CENG 244/244L: Introduction to Digital Systems

CATALOG DATA:

CENG 244/244L – Introduction to Digital Systems: (3-1) 4 Credits. Prerequisite: Completion of college algebra or equivalent. This course is designed to provide Computer Engineering, Electrical Engineering, and Computer Science students with an understanding of the basic concepts of digital systems and their hardware implementation. Topics covered include combinational logic circuits, sequential logic circuits, and CPU control.

TEXTBOOK:

Digital Design, Fifth Edition, M. Morris Mano and Michael D. Ciletti, Prentice Hall, 2013, ISBN-10: 0-13-277420-8 • ISBN-13: 978-0-13-277420-8.

COORDINATOR:

Dr. Thomas P. Montoya, Associate Professor

GOALS:

The objective of this course is to provide students with an understanding of the basic concepts associated with the analysis and design of combinational and sequential circuits. Combinational circuits include AND, OR, NOT, NAND, and NOR logic gates, adders, code converters, and memory devices. Sequential circuits include flip-flops, registers, counters, and programmable logic devices.

CLASS SCHEDULE:

Lecture: 3 hours per week.
Laboratory: 2 hours every week (1 credit hour).

TOPICS:

- Binary Systems
  - Binary, Hexadecimal, Decimal, and Binary Coded Decimal Numbers
  - Number Conversion
  - Signed and Unsigned Binary Numbers
  - Two's Complement
  - Binary Logic
- Boolean Algebra
  - Postulates and Theorems
  - Logic Gates
  - Truth Tables
  - Implementation of Boolean Functions with Logic Gates
  - Integrated Circuits
- Boolean Function Simplification
  - Karnaugh Maps
  - Product of Sums
  - Sum of Products
- Combinational Logic
  - Design Procedure
  - Adder Circuits
  - Analysis Procedure

- Truth Tables
- Decoders and Encoders
- Demultiplexers and Multiplexers
- Read Only Memory & Random Access Memory
- Programmable Logic Array

Sequential Logic
- Flip-Flops
- Analysis
- State Tables
- State Diagrams
- Excitation Tables
- Design
- Registers
- Counters
- Timing Diagrams

Algorithmic State Machines
- ASM Charts
- Control Implementation
- Data Processing Implementation

COMPUTER USAGE:

Program EPROMs and PALs, schematic entry and simulation.

LABORATORY:

A one credit hour laboratory CENG 244L accompanies this course. The laboratory meets weekly for two hours for about 12 laboratories during the semester. In general, the laboratories will cover the following topics:

1. Introduction to Logic Gates
2. Logic Circuits
3. Boolean Expressions and Simplifications
4. Karnaugh Maps
5. NAND/NOT Implementation
6. Binary Math
7. Multiplexers
8. Keypad Encoder/Decoder
9. Counters
10. Serial Adder
11. Sequential Counter
12. PAL Programming

The students use some basic equipment in the laboratories including a trainer board and digital multimeter. In the pre-laboratory work, the students typically analyze the circuits to familiarize themselves with the upcoming laboratory.

OUTCOMES:

Upon completion of this course, students should demonstrate the ability to:

1. Convert numbers between binary and decimal, binary and hexadecimal, and decimal and binary coded decimal notation.
2. Perform the mathematical operations of addition, subtraction, multiplication, and division using signed and unsigned binary numbers.
3. Analyze combinational logic circuits using AND, NOT, OR, NOR, NAND, and XOR logic gates.
4. Design combinational logic circuits using truth tables and Karnaugh maps.
5. Program EPROMs and PALs.
6. Analyze sequential logic circuits and prepare timing diagrams using Flip-Flop Characteristic Tables.
7. Design sequential logic circuits using state diagrams, state tables, and Flip-Flop Excitation Tables.
8. Construct logic circuits in the laboratory using student trainer boards.
9. Design and construct digital control and data processing circuits using ASM charts to define digital hardware algorithms.

RELATION OF COURSE TO PROGRAM OBJECTIVES:

These course outcomes fulfill the following program objectives:

(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 on multi-disciplinary 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.

The following table indicates the relative strengths of each course outcome in addressing the program objectives listed above (on a scale of 1 to 4 where 4 indicates a strong emphasis).

Outcomes / Objectives	1	2	3	4	5	6	7	8	9
(a)	1	2	1	2	2	2	2		2
(b)			1	3	2	1	3	2	3
(c)				3			3		4
(e)		1	2	3	2	2	3	2	4
(k)		1		1	2	2	2	2	4

PREPARED BY:

Revised: Thomas P. Montoya, Date: 1/14/2014