CSCE 5983 Application Specific Integrated Circuit Design (3 credit hours), Elective

Co-listed as ELEG 587V Section 8

Catalog Description: ASIC design is taught with emphasis on industrial preparation. Topics include ASIC technologies, design entry, simulation, and synthesis. Advanced design methods and techniques are studied for cell based and gate array ASICs.

In this class, we will use Intel FPGA DE1-SOC with embedded ARM Cortex A9 core to prototype and verify the functionality of the ASIC chip. We will implement an ARM Cortex M0 core using Intel FPGA. Further, we will design an ASIC 8051 microprocessor with a 45nm technology process using Cadence, Synopsys, and Mentor Graphics CAD tools.

Prerequisites: CSCE 4213 Computer Architecture or ELEG 3924 Microprocessor Systems Design with a grade of C or better.

Textbook / Required material: There is no required textbook for this course. Course notes for all lectures will be used. However, the following books are recommended:

- CMOS VLSI Design: A Circuits and Systems Perspective, Neil Weste and David Harris, 2011, ISBN 978-0321547743
- Hands-on Experience with Altera FPGA Development Boards, Jivan S. Parab, Rajendra S. Gad, G.M. Naik, Springer, ISBN 978-8132237679
- A Practical Introduction to Hardware/Software Codesign, Patrick R. Schaumont, Springer 2013, ISBN 978-1441959997
- Digital VLSI Chip Design with Cadence and Synopsys CAD Tools, Erik Brunvand, Pearson, 2010, ISBN 978-0321547996

Goals: The goal is for students to learn advanced learn advanced ASIC design concept and the practical aspects of Hardware-Software Codesign techniques, including FPGA prototyping with embedded ARM Cortex-A9 IP core, circuit analysis and logic design, data path elements design and memory block usage, architecture and SOC design, ASIC design techniques for timing optimization and low power computing, and ASIC processor design including 8051 processor design.

Student Learning Outcomes. By the end of this course, students will be able to:

- Understand the theory and modeling of the basic factors affecting the design: performance, power, area, and cost.
- Use FPGA and embedded soft IP cores to prototype ASIC designs
- Write testing programs and simulate the functionality of ASIC chips
- Design data path units and memory subsystem
- Understand the tradeoff in architecture design
- Design and Layout large scale digital integrated circuits
- Optimize propagation delay in CMOS digital circuitry on an integrated circuit chip
- Use CAD tools to simulate, synthesis, layout and verify ASIC designs

Topics covered:

- Introduction to ASIC Designs (1 week)

- ASIC Prototyping with FPGA Board (1 week)
- Using an ARM Cortex-A9 System (1 week)
- Using Logic Instructions with the ARM Processor (1 week)
- Using C code with the ARM Processor (1 week)
- Design and Optimization of Static CMOS Gates (1 week)
- Design of Flip-Flops, Latches, and Sequential Circuits (1 week)
- Datapath Element Design for Synchronous Circuits (1 week)
- Memory Block Design (1 week)
- Synthesis and Simulation (1 week)
- Physical Design (1 week)
- Parasitic Extraction and RC Delay Model (1 week)
- Static Timing and Power Analysis (1 week)
- Economy and Scaling (1 week)

Grading

The grading in this course will be distributed as follows.

- Class Attendance and Participation: 10%
- Homework and Design Assignment: 40%
- Midterm Exams: 20%
- Final Project: 30%

Academic Dishonesty Policy

As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail. Each University of Arkansas student is required to be familiar with and abide by the University's 'Academic Integrity Policy' at honesty.uark.edu. Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor.

Class/laboratory Schedule: Meets either 3 times a week for 50 minutes or 2 times a week for 75 minutes for 15 weeks.

Course Website:

You must check these websites on a regular basis for most up-to-date information!

- Main Website:
  - Including course materials, grades, and reports
  - https://e3da.csce.uark.edu/teaching/CSCE5983
- Blackboard:
  - Used for announcement and assignment submission
  - Make sure to turn on email notifications

    - https://learn.uark.edu/
- Piazza Q&A Forum:
    - Used for FAQs and Student discussion
    - https://piazza.com/class/CSCE5983

Absences:

You must notify the instructor via email if you are not able to attend a test or will be late with an assignment. You are to notify the instructor **before** the test or assignment due date if at all possible. Excused absences are allowed with a **written** record for illness, death of a family member, and other reasonable emergencies. For student sickness, you can use the course absence form after visiting a doctor or Pat Walker Health Center:
http://e3da.csce.uark.edu/teaching/download/class_absence.pdf

Academic Honesty:

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Emergency Preparedness:

Many types of emergencies can occur on campus; instructions for specific emergencies such as severe weather, active shooter, or fire can be found at emergency.uark.edu. The University of Arkansas has a campus-wide alert system for any hazardous conditions that may arise on campus. To learn more and to sign up: http://safety.uark.edu/emergency-preparedness/emergency-notification-system/

Inclement Weather:

If the university is officially closed, class will not be held. When the university is open, you are expected to make a reasonable effort to attend class, but not if you do not feel that you can get to campus safely. Any changes to due dates or the class schedule will be communicated via email to your uark email address.

Academic Support:

University of Arkansas Academic Policy Series 1520.10 requires that students with disabilities are provided reasonable accommodations to ensure their equal access to course content. If you have a documented disability and require accommodations, please contact me privately at the beginning of the semester to make arrangements for necessary classroom adjustments. Please note, you must first verify your eligibility for these through the Center for Educational Access

(contact 479–575–3104 or visit http://cea.uark.edu for more information on registration procedures).

Relationship of course to ABET Computer Engineering Student Outcomes:

- CE1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- CE3. An ability to communicate effectively with a range of audiences.
- CE6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Relationship of course to ABET Computer Science Student Outcomes:

- CS1. An ability to analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
- CS3. An ability to communicate effectively in a variety of professional contexts.

Relationship of course to ABET Computer Science Topics:

- T6. Computer architecture and organization.
- T11. A major project that requires integration and application of knowledge and skills acquired in earlier course work.

Prepared by: Yarui Peng **Date**: 12/10/19