CMPEN 471
Logical Design of Digital Systems
Elective Course for Computer Engineering

Catalog Data: Logical Design of Digital Systems (3)
Basic switching theory and design of digital circuits, including combinatorial, synchronous, sequential, and asynchronous sequential circuits. Prerequisite: CMPEN 331.


Course Objectives: This course introduces the analysis, design, and implementation of digital circuits and systems using the state-of-the-art CAD tools and programmable chips. Students will obtain sound knowledge and skills of digital system specification, design process, and use of modern CAD tools. Through lectures, projects, and homework 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:

- The ability to analyze and design optimized complex combinatorial circuits in both transistor and gate level.
- The ability to analyze and design optimized synchronous digital circuits.
- The ability to analyze and design optimized asynchronous sequential circuits.
- 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).
- The ability to design and implement a functioning microprocessor with CPU, memory, and I/O ports in a FPGA or a CPLD chip.
- An understanding of the design options to implement digital systems in hardware and their cost benefit tradeoffs.

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.
- Design of the organization and architecture of the basic components of a computer system.
- Demonstrate independent learning by using unfamiliar computer systems and software tools to solve technical problems.
- The ability to discuss major trends in industry and current research activities within computer architecture design.
- An ability to apply knowledge of mathematics, science, and engineering.
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- An ability to identify, formulate, and solve engineering problems.
- A knowledge of contemporary issues.
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
Required Topics:  
(38 hours)

- Modern Digital Design & CAD Tools: VHDL (3 Hours).
- Combinational Circuit Analysis & Optimization (6 Hours).
- Optimum Multiple-Output Circuit Design (3 Hours).
- Optimal Function Implementation in CMOS, nMOS, & TTL Technologies (3 Hours).
- Multilevel Design & Complex Functions (3 Hours).
- Sequential Circuit Analysis (3 Hours).
- Synchronous Sequential Circuit Design and Optimization (6 Hours).
- Incompletely Specified Sequential Circuits (3 Hours).
- Level Mode Circuit Design and Optimization (3 Hours).
- Test Generation for VLSI (3 Hours).
- Complex System Design and Implementation (3 Hours).
- Examinations (3 Hours).

Class Format: Two lectures per week; each lecture is 75 minutes. Students work in an unsupervised, open lab/home to complete projects/assignments.

Projects and/or assignments – Approximately seven design projects are assigned. Each student completes projects on their own computer with downloaded CAD tool or the department laboratory computer with pre-installed CAD tool. Design and debugging can be done inside or outside of the laboratory but the project report must be submitted.

Professional Component: CMPEN 471 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 digital system and component design in the context of electronic and computer product development.

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

Suggested breakdown based on 100 pts as follows:  
15 Exam 1  
15 Exam 2  
20 Final  
40 Projects and Homeworks  
10 Quizzes

Author: Kyusun Choi  
Last Revised: January 30, 2008