Course Syllabus

ELEG 4293 – Modeling and Simulation of Mixed-Signal Circuits and Systems
Spring Semester, 2006

Instructor:
Dr. Alan Mantooth
Office: BEC 3175
Telephone: 575-4838
e-mail: mantooth@engr.uark.edu
course website: http://intra.engr.uark.edu/~mantooth
MSCAD Lab website: http://mixedsignal.eleg.uark.edu
FAX: 575-7967

Prerequisite: ELEG 3213, 3223.

Textbooks: *Electronic Circuit and System Simulation Methods*, L. T. Pillage, R. A. Rohrer, C. Visweswariah, McGraw-Hill, 1995.
The System Designer's Guide to VHDL-AMS, P. Ashenden, G. Peterson, D. Teegarden, Morgan-Kaufman, 2003.

Grading: Grades will be determined by your performance on exams, quizzes, modeling assignments and other homework assignments.

There will be a mid-term and a final exam. The mid-term exam will be scheduled just before Spring Break. A tentative date for the mid-term is Tuesday, March 14. it may be given in the evening. The final will be given during our final examination period (***Saturday, May 6, 3:00-5:00pm***) and will be comprehensive in nature. Exams given in the evening will count as a class meeting to make up for when the instructor must be absent due to travel commitments.

Each exam will count 150 points toward your course grade. Modeling assignments/quizzes/homework will be another 150 points. Sometimes quizzes are announced, while at other times they are given unannounced.

In summary, the weighting of all aspects of your grade will be as follows:

Exams:	300 pts.
Homework/Quizzes:	150 pts.
TOTAL	450 pts.

You can estimate your grade at any time by using the following ranges based on total points to date:

A = 90% or better
B = 80-89.9%
C = 70-79.9%

D = 60-69.9%
F = less than 60%.

SPECIAL NOTES

If you are forced to miss an exam due to an emergency, you should inform the instructor prior to missing the exam. Leave me voice mail on my extension (5-4838) and leave the time at which you call. I will check it prior to leaving my office for the exam and after the exam is complete. If you miss an exam with a valid excuse and the permission of the instructor, it is up to the instructor's discretion as to whether a makeup exam will be offered or your grade will be based on your performance on the remainder of exams, homework, and quizzes. Students who miss an exam without permission of the instructor will receive a grade of "F" for the course. Any person found cheating on a quiz or exam will receive a grade of "F" for the course.

This course is being developed for online delivery via Internet2. We have some plans to "test" this delivery during the semester. You will be asked to evaluate all aspects of this. Your cooperation is appreciated as well as your patience. We may be working in teams on some assignments and on the class project. You will be graded by your peers to some degree on intangibles such as teamwork, so establish a "can do" attitude early. If you make your goal in this class that of learning some new modeling and analysis techniques and you won't be disappointed. Some lectures may be given by people from industry. Take advantage of their contribution and their availability.

Attendance: Though attendance is not mandatory, it is **highly** recommended. You are responsible for all handouts and announcements given during the regular class meeting.

Office Hours: T, Th 2:30-3:30 p.m. or **by appointment ONLY**. **Do not hesitate to make an appointment and see me if you have questions or problems.** However, without an appointment or outside of office hours I am unavailable.

This course on HDL modeling and simulation will first introduce the students to basics behind analog and digital simulation. The general algorithmic flow of each will be described as well as a detailed description of algorithms that are executed during simulations. Next, hardware description languages will be described in the context of the simulation process. Semantic and syntactic information will be described. Most importantly the conceptual level information surrounding model creation will be presented. The modeling and simulation tools will be used together in case studies where the focus will be on analysis techniques and getting the most from the simulation tools. This class is recommended for all students considering employment involving mixed-signal circuit (including analog and digital ICs) or mixed-technology system design and test.

The following is a preliminary outline of the HDL modeling and simulation course along with the approximate amount of time spent on each topic (15 weeks total).

I. *Analog Circuit Simulator Algorithms (2 weeks)*
The focus of this material is on learning the basic flow of the circuit simulator - what it accepts as input, what it produces as output, and what happens in between. Next, the solution algorithms will be examined. This includes such things as Modified Nodal Analysis, LU decomposition, sparse matrix algorithms, Newton-Raphson iterative techniques, and numerical integration. Convergence issues and simulation accuracy will be explored.

II. *Digital Simulator Algorithms (2 weeks)*
The analogous information to the analog algorithms in part I will be explored. The basics of logic simulation will be covered. Event queues and event-driven simulation techniques will be described.

III. *Modeling with Hardware Description Languages – VHDL-AMS (10 weeks)*
Constituting the bulk of the course, this portion will focus on the semantics of representing mixed-signal circuit behavior. This will include learning how to model such things as conservation laws, implicit relationships, multi-dimensional observed phenomena, and multiple technology domains (e.g., thermal, electrical, mechanical, etc.). Also, it will include lectures on event-driven modeling for analog and digital. It will describe the mechanisms by which foreign routines (e.g., C or FORTRAN) can be used in HDL models. This portion will also cover the underlying operations for moving from analog to digital and vice-versa, which are:

- Thresholding to obtain an event from an analog quantity. The threshold function generates an event when an analog quantity crosses a threshold value; the event is then available in the discrete-time domain.
- Ramping to convert an event into an analog quantity.

IV. *Analysis of Mixed-Signal Circuits and Systems (1 week)*
No course on HDL modeling and simulation would be complete without some discussion of the basic and advanced analysis capabilities available in the state-of-the-art simulators. Examples of basic analysis capability include: AC, DC, transient, noise and distortion analyses. Advanced analysis capabilities include: stress, sensitivity, and failure modes and effects.

At particular points during the course, experts in the field may give lectures associated with their areas of expertise. This will provide added insight into the course material for the students, give them access to leaders in the field for a short time, and generally make the course more intellectually stimulating.