CS/ECE 5740: Computer-Aided Design of Digital Circuits

Credits and Contact Hours: 3.0 Credit Hours
15 weeks: Three 50-minute lectures per week

Instructor’s Name: Priyank Kalla

Text Book(s) and/or Required Material:

Catalog Description: Introduction to theory and algorithms used for computer-aided synthesis of digital integrated circuits. Topics include algorithms and representations for Boolean optimization, hardware modeling, combinational logic optimization, sequential logic optimization, and technology mapping. Undergraduate students only.

Prerequisites:
- Full major status in Computer Science or Computer Engineering; and
- C- or better in (C- 3700 or ECE 3700)

Designation: Elective

Contribution of Course to Meeting the Requirements of ABET Criterion 5: Engineering sciences and engineering design: Students learn the science and engineering of electronic design automation and study how CAD techniques are engineered for VLSI circuit synthesis and optimization.

Specific Outcomes of Instruction:
1. The course will describe techniques, algorithms and methodologies for Physical Design Automation. Mathematical models of VLSI layouts and algorithms for their optimization will be studied. These issues will also be addressed through a graph-theory and a mathematical optimization perspective. Stochastic techniques such as Simulated Annealing will also be used for problem solving. In addition to HWs and programming assignments, students will also have to undertake a term project studying a physical design problem.

Relationship of the Course to the Program Outcomes:
(a) An ability to apply knowledge of mathematics, science, and engineering. The students must apply knowledge for their digital logic design course as well as their programming and algorithms courses to solve software problems that are specific to the area of computer-aided design for VLSI.

(c) An ability to design a system, component, process or software package to meet desired needs. Students must complete a project in which they design a CAD tool to solve a particular problem based on a research paper of their choosing.
(e) An ability to identify, formulate and solve engineering problems. Again, the project in this course requires the students identify, formulate, and solve an engineering problem.

(g) An ability to communicate effectively in written and oral form. Students must write a high-quality technical paper describing the results of their project.

(i) A recognition of the need for, and an ability to engage in life-long learning. Students must read and recreate results from a research paper during their project. This helps students learn how to extract results from technical publications. This is a skill that is very important in lifelong learning.

(j) A knowledge of contemporary issues. This course is on the cutting edge of current research. The text draws from numerous recent publications in the field and the lectures include discussion of ideas that have surfaced since the publication of this book. Students should get a keen awareness of the current research problems in this area.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. Students must use modern design methods and tools to solve problems in this course.

Topics Covered in the Course:
- Graph Theory and Mathematical Optimization
- Partitioning
- Floorplanning and Placement
- Global Routing
- Channel Routing
- Clock-Tree Routing and Timing Closure
- Advanced Concepts such as Quadratic Optimization, Lagrange Multipliers, Quadratic Programming with Linear Constraints, GORDIAN Placer, Lagrangian Relaxation, Complementary Slackness, Duality Theory, and Global Routing via Integer Programming (GRIP)