CSE 4356 System on Chip Design
CSE 5356 System on Chip Design
EE 4328 System on Chip Design
EE 5315 System on Chip Design
Fall 2021

Instructor Information

Instructor:
Bill Carroll, Ph. D.
Jason Losh, Ph.D.

Office Number:
ERB 521 (Carroll)
ERB 649 (Losh)

Office Telephone Number:
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Faculty Profile:
https://mentis.uta.edu/explore/profile/bill-carroll
https://mentis.uta.edu/explore/profile/jason-losh

Office Hours:
E-mail and virtual Q&A sessions in Teams.

Graders:
No grader is assigned to this course.

Course Information

Section Information:
CSE 4356-001, CSE 5356-001, EE 4328-002, and EE 5315-001

Time and Place of Class Meetings:
ERB 131, TTh 2:00 to 3:20 pm

Description of Course Content:
Design of FPGA-based system on chip solutions, including processor subsystems, FPGA fabric, processor to FPGA bridges, and device drivers. Prerequisite: C or better in CSE 3442, CSE 5400, or EE5314.

Student Learning Outcomes:
Upon successful completion of this course, students will have knowledge of:

- Knowledge of the architecture of FPGA-based SoC solutions
- Differences between soft- and hard-processor subsystems (HPS)
- Survey of common hard-processor subsystems
- Detailed knowledge of the DE1 SoC development board and environment
- Functional knowledge of the Quartus development platform
- Review of Verilog coding
- Development, coding, and testing of FPGA-only solutions
- Development, coding, and testing of HPS-only solutions
- Creating bridges from the processor to the FPGA fabric
- Designing CPU-accessible peripherals
- Designing clock-crossing with multiple and asynchronous clock domains
- Write Linux virtual memory and virtual file system interfaces
- Writing Linux device drivers for FPGA access
- Developing SoC real-world applications

Class Web Page:
Carroll: Course materials, assignments, videos, etc will be posted on Canvas.
Losh: Additional files will be provided at http://ranger.uta.edu/~jlosh/.

Communication:
Carroll: My primary communication link is email carroll@uta.edu. Course materials will be on Canvas.

Losh: All class-wide communication by the instructor, including distribution of homework sets, will occur via the class listserv. Please sign up for the CSE4356-L listserv by sending an e-mail from your UTA e-mail account to listserv@listserv.uta.edu from your UTA e-mail account (no subject line needed) and the command SUBSCRIBE CSE4356-L as the message body. You will then receive an e-mail from the listserv server to which you must acknowledge to join the listserv with "OK" in an e-mail.

Textbooks and Other Course Materials:
FPGA half of course:
Victor P. Nelson, Bill D. Carroll, H. Troy Nagle, and J. David Irwin, Digital Logic Circuit Analysis and Design, 2ed. New York: Pearson, 2021. Pearson eText, ISBN 9780135305706.

HPS/SoC half of course:
Extensive references, datasheets, application notes, and class notes will be provided on the course web site at http://ranger.uta.edu/~jlosh/.

Students will checkout a DE1-SoC kit and Analog Discovery 2 kit for the semester on Thursday, August 26. These kits must be returned no later than Friday, December 10 to prevent a grade and financial hold.

Major Assignments and Examinations:

Digital Labs:	Various lab assignments will be made during the semester.
Digital Test:	Tuesday, September 30
HPS/SoC Test:	Tuesday, November 23
HPS/SoC Project:	Tuesday, December 7

Technology Requirements:
Students will need a computer capable of accessing Canvas, Teams, and watching the Echo360 lectures. The computer and OS must be capable of running Intel Quartis Prime Lite 20.1.1.

Grading Information

Grading:

- Grade scale: A (90-100), B (80-89), C (70-79), D (60-69), and F (0-59)
- Grade calculation: Digital Test (20%), Digital Labs (20%), HPS/SoC Test (25%), HPS/SoC Project (35%)
- The instructor reserves the right to make reasonable changes in performance evaluation as needed.
- Any request for re-grading must be submitted to the Grader within one week of the completion of grading. If, after requesting a re-grade from the Grader and getting a response, you may refer the case to the instructor iif you think further action is needed.

