ECE 462 - Logic Synthesis

Instructors:
The course it taught by Professor Shobha Vasudevan. She has prior industry experience and thus knows how the course material relates to work after school.

Prerequisites:
The course is cross-listed as CS 462 and MATH 491. The prerequisite is ECE 220 or CS 233. ECE 220 is definitely necessary, as all topics build upon the digital logic design material.

When to Take It:
ECE 462 is only offered in the fall. Many of the topics such as logic optimization and finite state machines are carried over from ECE 220. It is especially important to remember the logic design concepts taught in ECE 220, so taking this class soon after taking 220 is advisable, though the important part is remembering how to use concepts from 220 (ECE 385 and ECE 411 may help in this respect). Knowledge of hardware design will help you appreciate the concepts in this course, but is not necessary to do well, as algorithms used by electronic design automation (EDA) tools are the main focus of the course, along with post-silicon testing.

Students who have taken CS 225 (Data Structures) may be disappointed to find that, although this course is primarily about algorithms, no big-O analysis is done. Students who have taken CS 374 (Intro to Algorithms) will notice quite a bit of overlap between Finite Automata (in CS 374) and Finite State Machines, though this isn't a large portion of the course. More notably, the occasional proofs required by this class are usually nowhere near as difficult as those required in CS 374.

Class Content:
Although many students come into this class expecting ECE 220 part 2, this class really isn't so much an extension to ECE 220 as a tangent to it; it's not so much about advanced logic design techniques, but rather focuses on algorithms used in EDA tools (such as Quartus II, used in ECE 385) to automatically minimize the logic for combinatorial and sequential circuits. Additionally, some time is spent on teaching students the basics of equivalence checking and post-silicon testing. If you are look for advanced logic design techniques, chances are the class you want is ECE 411 (Computer Organization and Design).

The course begins with logic optimization, starting with K-maps from ECE 290 and discussing algorithms for optimization such as the Quine-McCluskey method - a lot of time is spent discussing this algorithm (despite it's high computational complexity and thus, questionable utility); binary decision diagrams, which are data structures that represent combinatorial functions, will also be discussed in depth, along with the boolean algebra concepts they are based on. Then finite state machine optimization and algorithms to compare two finite state machines are discussed. The class also covers hardware verification techniques used before a circuit is fabricated. Fault detection and correction is then discussed in the context of post-silicon testing, and algorithms to produce tests for faults are discussed. Finally, the class covers technology mapping, which involves optimizing logic (for area or for timing) using a predefined set of logic gates, and multi-level logic synthesis.

Work:
The course has a light workload compared to other 400-level ECE electives, requiring on average 5-10 hours per week to finish homework and review material from lecture. As of Fall 2012, the homework starts out being due every Thursday, but after the first exam two weeks are given for each assignment instead of one. Homework assignments typically involve working through algorithms by hand or doing some simple boolean-algebra proofs; occasionally tougher proof problems or algorithm design problems appear. Students are allowed to work together on the assignments, in groups of at most 3. In the past, the course had no labs or MPs, but in Fall 2014 extra homework problems using the Berkeley ABC logic software were assigned each week for students to work with the logic algorithms learned in class.

ECE 462 has two midterms and a final. The problems given on these exams are similar to the ones given in the homework, and are for the most part straightforward. However, there are a couple of proofs on each exam, which can be difficult to prepare for but are not graded very harshly and do not make up a large portion of the exam. Overall, the course is designed to be a fairly small weekly time commitment.

Life After:
ECE 462 is one of the few courses that teaches students the algorithms used in EDA tools, as well as verification and testing. Anyone considering a career in verification and testing, hardware design, or EDA software design would benefit from ECE 462. Additional work related to digital verification and testing is offered as a section of ECE 498 - Special Topics, the most recent occurrence of this was Fall 2013.