

CMPEN/EE 417
Digital Design Using Field Programmable Devices
Elective Course in Computer Engineering

Catalog Data: Digital Design Using Field Programmable Devices (3)
Field programmable device architecture and technologies; rapid prototyping using top down design techniques; quick response systems. Prerequisite: CMPEN 331.

Typical Textbook: *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.

Primary 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.

Relationship to Undergraduate Program Outcomes:

This course supports the following program outcomes:

- Design of the electronic/logic circuits that form the basic building blocks of a computer system.
- Analyze the performance of hardware systems using simulation methods.
- Use probabilistic and statistical methods to evaluate the performance of software and/or hardware system.
- Design of the organization and architecture of the basic components of a computer system.
- Demonstrate basic laboratory skills, including the use of standard laboratory equipment.
- Demonstrate independent learning by using unfamiliar computer systems and software tools to solve technical problems.
- Write clear and effective technical prose for a technical audience.
- The ability to discuss major trends in industry and current research activities within computer architecture design.

Required Topics:

Overview of chip design options (~ 2 hrs)
Programmable logic circuits and rapid prototyping (~ 2 hrs)
FPGA Programming technology and programming (~ 4 hrs)
CAD tools and design flow (~ 5 hrs)
Synthesizable HDL (~ 6 hrs)
FPGA Architecture (~ 4 hrs)
HDL Performance Optimizations for FPGAs (~ 4 hrs)
Power-Aware Design Techniques (~ 2 hrs)

Reliability-Aware Design Techniques (~2 hrs)
Embedded System Design using FPGA (~4 hrs)
Review and exams (~3 hrs)

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.

Professional Component: CMPEN/EE 417 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.

Evaluation: ~50% proctored assessments (exams)
~50% unproctored assignments (homeworks, programming projects)

Suggested breakdown based of 100 pts as follows:

15	Exam 1
15	Exam 2
15	Final
50	Homeworks and Lab projects
5	Quizzes

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.

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