Test:

- Tests are on-campus
- Test is open-book, open-notes, calculators allowed.
- No makeup will be provided for any test missed. Generally, you can request an incomplete in the course and makeup the missed test in the following semester.

Labs:

- Labs are individual assignments. Discussing lab topics is allowed, but the submissions must be unique. Sharing of code is not allowed.

Project:

- The projects will consist of hardware construction and firmware development and it is expected that it will take approximately 80 hours to complete.
- Projects teams will consist of 1 or 2 students. Discussing project topics is allowed, but the submissions must be unique to the team. Sharing of code is not allowed.
- Interim deadlines for the project will apply.

Course Schedule

- Syllabus overview, course objectives, course resource requirements (1 hr) [Carroll & Losh]
- Discussion of DE1-SoC kit and check out. (0.5 hrs) [Carroll & Losh]
- Review of combinational logic, Verilog, and Quartus. (1.5 hrs) [Carroll]
- Review of sequential logic, Verilog, and Quartus (3 hrs) [Carroll]
- Designing registers and register stacks (1.5 hrs) [Carroll]
- Designing FIFO buffers (1.5 hrs) [Carroll]
- Designing counters and frequency dividers (1.5 hrs) [Carroll]
- Designing clocks and timers (1.5 hrs) [Carroll]
- Using the Quartus Signal Tap Logic Analyzer (1.5 hrs) [Carroll]
- Designing fractional frequency dividers (1.5 hrs) [Carroll]
- Digital Exam/Test (1.5 hrs) [Carroll]
- Lab demos (1.5 hrs) [Carroll & Losh]
- Project introduction, selection of teams (0.5 hrs) [Losh]
- Project-specific lecture (SERDES design) (1.5 hrs) [Losh]
- Memory mapped interface (1 hr) [Losh]
- Using the Quartus Platform Design (was Qsys) (1.5 hr) [Losh]
- Designing a memory-mapped register interface (1.5 hrs) [Losh]
- Case study: Designing a GPIO peripheral (2 hrs) [Losh]
- Case study: Designing a quadrature encoder peripheral with multiple clock domains (2 hrs) [Losh]
- Case study: Designing a PWM peripheral (2 hrs) [Losh]
- Virtual memory interface (/dev/mem) (1 hr) [Losh]
- Virtual file system (/sys/class/*) kernel module design (1.5 hrs) [Losh]
- Higher-level kernel modules (1 hr) [Losh]
- Interrupts in Linux (1 hr) [Losh]

- Project-specific lectures (2.5 hrs) [Losh]
- HPS/SoC Test (1.5 hrs) [Losh]

The instructors reserve the right to make changes in the schedule as needed as the class progresses.

The official dates for registration, census, and dropping are available at www.uta.edu/acadcal.

Academic Integrity

This information is copied from http://www.uta.edu/conduct/academic-integrity/index.php.

The University of Texas at Arlington strives to uphold and support standards of personal honesty and integrity for all students consistent with the goals of a community of scholars and students seeking knowledge and responsibility. Furthermore, it is the policy of the University to enforce these standards through fair and objective procedures governing instances of alleged dishonesty, cheating, and other academic/non-academic misconduct.

Scholastic dishonesty includes, but is not limited to, cheating, plagiarism, and collusion on an examination or an assignment being offered for credit. Each student is accountable for work submitted for credit, including group projects.

