System-on-Chip Design
EEL 5934
Class Periods: TBD
Location: Classroom location
Academic Term: Spring 2021

Instructor:
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Office Hours: TBD

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website
- TBD

Course Description
The specification, design, implementation, and verification of complex hardware-software systems on chip. Overview of transaction-level modelling (TLM) with refinement down to register-transfer level (RTL). Review of state-of-the-art languages and tools and practice on an FPGA project. Credits: 3.

Course Pre-Requisites / Co-Requisites
- Digital Design and Microprocessor Applications

Course Objectives
The goal of this course is to provide the fundamentals of designing system-on-chip, from the high-abstraction level and refine it down to the implementation. The course will discuss and practice the various state-of-the-art languages and tools used in the industry. Course content is built around a complex SoC-Project (RC car with embedded FPGA, camera, and ultrasound sensors) that students will design, from the high-abstraction level using SystemC TLM and implement in the target FPGA-Platform.

Materials and Supply Fees
N/A

Required Textbooks and Software
- None

Recommended Materials
- TLM-Driven Design and Verification Methodology, Brian Bailey, Felice Balarin , Michael McNamara, Guy Mosenson, Michael Stellfox , Yosinori Watanabe, Publisher: lulu.com; 1ST edition (July 20, 2010), ISBN-10: 0557539064, ISBN-13: 978-0557539062
- ESL Design and Verification: A Prescription for Electronic System Level Methodology. Grant Martin, Brian Bailey, Andrew Piziali. Publisher: Morgan Kaufmannl; 1st edition, March 9, 2007 ISBN-10: 0123735513, ISBN-13: 978-0123735515
- Bashir M. Al-Hashimi (Ed.) , "System On Chip: Next Generation Electronics ", Institution of Engineering and Technology (January 31, 2006)
- SystemC-TLM: http://www.accellera.org/

Course Schedule

Week	Class Topic	Outcome
1	Introduction	• Trends in Computer Systems • SoC definition, benefits, challenges • Class objectives, syllabus, discussions • Homework (Basic SoC concepts, computing performance, cost, yield, etc of a given system)
2, 3	SoC Components	• Processing (CPU, Accelerators, IPs) • Memory and peripherals • On-chip interconnect • Homework (OpenCV tutorial + virtual hardware integration)
4,5	SoC-Implementation (ASIC, FPGAs)	• FPGA overview and System on FPGA with Xilinx/Intel • VLSI design overview • Homework (Practice of SoC with FPGA, performance measurement and documentation)
6	OS & Software Integration	• OS Basics, resource management, multithreading • Linux installation and configuration on a FPGA SoC • Homework (Practice of SoC with FPGA, multithreading, performance measurement and documentation)
7, 8	System-Level Design	• Models of computation • SystemC overview • Transaction-Level Modeling (initiators, transactors) • Homework (SystemC-TLM, Virtual prototyping with OpenCV+SystemC)
9,10	SoC Verification	• Overview of verification techniques • Verification flow • Verification tools (UVM, SCV) • Case Studies • Homework (SystemC-TLM, Virtual prototyping with OpenCV+SystemC, SCV, UVM)
11.12	SoC Security	• HW/SW Multi-Level Security • Overview of hardware security • IP protection, Encryption, etc… • Homework (Securing HW/SW with FLASK architecture)
13, 14, 15	Final Project	• Design of a camera-based autonomous RC-Car • Project (group of up to 5 students) • Homework (Implementation of a self-driving application starting from a virtual prototype OpenCV+SystemC, refinement down to FPGA, documentation)

Attendance Policy, Class Expectations, and Make-Up Policy
Excused absences must be in compliance with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations/) and require appropriate documentation.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Class Attendance		10%
Homework		30%
Review Exam		20%
Final Project		40%
		100%

- Homework will be mix of fundamental design problem and small project to practice concepts and tools presented in the class.
- Class participation is assess using random quizzes.
- The final exam will be provided in paper form and will cover the core concepts learned during the semester.
- The final project will use a RC car with embedded FPGA, camera, and ultrasound sensor. Students will use this platform to design an application, from the high-abstraction level using SystemC TLM and implement in the target FPGA-Platform.
- The final project will be conducted in a group of 4-5 students. Students will designate a leader in each group who will oversee the division of work. Each student will document his contribution to the project and will be graded accordingly.
- Project work will be equally distributed among participating students. The assessment of individual students in a group project will be done according to the level of participation of each student.

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	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:

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.