

# **ENG312-01 Digital Circuits and Microprocessors**

The College of New Jersey

Fall 2015

**Instructor: Hibbert Duncan.**

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**Office Hours:** By appointment

## **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.

## **REQUIRED TEXT**

Digital Design, 5<sup>th</sup> Edition, by M. Morris Mano and Michael Ciletti.

Publisher: PEARSON Prentice Hall, 2013.

ISBN-13: 978-0-13-277420-8 ISBN-10: 0-13-277420-8

**CLASS SCHEDULE:** August 22nd to December 18th, 2015

Armstrong Hall 128

**TF 7:30 AM–9:20 AM**

## **COREQUISITE:**

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

## **READING ASSIGNMENTS AND HOMEWORK**

Reading the chapter prior to its introduction in class will facilitate your understanding of the material minimally by bringing important concepts to your attention, and allowing you to start formulating questions to be addressed in class. Students are encouraged and expected to complete reading assignments prior to attending each class. Assigned homework problems are also an integral part of the course, when assigned, is expected to be completed by the next scheduled Friday class.

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

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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

### **Educational Objectives**

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

The Department of Electrical and Computer 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;
- 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 programs give 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;**  
Students use binary math and Boolean algebra in homework problems, projects, and exams.
- b. **an ability to design and conduct experiments, as well as to analyze and interpret data;**  
Students perform projects that involve experimental hardware setups.
- c. **an ability to design a system, component, or process to meet desired needs;**  
Students perform projects that involve design.
- d. **an ability to function in multidisciplinary teams;**

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**Students do projects in teams that can involve EE, CoE, ME, and BME majors.**

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

**Students perform projects that involve the solution of engineering problems.**

- f. an understanding of professional and ethical responsibility;

- g. **an ability to communicate effectively;**

**Students write three Project Reports.**

- 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;**

**Students use the Xilinx ISE design tools, ModelSim, FPGAs, and CPLDs.**

### Tentative Class Schedules

Date	Topic/Activity	Reading
Week 1	<b>Digital Systems and Concepts</b> Number Systems Number Operations <b>Project and Design: Orientation</b>	Chapter1 1.1-1.6
Week 2	<b>Digital Systems and Concepts</b>  Binary Codes, Storage and Registers <b>Project and Design: Orientation</b>	Chapter 1 1.7-1.9
Week 3	<b>Boolean Algebra and Logic Gates</b> Axiomatic Definition of Boolean Algebra Theorems and Properties of Boolean Algebra <b>Project and Design: HDL Basics</b>	Chapter2 2.1-2.4
Week 4	<b>Boolean Algebra and Logic Gates</b> Boolean Functions and Standard Forms Digital Logic Gates and Integrated Circuits <b>Project and Design: HDL Basics</b>	Chapter2 2.5-2.9
Week 5	<b>Gate-Level Minimization</b> Algebraic Manipulation Karnaugh Maps <b>Project and Design: Introduction to Xilinx</b>	Chapter3 3.1-3.4
Week 6	<b>Gate-Level Minimization</b> <b>MID-Semester Exam I</b> Don't- Care Conditions <b>Project and Design: Introduction to Xilinx</b>	Chapter3 3.5-

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Week 7	<b>Gate-Level Minimization</b> Nand and Nor Implementation Exclusive-OR Function	Chapter3 3.6-3.8
Week 8	<b>Project and Design: Introduction to Xilinx</b> <b>Combinatorial Logic</b> Combinational Circuits Analysis Procedure	Chapter4 4.1-4.3
Week 9	<b>Project and Design: Combinational Logic Design</b> <b>Combinatorial Logic</b> Design and Implementation Combinational Logic Functions	Chapter4 4.4-4.8
Week 10	<b>Project and Design: Combinational Logic Design</b> <b>Combinatorial Logic</b> Functions of Combinational Logic	Chapter 4 4.9-4.11
Week 11	<b>Synchronous Sequential Logic</b> Sequential Circuits Latches and Flip-Flops	Chapter 5 5.1-5.4
Week 12	<b>Project and Design: Sequential Logic Design</b> <b>Synchronous Sequential Logic</b> Analysis of Clocked Sequential Circuits	Chapter 5 5.5-5.6
Week 13	<b>MID-Semester Exam II</b> <b>Project and Design: Sequential Logic Design</b> <b>Registers and Counters</b> Registers Ripple Counters	Chapter 6 6.1-6.3
Week 14	<b>Project and Design: Sequential Logic Design</b> <b>Registers and Counters</b> Synchronous Counters	Chapter 6 6.4-6.5
Week 15	<b>Project and Design: Sequential Logic Design</b> <b>Register Transfer</b> Register Transfer Level Algorithmic State Machines	Chapter 8 8.1-8.2 8.4-8.5

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## Project and Design: Presentations

Week 16

Revision Class

Final Examination

## ACADEMIC INTEGRITY

The College's Academic Integrity Policy will be strictly enforced.

TCNJ's academic integrity policy: <http://www.tcnj.edu/~academic/policy/integrity.html>

## ATTENDANCE POLICY

Attendance is essential. Students are expected to be present for all classes. Students who miss a class are expected to contact a fellow student to obtain notes from the missed class.

TCNJ's attendance policy: <http://www.tcnj.edu/~recreg/policies/attendance.html>.

## GRADING:

3 or 4 Quizzes (based on home work)	15%
2 – Mid Semester Exams	35%
Lab/Design Projects	20%
Final Exam	30%

## GRADING SCALE

A	(94% - 100%)	C	(73% - 75%)
A-	(90% - 93%)	C-	(70% - 72%)
B+	(86% - 89%)	D+	(66% - 69%)
B	(83% - 85%)	D	(60% - 65%)
B-	(80% - 82%)	F	(<60%)
C+	(76% - 79%)		

## Americans with Disabilities Act (ADA) Policy

Any student who has a documented disability and is in need of academic accommodations should notify the professor of this course and contact the Office of Differing Abilities Services (609-771-2571). Accommodations are individualized and in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1992.

TCNJ's Americans with Disabilities Act (ADA) policy: <http://www.tcnj.edu/~affirm/ada.html>

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