

EE/CMPEN 417 – Digital Design Using Field Programmable Devices

Designation: EE elective course for electrical and computer engineering majors.

University Bulletin Description: EE/CMPEN 417: (3) Field programmable device architecture and technologies; rapid prototyping using top down design techniques; quick response systems.

Prerequisite: CMPEN 331.

Textbooks:

Application-Specific Integrated Circuits, M. J. S. Smith, Addison-Wesley, 1997

Advanced Digital Design with Verilog HDL, M. Ciletti, Prentice Hall

Online Course Documentation provided through Penn State Course Management System

Course Objectives:

This course introduces the design and implementation of digital circuits using modern FPGA architectures using synthesizable HDL exploiting various features of state-of-the-art FPGA design flow. Through lectures and laboratory assignments, students are provided learning experiences that enable them to accomplish the course outcomes as listed below.

Course Outcomes:

Upon completion of the course, students should possess the following knowledge and skills:

An understanding of the design options to implement digital systems in hardware and their cost benefit tradeoffs.

The ability to specify and synthesize a digital system using hardware description language (e.g., either VHDL or verilog) and proprietary design tools (such as Xilinx ISE software).

An understanding of the design and functioning of a Field Programmable Gate Array (FPGA) architecture

The ability to apply reliability-enhancing and low-power design techniques in realizing FPGA implementations of digital systems

Required Topics (38 hrs):

1. Overview of chip design options (~ 2 hrs)
2. Programmable logic circuits and rapid prototyping (~ 2 hrs)
3. FPGA Programming technology and programming (~ 4 hrs)
4. CAD tools and design flow (~ 5 hrs)
5. Synthesizable HDL (~ 6 hrs)
6. FPGA Architecture (~ 4 hrs)
7. HDL Performance Optimizations for FPGAs (~ 4 hrs)
8. Power-Aware Design Techniques (~ 2 hrs)
9. Reliability-Aware Design Techniques (~2 hrs)
10. Embedded System Design using FPGA (~4 hrs)
11. Review and exams (~3 hrs)

Professional Component:

CSE 478 provides a design emphasis in the area of digital, computer, and electronic circuits. It is designed for the senior-level system designing. Topics pertaining to economics and time-to-market analysis are considered in the context of electronic and computer product development.

Class Format: Two lectures per week; each lecture is 75 minutes. 5 lectures are held in the laboratory to provide hands-on-tutorials to students. Students work in an unsupervised, open lab to complete assignments/projects.

Laboratory projects and/or assignments:

Approximately seven design projects are assigned. Each student team is assigned with take-home FPGA board, PC parallel port cable, and a power supply unit. Design and debugging can be done inside or outside of the laboratory but the project demonstrations must be in the laboratory.

Contribution to Meeting the Requirements of Criterion 5. Curriculum:

This course contributes to both the engineering topics and design components.

Relationship to Program Outcomes:

- O.1.1. Graduates will possess mathematics skills necessary for electrical engineering.
- O.1.3. Graduates will have attained computer proficiency.
- O.2.1. Graduates will understand how to analyze and design simple electrical/electronic circuits.
- O.2.5. Graduates will have knowledge of digital systems.
- O.3.1. Graduates will have in-depth technical knowledge in one or more areas of specialization.
- O.3.2. Graduates will have practical understanding of the major electrical engineering concepts and demonstrate application of their theoretical knowledge of the concepts.
- O.4.1. Graduates will interact with industry both within and outside of a classroom setting.
- O.5.1. Graduates will have good teamwork skills.
- O.5.2. Graduates will possess good oral and written communication skills.

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