EEL4930/5934 Reconfigurable Computing (dual-listed course)
Department of Electrical and Computer Engineering
University of Florida

Fall Semester 2007

Catalog Description: *Prereq: EEL4712C or EEL5764 or consent of instructor.* Fundamental concepts at advanced undergraduate level (EEL4930) and introductory graduate level (EEL5934) in reconfigurable computing based upon advanced technologies in field-programmable logic devices. Topics include general concepts, device architectures, design tools, metrics and kernels, system architectures, and application case studies.

Credit Hours: 3

Prerequisites by Topic: Fundamentals of digital design including design technologies, design methodology and techniques, and design environments and tools; fundamentals of computer organization and architecture, including microprocessor datapath and control structures, data formats, instruction-set principles, pipelining, instruction-level parallelism, memory hierarchy, and interconnects and interfacing.

Course Objectives: Students will gain fundamental knowledge and understanding of principles and practice in reconfigurable architecture and computing through class lectures and discussions, reading assignments, homework and lab experiments, and a major research project.

Instructor(s): Dr. Stitt (323 Benton, gstitt@ece.ufl.edu, www.gstitt.ece.ufl.edu),

Dr. Lam (225 Larsen, hlam@ufl.edu, www.hlam.ece.ufl.edu)

Teaching Assistant: To be determined.

Meeting time: Period 5, M W F

Class/laboratory schedule: Boards will be made available for use outside of class.

Meeting Location: Larsen 0239

Material and Supply Fees: $29.61

Required Textbook(s):

- C. Maxfield, *The Design Warrior's Guide to FPGAs*, Newnes, 2004, ISBN: 978-0750676045. (supplemented by readings from the literature).

Potential References (Recommended Reading):

- M. Gokhale and P. Graham, *Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays*, Springer, 2005, ISBN: 978-0-387-26105-8.
- C. Bobda, *Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications*, Springer, 2007, ISBN: 978-1402060885.
- P. Lysaght and W. Rosenstiel (eds.), *New Algorithms, Architectures and Applications for Reconfigurable Computing*, Springer, 2005, ISBN: 978-1402031274.
- D. Pellerin and S. Thibault, *Practical FPGA Programming in C*, Prentice-Hall, 2005, ISBN: 978-0131543188.
- W. Wolf, *FPGA-based System Design*, Prentice-Hall, 2004, ISBN: 0-13-142461-0.
- R. Cofer and B. Harding, *Rapid System Prototyping with FPGAs: Accelerating the Design Process*, Newnes, 2005, ISBN: 978-0750678667.

- N. Voros and K. Masselos (eds.), *System-Level Design of Reconfigurable Systems-on-Chip*, Springer, 2005, ISBN: 978-0387261034.
- G. De Micheli, *Synthesis and Optimization of Digital Circuits*, McGraw-Hill, 1994, ISBN: 978-0070163331

Course Outline: The following is an overview of the topics to be covered.

I. General overview (< 1 week)
- Goals and motivations
- History, state of the art, future trends
- Basic concepts and related fields of study
- Performance, power, and other metrics
- Algorithm analysis and speedup projections

II. FPGA Architectures (~1 week)
- Device characteristics
- Fine-grained FPLDs
- Coarse-grained FPLDs
- Design strategies

III. FPGA Physical Design Tools (~1 week)
- Technology Mapping
- Placement & Routing

IV. Register Transfer (RT)/Logic Synthesis (1-2 weeks)
- Controller/Datapath synthesis
- Logic minimization

V. High-level Design (~3 weeks)
- High-level synthesis
- High-level languages
- Design tools

VI. Hybrid architectures (~1 week)
- Hybrid architectures
- Communication
- Hw/sw partitioning
- Soft-core microprocessors

VII. System architectures (2-3 weeks)
- System design strategies
- System services
- Small-scale architectures
- HPC architectures
- HPEC architectures
- System synthesis
- Architectural design space explorations

VIII. Case Studies (~1 week)
- Signal and image processing
- Bioinformatics

- Security

IX. Special Topics (~3 weeks)
- Partial Reconfiguration
- Numerical Analysis
- Performance Analysis/Prediction
- Fault Tolerance

Lab Experiments: A series of laboratory experiments will be assigned in synchronization with the topics covered in class lecture. These experiments will be undertaken by small teams of students in an open-lab environment in the first half of the semester. Students enrolled in the graduate section of this course will be assigned extra tasks for each lab.

Research Project: Students will form teams of two or three students each and undertake a major research project (on a topic subject to instructor approval) exploring fundamental issues in reconfigurable computer architectures, systems, and applications. This project will span the second half of the semester and provide students the opportunity to more deeply explore fundamental issues in RC. Students enrolled in the graduate section of this course will undertake a significantly broader and deeper topic or role than those in the undergraduate section. The culmination of each project for a graduate student will be a clear and concise technical report suitable for publication discussing project concepts, development, experiments, results, and analyses. The most important outcome of each project and report will be the research results that are achieved, analyses rendered, and conclusions drawn with demonstrable insight.

Equipment: The state-of-the-art Reconfigurable Computing equipment available for this course is made possible by a generous grant from the Rockwell Collins Growth Relationship Grant Program and an equipment/software donation from Nallatech.

Attendance: not required, but highly recommended.

EEL4930 Grading:
- Mid-term1: 20% (Wednesday, October 3)
- Mid-term2: 20% (Wednesday, October 31)
- Final exam: 20%
- Labs/Homework: 10%
- Project: 30%

EEL5934 Grading:
- Mid-term1: 20% (Wednesday, October 3)
- Mid-term2: 20% (Wednesday, October 31)
- Final exam: 20%
- Labs/Homework: 10%
- Project: 30%

Grading Scale: Final grade to be determined by curved average of exams, assignments, and project.

Make-up Exam Policy: Missed exams cannot be made up, except in case of documented medical emergency.

Honesty Policy: All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and

understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

Accommodation for Students with Disabilities: Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

UF Counseling Services: Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
- SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
- Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
- Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

Software Use: All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.