 5% individual – Written report (cycle report must be
- 4% individual – Oral presentation
- 4% individual – Evaluation by peers
- 2% individual – Evaluation of peers

The two cycles account for 50% of the overall course grade.

Customer Evaluation
At the end of the last cycle, the final product will be delivered to the customer to install, set up, and use. The team MAY NOT assist the customer in installation and deployment. The customer assesses how well the project meets her needs. This portion of the course accounts for 10% of the course grade, broken down as follows:
- 3% team – Success of the installation and setup
- 3% team – Quality of the documentation for user
- 4% team – Customer assessment

Engineering Design
An additional 25% of the grade will be allocated based on the engineering quality of the team’s work, meeting the design goals, and peer teamwork assessment. This will be determined on:
- How well the team planned for and reacted to risks and obstacles.
- Quality of communication with instructors and customers.
- How well the team adhered to the process.
- Confidence the instructors have in the final product.
- Peer assessment of teamwork for each team member

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.
PROJECT DELIVERABLES:

**Project Proposal:** Each team is to develop and submit a project proposal during the first three weeks of the course. 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:** Each team will submit a weekly status report, using the Excel spreadsheet template provided. This memo 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.

**Oral presentations:** Each 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 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 one or two presentations. The final presentations will be judged by the instructor and a panel of other evaluators.

**Written Cycle Reports:** Each 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 judging panel at least one week before the end of the semester 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:** Each 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, user stories, 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.

**ACCESSIBILITY:**

It is the policy of Auburn University to provide accessibility to its programs and activities, and reasonable accommodation for persons defined as having a disability under Section 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of 1990. Students
who need special accommodations should make an appointment to see the instructor as soon as possible or contact the Students with Disabilities Office at (334) 844-5943 (Voice/TT).