Course Reconfigurable Computing (dual-listed course)

EEL4720/5721
Class Periods: MWF, Period 4, 10:40 – 11:20 am
Location: CHE 237
Academic Term: Spring 2020

Instructor:
Dr. Herman Lam
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Benton 313, (352)392-2689
Office Hours: TBA

Teaching Assistant

- Samantha Soto, ssoto65@ufl.edu, office location TBA, office hours TBA

Course Description

Fundamental concepts at advanced undergraduate level (EEL4720) and introductory graduate level (EEL5721) in reconfigurable computing (RC) based upon advanced technologies in field-programmable logic devices. Topics include general RC concepts, device architectures, design tools, metrics and kernels, system architectures, and application case studies. Credit Hours: 3

Course Pre-Requisites / Co-Requisites

Prereq: EEL4712C or EEL5764 or consent of instructor.

Course Objectives

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

Required Textbooks and Software

- No textbook is required.
- Xilinx Vivado WebPack
- Students will have remote access to Zynq-7000 ZedBoards installed on departmental servers.

Recommended Materials

- Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation, edited by Scott Hauck and Andre DeHon, Elsevier, Inc. (Morgan Kaufmann Publishers), Amsterdam, 2008. ISBN: 978-0-12-370522-8
- C. Maxfield, The Design Warrior's Guide to FPGAs, Newnes, 2004, ISBN: 978-0750676045.
- Research papers
- Vendor documentation

Course Topics:

I. General overview

- Goals and motivations
- History, state of the art, future trends
- Basic RC concepts and related fields of study
- Performance, power, size, and other metrics

II. RC devices and architectures

- FPGAs in general
  - Xilinx Zynq 7000 family programmable SOC (system on chip) in particular - hybrid device with ARM + FPGA architecture

- RC architectures in general
- ZedBoard platform
  - Zynq®-7000 All Programmable SoC XC7Z020-CLG484-1
  - Other key components in more detail
- Novo-G reconfigurable supercomputer
  - GiDEL board
- Other RC platforms
  - Amazon EC2 F1 Instances
  - Microsoft Catapult

III. Design tools and languages
- Hardware description languages, review VHDL
- Xilinx Vivado
- Synthesis, PAR, simulation, debug tools
- High-level synthesis (HLS) languages and tools
  - OpenCL, Vivado HLS, C-to-gates languages

IV. RC application development
- Compute models and system architectures: parallelism, systolic arrays, pipelining, optimizations, bottlenecks
- RC application domains and case studies
  - Machine learning, image processing, data analytics applications, computational biology, computational finance, others.
- Other topics
  - Hardware/software partitioning, numerical analysis, performance analysis and prediction, etc.

VI. Special topics in RC (guest lecturers from CHREC projects)
- Heterogeneous computing (HGC) for machine learning
- FPGA-based compute-near-memory (CnM) and compute-in-memory (CiM) architectures and applications
- Behavioral emulation of future-generation computing systems
- High-level synthesis (HLS) development & studies
- Device and app characterization
- Partial reconfiguration

Lab Experiments: A series of laboratory experiments (spanning the first half of the semester) will be assigned in synchronization with the topics covered in class lectures.

Research Project: Students will form teams of two to four students each and undertake a 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.

Attendance Policy, Class Expectations, and Make-Up Policy

Class attendance is not required, but highly recommended (lecture materials, software demonstration, etc. may not be available online or elsewhere).

Missed or late labs will be penalized, as specified in the lab assignment writeups. There are no scheduled makeup exams. Makeup exams are handled case-by-case, only for documented illness and emergencies.

Excused absences for exams must be in compliance with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations/) and require appropriate documentation.

Evaluation of Grades (eel 4720)

Assignment	Total Points	Percentage of Final Grade
Midterm Exam	100 pts	30%
Final Exam	100 pts	30%
Labs	100 pts each	15% (all labs)
Project	100 pts	25%

Evaluation of Grades (eel 5721)

Assignment	Total Points	Percentage of Final Grade
Midterm Exam	100 pts	30%
Final Exam	100 pts	30%
Labs	100 pts each	15% (all labs)
Project/Research Paper	100 pts	25%

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at: https://catalog.ufl.edu/graduate/regulations/

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor

Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students 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.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall*,* 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://care.dso.ufl.edu.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.