Course Description

This course introduces students to the basic concepts of digital systems, including analysis and design. Both combinational and sequential logic will be covered. Students will gain experience with several levels of digital systems, from simple logic circuits to programmable logic devices and hardware description language.

Course Overview

This is the fundamental course in electrical and computer engineering. This course will provide the fundamental background needed to understand how digital systems work and how to design digital circuits.

We begin by covering the mathematical concepts necessary in the study of digital systems. We will then move onto studying digital gates and how they work. We will design and analyze combinational circuits, and show how to construct the minimal (least number of gates) circuit necessary to implement a specific function. We will then move on to sequential circuits which add a concept of memory or feedback to the combinational design. We will analyze and design these circuits. Finally, we will look at common electronic components (such as counters and shift registers) and then look into programmable logic devices. Throughout the course, we will use verilog HDL to analyze and simulate digital systems.

This course will stress fundamentals. We will pay particular attention to design principles and techniques, timing analysis, and finite state machines. The concepts covering in this class are needed in other courses in electrical and computer engineering. It is imperative that these concepts are well understood.

The material covered in this course is not hard, but it does require significant amounts of effort. Be prepared to work hard and come out of this course with a good knowledge of the fundamentals of digital systems. Just like with anything worthwhile in life, if you aren’t willing to put in the time and effort, you won’t ever become good at it. Be prepared to devote considerable time and effort to this class.
Course Topics

- Binary number systems, number representations, and codes
- Boolean algebra Boolean functions
- Logic gates and circuits
- Logic simplification using Boolean algebra and Karnaugh maps
- Combinational logic design and building blocks
- Synchronous sequential logic design and state machines
- Latches, flip-flops, registers and counters
- Programmable logic
- Memory basic
- Verilog programming (verilog simulation tool)

Course Learning Objectives (CLO)

Students completing this course should be able to

1. represent and manipulate decimal numbers in different coding systems and convert decimal numbers between different positional number systems including decimal, binary (unsigned, signed-magnitude, and two's complement), hex, and octal.

2. do negation and addition in the two’s complement number system, and detect overflow.

3. express and simplify logic expressions using the theorems of Boolean algebra and Karnaugh maps.

4. find the minimal sum-of-products (SOP) and product-of-sums (POS) expressions, and create a corresponding circuit from AND, OR, NAND, and NOR gates.

5. analyze and design combinational and sequential digital systems and use standard combinational and sequential digital building blocks including adders, multiplexers, decoders, encoders, and registers.

6. analyze and design clocked synchronous state machines.

7. analyze a schematic of a combinational logic circuit and write its logic function.

8. understand the functionality of common digital building blocks including multiplexers, decoders, encoders, and comparators. Know how to use them to implement logic functions.
9. calculate the propagation delays through a circuit and draw a timing diagram.

10. design and simulate digital circuits using Hardware Description Language (HDL).

11. describe—in gate-level modeling, dataflow modeling, and behavioral modeling—and implement the functionality of digital systems (e.g., logic and arithmetic functions, flip-flops, registers and counters, and state machines) in Verilog.

12. write proper lab reports, communicating their objectives, approach, observations, and conclusions.

13. design various arithmetic, logic, and memory components, e.g., ALUs, shifters, decoders, multiplexers, RAMs, and ROMs;

Course Information

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Prerequisite

EE 311

Textbook


Grading

The course has two midterm exams and a final exam, weekly homework assignments and labs. In addition, quizzes (in class quizzes, pop quizzes or online quizzes) will be given during the semester. Your homework should reflect your individual work. Labs will be done in groups of 2-3. Grading will follow approximately the divisions shown below.

- Assignments 10%
- Labs 20%
- Quizzes (in class quizzes, pop quizzes or online quizzes) 10%
Midterm Exams $2 \times 15\%$
Final Exam $30\%$

Exams will be cumulative, but will focus on the most recent material.

Class Web Page

We shall use Moodle for this class. Moodle is a Course Management System (CMS) which helps to communicate outside of the classroom. Students in this class should visit the site http://ece.kau.edu.sa/moodle and create an account. This site contains information about the class - syllabus, homework list, due dates for assignments, links to other web sites, etc. In addition, we shall also use it for discussion and questions about the material covered in the course.

For each course, students should register for that course on the moodle site. Registration is enabled by a key that will be given to students in class during the first lecture. You have to notice that registration for the course does not automatically entail registration on the moodle site and vice versa.

Tips for Success in this Class

- Don't miss class. New material is covered each lecture. If you miss class, you are responsible for covering the missed material on your own. Repeat lectures will not be given during office hours.

- Read in advance. The reading assignments are listed in the next section. Your textbook author has written many digital design and computer engineering texts, and your text in particular is considered one of the most "readable" in print. The argument "but the book is difficult to read" receives very little respect in any forum.

- Start homework early. Give yourself some time to consider the problems and determine whether or not you need instructor assistance. Last-minute questions are a bad idea.

- Don't ignore the homework, and quizzes. They comprise 20% of your grade!

- Ask questions. This includes during class, during discussions, and during office hours. I don’t like a silent class —feel free to ask questions or make reasonable comments at will (but no distracting side conversations).

- Don’t arrive late for class. If you know you’ll be delayed (or absent) for some reason, just let me know ahead of time in person or via e-mail. It’s the courteous and adult thing to do.
Policies

- All assignments will be due at the beginning of the class on the due date. No late submissions will be accepted unless a valid excuse is given to the instructor by the day prior to the due date.

- You are expected to attend all classes. If you miss a class, you are responsible for finding out the material covered in that class. If you miss an exam, a grade of zero will be assigned, unless a valid excuse is given.

- All assignments are expected to be done by each student individually. Verbal and informal exchange of ideas is permitted, indeed encouraged. However, written solution should NOT be shown to another student or copied from another student. Any act of academic dishonesty will result in an F grade.