Course Information

Professor: Orlando Hernandez
Fall 2005: MR 10:00AM–11:20AM, W 9:00AM–9:50AM

Course Description: Analysis and design of digital systems including Boolean algebra, combinational and sequential circuit design, programmable logic devices, HDL, CMOS logic circuits and computer basics.

Office Hours: Mondays 4:00 PM – 5:20 PM
Thursdays 11:30 AM – 12:20 PM
By appointment (send me email)
And whenever my office door is open

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Corequisite: Computer Science I for Science and Engineering (CSC 215) or permission of the instructor.

Grading Policy: Homework 10%
Homework to be collected for grading will be announced for each chapter after the chapter has been covered, and it will be due one week after announcement.
Four Tests 40%
Comprehensive Final Exam 30%
Design Projects 20% (5% for each project)

Tips for Success: Read the book sections prior to their discussion in class.
Do as much homework as possible. Attempt to do all the problems, even the ones that have not been assigned.
Do not be shy about asking questions, either during class or outside of the class.

Tentative Agenda:

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Educational Objectives
(What TCNJ engineers should be able to accomplish during the first few years after graduation)

The School of Engineering at the College of New Jersey seeks to prepare its graduates:

- To contribute to the economic development of New Jersey and the nation through the ethical practice of engineering;
- To become successful in their chosen career path, whether it is in the practice of engineering, in advanced studies in engineering or science, or in other complementary disciplines;
- To assume leadership roles in industry or public service through engineering ability, communication skills, teamwork, understanding of contemporary global and socio-economic issues, and use of modern engineering tools;
- To maintain career skills through life-long learning and be on the way towards achieving professional licensure.

Electrical and Computer Engineering Program Outcomes
(What TCNJ Electrical and Computer Engineering students are expected to know and be able to do at graduation. What knowledge, abilities, tools and skills the program gives the graduates to enable them to accomplish the Educational Objectives)

The Program Outcomes listed below are expected of all graduates of the Electrical or Computer Engineering Program.

ECE graduates will have:

a. an ability to apply knowledge of mathematics, science and engineering;

b. an ability to design and conduct experiments, as well as to analyze and interpret data;

c. an ability to design a system, component, or process to meet desired needs;

d. an ability to function in multidisciplinary teams;

e. an ability to identify, formulate and solve engineering problems;

f. an understanding of professional and ethical responsibility;

g. an ability to communicate effectively;

h. the broad education necessary to understand the impact of engineering solutions in a global and societal context;

i. a recognition of the need for and an ability to engage in life-long learning;

j. a knowledge of contemporary issues;

k. an ability to use the techniques, skills and modern engineering tools necessary for engineering practice;

l. an ability to analyze and design complex electrical and electronic devices;

m. an ability to analyze and design software and systems containing hardware and software components.
Course Objectives:

Objective 1  To understand number system representations, binary codes, binary arithmetic and Boolean algebra, its axioms and theorems, and its relevance to digital logic design. [a, e, l, m]

Objective 2  To understand and apply the representations, design methodologies, and computer-aided design tools for combinational and sequential circuits. [c, e, k, l, m]

Objective 3  To introduce the student to digital systems design using State Machine design, CMOS Logic and a hardware description language like VHDL or Verilog. [c, e, k, l, m]

Objective 4  To expose students to laboratory safety, group interaction, and technical writing. [b, d, g]

Topics Covered:  
1. Design and Analysis  
2. Binary Systems and Logic Circuits  
3. Boolean Algebra and Mapping Methods  
4. Logic Function Realization with MSI Circuits  
5. Flip-Flops, Counters, and Registers  
6. State Machines  
7. Synchronous State Machine Design  
8. Interfacing and Design of Synchronous Systems  
9. Analog-to-Digital and Digital-to-Analog Converters  
10. Digital Hardware  
11. First concepts in VHDL or Verilog  
12. CMOS Logic Circuits

Evaluation:  
A. Examinations  
B. Homework  
C. Laboratory/Design Reports  
D. Group Activities

Performance Criteria:*

Objective 1  
1. Students will demonstrate knowledge of binary number theory, Boolean algebra and binary codes. [A, B, C]  
2. Students will understand MSI-level combinational logic components such as adders, decoders, encoders and multiplexers. [A, B, C]  
3. Students will understand MSI-level sequential logic components such as registers, shift registers and counters. [A, B, C]

Objective 2  
1. Students will understand and apply the methods of sequential logic design, starting with a high-level problem specification. [A, B, C]  
2. Students will understand and be able to explain the basic operation and organization of a computer including fetch-decode-execute, SPU, input/output, memory, bus, etc. [A, B]  
3. Students will have an introduction to hardware description language programming. [A, C]

Objective 3  
1. Students will be able to design and analyze synchronous finite state machines and their use in controllers and embedded systems. [A, B, C]  
2. Students will understand and be able to apply the representations, design methodologies and computer-aided design tools for combinational and sequential circuits. [A, B, C]

Objective 4  
1. Students must demonstrate that they can work effectively in teams and communicate experimental results clearly. [C, D]

* Small letters in brackets refer to the Program Outcomes
** Capital letters in brackets refer to the evaluation methods used to assess student performance
ENG 312: ADDITIONAL INFORMATION

1. DESCRIPTION OF DESIGN ACTIVITY

In the lab/design portion of this course, students start by getting familiar with the tools for digital logic circuits analysis and design. This portion of the course then culminates in a design experience, which comprises of the design of a state machine.

2. ENGINEERING STANDARDS

ASCII code and schematic symbols for logic gates.

3. REALISTIC CONSTRAINTS

**Economic:** Throughout the course, the economic tradeoffs between the different levels of integration of components used in digital logic design are addressed and discussed.  
**Health and Safety:** By working portions of this course in a lab environment and with hardware beyond that represented by a personal computer, students get an appreciation for working with equipment, in groups, and for the health and safety issues associated with working in such environment.

4. MODERN AND PROFESSIONAL ENGINEERING TOOLS USAGE

There is a main set of software tools used in this course. It is the Xilinx design package for Field Programmable Gate Arrays (FPGAs), which students use to design and simulate the design assignments of the course.

5. COMPUTER USAGE

Students use computers during the lab and design portions of the course to run the engineering tools, and to prepare reports on lab, design, and reading assignments.

6. FEEDBACK MECHANISMS

**Homework:** Homework problems are assigned and graded. Not all the problems are graded. These are selected randomly, but students do not know in advanced which problems are going to be graded, so they are behooved to do all assigned problems. These problems are a mixture of analysis and design problems.  
**Examinations:** Students are given three partial examinations and a comprehensive final one.  
**Laboratory and Design Reports:** Students are graded on laboratory and design reports, which include not only the technical aspects, but also the level of communication skills. There are at least two lab assignments and one design assignment.