Catalogue Description:
This course introduces digital systems design concepts. Topics include basic combinational building blocks and design methods to construct synchronous digital systems; alternative representations for digital systems; standard logic (SSI, MSI) vs. programmable logic (PLA, PAL); finite state machine design; digital computer building blocks as case studies; introduction to computer-aided design software in VHDL. The course also includes two projects, one combinational and one sequential.

Credit hours: 3 credits

Required or elective: Required for CCE/ECE students

Prerequisites:
- By Course:
  - EECE 210 Electric Circuits and Electronics
  - EECE 230 Introduction to Programming
- By Topic: Basic knowledge in Circuits, Electronics, and Programming Constructs


Course Objectives
To learn the fundamental principles needed to analyze and design digital logic circuits, both combinational and sequential. The course focuses on digital design methodologies and the use of computer-aided design tools. Also the students will learn how to interpret and write documentation for digital circuits.

Course Topics
1. Introduction (Ch. 1): Analog versus digital, Digital devices, Electronics and software aspects of digital design and Integrated circuits.
2. Number Systems and Codes (Ch. 2): Positional number systems, Octal and hexadecimal numbers, General positional number system conversions, Addition and subtraction of non-decimal numbers, Representation of negative numbers, Two’s complement addition and subtraction, Binary codes for decimal numbers, Gray code.
4. Hardware Description Languages (Ch. 5): HDL-based digital design, The VHDL hardware description language, Basic data types, Structural design elements, Behavioral design elements, Data flow design elements.

5. Combinational Logic Design Practices (Ch. 6): Circuit timing, PLDs, Decoder, Encoders, Multiplexers, Exclusive OR and parity circuits, Comparators, Adders, Subtractors and ALUs.

6. Sequential Logic Design Principles (Ch. 7): Latches and flip-flops, Clocked synchronous state machines, Designing state machines using state diagrams, VHDL sequential-circuit design features

7. Sequential Logic Design Practices (Ch. 8): Counters, Shift-registers.

8. Memory (Ch. 9): Read-Only Memory, Read/Write Memory SRAM, DRAM

**Course Learning Outcomes**

1. Work with binary number systems and arithmetic
2. Derive and manipulate switching functions
3. Interpret the specifications of digital systems and to implement corresponding systems
4. Analyze and design a combinational logic circuit
5. Optimize a combinational logic circuit
6. Analyze and design sequential logic circuits
7. Specify and implement finite state machines
8. Understand the logical functions of combinational building blocks for digital systems (gates, ALUs, decoders, encoders, de/multiplexers, PLAs, ROM, RAM, counters, registers, etc.)
9. Implement a digital system in a hardware description language.

**Class schedule:** Three 50-minute lectures per week

**Resources of the course:** Textbook, ModelSim, and Moodle

**Evaluation methods**

- Homework 10%
- Projects 20%
- Midterm 35%
- Final Exam 35%

**Professional Components**

Engineering topics: 90%
General education: 0%
Mathematics and basic sciences: 10%

**Person(s) who prepared this description and date of preparation**

Ali Chehab, February 2013