**EECE 690/890**

**Digital Radio Hardware Design**

**Fall 1998**

***Instructors:*** Bill Kuhn and Hafthor Oskarsson

265 Rathbone Hall 297A Rathbone Hall

532-4649

***Office Hours:*** For Dr. Kuhn:

Tues, Thurs 2:30 - 5:00 PM (except during bi-weekly Thurs faculty meetings)

Others by appointment

For Hafthor Oskarsson: To be determined.

***Prerequisites:*** Electronics II (EECE526) and Linear Systems (EECE512).

***Course Description:***

This course concentrates on system-level and hardware-level design of wireless telecommunications equipment. It complements the theoretical and laboratory studies provided in EECE660, EECE661, and EECE662, and should provide you with a well-rounded understanding of concepts essential to designing tomorrow's communications infrastructure.

A primary objective of the course is to provide you with a 'hands-on' (active) learning experience to reinforce the concepts presented in class lectures. The class as a whole will be divided into two competing companies, each of which will work to produce a *digital cordless telephone product*. Your designs will incorporate most of the same elements found today in commercial high-end cordless phone products as well as in Cellular Phones and future Wireless Local Area Networks. Since the design of such products requires substantially more work than a single individual can do on his/her own, different students will be assigned different tasks and will work in parallel with others within their company to develop the final product. Thus, you will learn not only essential technical information, but also valuable skills in (real-world) project teamwork.

The keys to success in the course will be the same as those in today's industry - an understanding of the full product being developed (to facilitate coordination across teams within the company), and structured design practices within each team to guarantee first-pass design success.

***Text:*** This course covers a wide range of material in a very condensed format. Unfortunately, there is no single textbook available today which covers all topics, and purchasing all the needed texts is not practical. Thus, we will work primarily from lecture notes, supplemented by recommended readings in material on the Web or in class handouts.

A good reference, especially for the material presented in the second half of the course is Dr. Rappaport's book *"Wireless Communications"*published by Prentice-Hall PTR, 1996. If you plan to work in this field upon graduation, this text is highly recommended and can be purchased through Varney's bookstore for about $75. A copy of the book will be placed in the Comm Circuits Lab (RA 297) for you to look at. Feel free to use this book as much as you like, but do not remove it from the lab.

***References:*** A number of additional textbooks which could prove useful, will also be placed in 297 for your reference.

***Homework, Projects, and Exams***

The goals of this course are very challenging. On the one hand, you will be attending class, taking notes, and working (brief) homework assignments - while on the other, you will be a critical player in the design of a significant product and will need to perform your project assignments well and in a timely fashion. *Clearly, this is a lot to demand in a Senior-level course.* Unlike employees in a real industry setting, you are taking several other classes and cannot afford to spend 8 hours a day on your project.

To deal with this problem, your instructors will work hard to guarantee that you are not left "on your own" as you would be in a job setting. They will do their best to make many of the critical and time-consuming decisions (such as which IC s to use, what the top-level block diagram and interfaces will be, etc.) and to help you as much as possible. Your tasks will then be to work out the "details" (of which there will be many), and to work diligently see that the final product works. You will be given assignments throughout the semester which will guide you through the steps needed for successful completion of your individual tasks, and if your work hard and coordinate well with other members of your team and company, your final product should work well.

As an additional concession to the amount of effort you will need to put into your project work, there will be no tests, except an *open-notes* final exam. This exam will cover primarily the material from the general homework assignments that all students will work.

***Undergraduate versus Graduate Credit***

***890 Credit:*** This course is offered for both undergraduate (690), and graduate (890) credit. If you are an undergraduate student, you should register for EECE690 only. If you are a graduate student, you may register for 690 or 890, depending on your program of study and graduation requirements.

Those enrolled at the 890 level will be required to do project documentation. Members of your team will provide you with schematics, notes, etc., but you will be required to produce a final report. The report will be provided to all members of your team, giving each student a valuable item to add to their resume when interviewing for jobs!

***Grading***: If you are registered in EECE690, weighting of the individual components of your grade will be computed as follows:

* Homework assignments 20 % (lowest homework dropped)
* Project assignments 40 %
* Functionality of final product 20 %
* Final Exam 20 %

If you are registered in 890, weighting will be the same, except that your documentation will also enter into your project assignment grade. The final grading curve is subject to the discretion of the instructor but will generally follow the classical assignment pattern: 90% - 100% = A, 80% - 90% = B, etc. ***Late Work:*** To receive full credit, you must turn in your work on the due dates. Late work (without official documentation of illness, or other significant circumstances outside your control) may be prorated as follows:

* < 48 hrs. 90 % maximum credit
* 48 - 96 hrs. 80 % maximum credit
* > 96 hrs. 70 % maximum credit

*Project design reviews and the final exam must be completed on time!* ***Cost:*** Since this course involves the construction of hardware, a moderate fee may be requested to help defray the cost of items purchased, PC boards fabricated, and copies of the final reports given to each student at the end. This cost will not exceed $40 per student (recall that there is no textbook, so this about half of a typical course). Each company will produce two radios - one for each end of a wireless link. Producing radios for each student is unfortunately not possible without significant extra cost (recall that 900 MHz digital phones sell for approximately $100 in stores). To provide the most exposure of your hard work to the public, we anticipate showing off the phones produced at Open House. In addition, color photos will also be included in the final reports so that you can show family, friends, and prospective employers. ***Disabilities:*** If you have any condition, such as a physical or learning disability, which will make it difficult for you to carry out the work as outlined or which will require academic accommodations, please notify me in the first two weeks of the course. ***Academic Honesty:*** This is a challenging course. Collaborating to accomplish team tasks is in fact critical to your success. However, the bulk of the effort put forth on your homework and assigned tasks should be your own, and the final exam must (of course) be done on your own. A portion of your project grade may in fact be determined by your classmates, so be sure to hold up your end of the project assignments so that they are pleased with your efforts.

**Draft Syllabus**

Week Topic Assignments1 ------- ------ ----------------- 1 Orientation/ intro to digital radio communications Resumes submitted 2 Radio Transceiver design Teams formed, List servers setup 3 Frequency synthesizer design Team 1 Starts 4 System-level protocols, ADPCM codec and PLD Team 2 Starts 5 PIC microcontroller and software Team 3 Starts2 6 EDA tools, board layout, and mechanical engineering Team 4 Starts2 7 Radio wave generation, tx lines, and antennas 8 Radio wave propagation Team1 PDR 3 9 Transceiver performance Team2 PDR 10 Digital modulations Team3 PDR 11 Digital modulations Team4 PDR 12 Final design review 13 Channel coding Board fabrication 14 Source coding Holiday 15 Duplexing/Multiple access, Cellular/PCS standards Build/test 16 Testing and Demonstrations 17 Exam (Tues, 12/15)4 NOTES: 1 Short homeworks will be assigned periodically throughout semester 2 Teams 3 and 4 may begin early if desired (see instructor) 3 PDR is "Preliminary Design Review" and will consist of (informal) presentations to class 4 In-class, open notes final primarily on homework material