- Cheating
  - Copying another's test or assignment (added note: remember this includes homework!)
  - Communication with another during an exam or assignment (i.e. written, oral or otherwise)
  - Giving or seeking aid from another when not permitted by the instructor
  - Possessing or using unauthorized materials during the test
  - Buying, using, stealing, transporting, or soliciting a test, draft of a test, or answer key
- Plagiarism
  - Using someone else's work in your assignment without appropriate acknowledgement
  - Making slight variations in the language and then failing to give credit to the source
- Collusion
  - Without authorization, collaborating with another when preparing an assignment

Institution Information

UTA students are encouraged to review the below institutional policies and informational sections and reach out to the specific office with any questions. To view this institutional information, please visit the Institutional Information page (http://www.uta.edu/provost/administrative-forms/course-syllabus/index.php) which includes the following policies among others:

- Drop Policy
- Disability Accommodations
- Title IX Policy
- Academic Integrity
- Student Feedback Survey
- Final Exam Schedule

Additional Information

Face Covering Policy:
While the use of face coverings on campus is no longer mandatory, all students and instructional staff are strongly encouraged to wear face coverings while they are on campus. This is particularly true inside buildings and within classrooms and labs where social distancing is not possible due to limited space. If a student needs accommodations to ensure social distancing in the classroom due to being at high risk they are encouraged to work directly with the Student Access and Resource Center to assist in these accommodations. If students need masks, they may obtain them at the Central Library, the E.H. Hereford University Center's front desk or in their department.

Academic Integrity
Students enrolled in UT Arlington courses are expected to adhere to the UT Arlington Honor Code.

I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.

I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

UT Arlington faculty members may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents' Rule* 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

Attendance
At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator of student success. Each faculty member is free to develop his or her own methods of evaluating students' academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, I expect you to attend class and attendance will be checked on a regular basis. Those with excessive absences from the lecture and/or laboratory may have their final grade reduced appropriately. However, while UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients "begin attendance in a course." UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report must the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Canvas. This date is reported to the Department of Education for federal financial aid recipients.

The lectures are taught face-to-face. You are expected to attend the lectures. The project will be defended on-campus demonstration on the defense date.

Emergency Exit Procedures
Should we experience an emergency event that requires evacuation of the building, students should exit the room and move toward the nearest exit, which is located straight ahead as you exit ERB 126 and 127. Please refer to evacuation route maps in each room for more details. When exiting the building during an emergency, do not take an elevator but use the stairwells instead. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

Academic Success Center

The Academic Success Center (ASC) includes a variety of resources and services to help you maximize your learning and succeed as a student at the University of Texas at Arlington. ASC services include supplemental instruction, peer-led team learning, tutoring, mentoring and TRIO SSS. Academic Success Center services are provided at no additional cost to UTA students. For additional information visit: Academic Success Center. To request disability accommodations for tutoring, please complete this form.

The IDEAS Center (https://www.uta.edu/ideas/) **(**2nd Floor of Central Library) offers **FREE** tutoring and mentoring to all students with a focus on transfer students, sophomores, veterans and others undergoing a transition to UT Arlington. Students can drop in or check the schedule of available peer tutors at www.uta.edu/IDEAS, or call (817) 272-6593.

The English Writing Center (411LIBR)
The Writing Center offers **FREE** tutoring in 15-, 30-, 45-, and 60-minute face-to-face and online sessions to all UTA students on any phase of their UTA coursework. Register and make appointments online at the Writing Center (https://uta.mywconline.com). Classroom visits, workshops, and specialized services for graduate students and faculty are also available. Please see Writing Center: OWL for detailed information on all our programs and services.

The Library's 2nd floor Academic Plaza (http://library.uta.edu/academic-plaza) offers students a central hub of support services, including IDEAS Center, University Advising Services, Transfer UTA and various college/school advising hours. Services are available during the library's hours of operation.

Librarian to Contact
Each academic unit has access to Librarians by Academic Subject that can assist students with research projects, tutorials on plagiarism and citation references as well as support with databases and course reserves.

Emergency Phone Numbers

In case of an on-campus emergency, call the UT Arlington Police Department at **817-272-3003** (non-campus phone), **2-3003** (campus phone). You may also dial 911. Non-emergency number 817-272-3381.