ECE/CS 3700: Fundamentals of Digital System Design

Credits and Contact Hours: 4.0 Credit Hours
15 weeks: Two 80-minute lectures + one 80-minute lab per week

Instructor's Name: Priyank Kalla

Text Book(s) and/or Required Material:

- S. Brown and Z. Vranesic, *Fundamentals of Digital Logic with Verilog Design*, Third Edition, McGraw-Hill, 2014

Catalog Description: Techniques for reasoning about, designing, minimizing, and implementing digital circuits and systems. Combinational (logic and arithmetic) and sequential circuits are covered in detail leading up to the design of complete small digital systems using finite state machine controllers. Use of computer-aided tools for design, minimization, and simulation of circuits. Laboratory is included involving circuit implementation with MSI, LSI, and field programmable gate arrays.

Prerequisites:

- C- or better in PHYS 2220: Physics for Scientists & Engineers II; and
  - C- or better in CS 1410: Intro to Object-Oriented Programming; or
  - C- or better in CS 2000: Intro to Program Design in C; and
- Full major status in Electrical Engineering or Computer Engineering

Designation: Required

Contribution of Course to Meeting the Requirements of ABET Criterion 5: This course teaches basic electrical and computer engineering concepts along with electrical engineering design, application of mathematical optimization concepts, and use of state-of-the-art computer-aided design tools to solve electrical engineering problems.

Specific Outcomes of Instruction: The objective of this course is to teach basic concepts related to digital logic; design, optimization, analyses, and synthesis of digital circuits and systems. Students will gain an understanding of: (1) basic binary Boolean algebra, (2) design of circuits that compute Boolean values, (3) design of systems that perform Boolean computations (combinational and sequential), (4) digital system design, and (5) use of CAD tools to model, analyze, and synthesize digital systems.

Relationship of the Course to the Program Outcomes:

(a) An ability to apply knowledge of mathematics, science, and engineering. Students apply knowledge of Boolean algebra to solve: (1) logical analyses, (2) design digital electronic systems, and (3) perform logic optimization using discrete mathematical optimization techniques.

(b) An ability to design and conduct experiments, as well as to analyze and interpret data. Students employ programming techniques via extensive use of CAD tools in labs for system

design and analyses. All labs require that data be collected, interpreted, and presented in a report.

(c) 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. Students design a digital system in a laboratory environment while performing optimization of the system (and/or its components) to minimize area of the implementation.

(i) A recognition of the need for, and an ability to engage in life-long learning. Students gain an understanding of the impact of technological advances in circuit design techniques and its effect on digital system characteristics such as performance, area, and power dissipation. Students understand the need to modify/update design methodologies and use of CAD tools vis-á-vis technology upgrades reflecting the need for differing optimization techniques required for different implementation technologies.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. As the digital design process has seen a lot of automation, understanding the use, capabilities and limitations of CAD tools is essential. Students gain such an understanding of CAD tools through their extensive use in lab and design experiments.

Topics Covered in the Course:

Some topics include:

- Logic functions, truth tables, Boolean algebra
- Transistors, CMOS logic, FPGASs + Synthesis, Verilog Intro
- Boolean optimization, algebra + K-maps, Q-M method
- Multi-level logic + CAD, number representation, adders
- Multipliers, ASCII, BCD, decoders + demuxes
- Combinational logic conclusions, sequential Ckt, latches, flip-flops
- Finite state machines (FSM), optimizations, analysis, and applications
- Advanced digital design concepts, CPU design
- Asynchronous circuits, CAD aspects of digital design concepts such as synthesis, testing, and verification