COURSE OUTLINE
ELEC-213
Digital Circuits
4 Credits

HOWARD COMMUNITY COLLEGE

Description

Principles of solid state devices will be utilized to study logic circuitry. The student will analyze, design, build and troubleshoot logic gates, pulse and switching circuits, arithmetic circuits, counters, registers, input/output, clock and control circuits, and memory units. Digital TTL integrated circuits and other logic families will be compared. The principles learned will be applied to various digital instruments and digital computer circuitry. Prerequisite: ELEC-107 or ELEC-112. (3 hours lecture, 3 hours lab)

Overall Course Objectives

Upon completion of this course, the student will be able to:

1. Distinguish between analog and digital representations by listing the advantages, disadvantages and major differences.
2. Describe the operation of, construct the truth tables for, and draw timing diagrams for NOT, AND, NAND, OR, NOR and EX-OR gates.
3. Simplify complex logic circuits by applying Boolean algebra theorems and use either of the universal gates (NAND or NOR) to implement the circuit represented by a Boolean expression.
4. Explain the advantages of constructing a logic circuit diagram using alternate gate symbols and describe the concept of active-LOW and active-HIGH logic symbols.
5. Perform the necessary steps to derive a sum-of-products expression to design a combinational logic circuit in its simplest form and design logic circuits with and without a truth table.
6. Construct and analyze the operation of a latch flip-flop made from a NAND gate and debounce a mechanical switch by using a latch circuit.
7. Understand several types of edge-triggered FF, such as the J-K, D-type and S-C and draw the output timing waveforms in response to a set of input signals (both synchronous and asynchronous).
8. Define the terms, register and contact register, for data transfer, frequency division and counting circuits using standard FF, Schmitt triggers and one-shots.
9. Convert between various number systems: binary, octal, decimal and hexadecimal.
10. Express numbers in BCD and Gray code and understand the need for alphanumeric codes (ASCII).
11. Describe the parity method of error detection (even or odd) for digital data.
12. Perform addition, subtraction and multiplication using binary or hexadecimal numbers and analyze the operation of full adders and serial binary multiplier circuits using 2's complement signed binary numbers.
13. Describe the operation of synchronous and asychronous counters (both up and down) and analyze various types of presettable counters and decode the counter.
14. Analyze the theory of operation of a frequency counter and of a digital clock.
15. Read and understand digital IC terminology as specified in manufacturers' data sheets and describe the major characteristics and differences among TTL, ECL, MOS, and CMOS logic families.
16. Analyze and use decoders and encoders in various types of circuit application.
17. Understand the operation of multiplexers and demultiplexers by analyzing several circuit applications.
18. Cite the precautions that must be considered when connecting digital circuits using the data-bus concept and interpret the notation used on the IEEE/ANSI symbols for various MSI devices.
19. Understand the theory of operation and circuit limitations of several types of DACs and ADCs.
20. Understand and correctly use the terminology associated with memory systems, determine the capacity of memory from its inputs and outputs, and combine memory ICs to form larger memory capacities and specify its memory map.

Major Topics

I. Logic Gates and Boolean Algebra
   A. Basic Gates
   B. Truth Tables
   C. Timing Diagrams
   D. Boolean Theorems
   E. Alternate Gate Representations
II. Combinational Logic Circuits
   A. Simplifying
   B. Sum-of-Products
   C. Parity
III. Flip-Flops
   A. Latch
   B. Clocked
   C. Synchronous/Asynchronous
   D. Data Storage and Transfer (registers)
   E. Schmitt Trigger and One-Shots
IV. Number Systems and Codes
   A. Binary, Octal, Decimal and Hexadecimal
   B. BCD, Gray Codes
   C. Alphanumeric Codes (ASCII)
   D. Error Detection
V. Digital Arithmetic
   A. Binary Addition
   B. Signed Numbers
   C. 2's Complement
   D. BCD Addition
   E. Hexadecimal
   F. Arithmetic ICs
VI. Counters and Registers
   A. Asynchronous (Ripple)
   B. Synchronous (Parallel)
   C. Presettable Counters (up and down)
   D. Decoding Counters
   E. Counter Applications (frequency counter/digital clock)
   F. IC Registers
VII. IC Logic Families
   A. TTL, ECL, MOS, CMOS
   B. Open Collector Devices
   C. Tristate
   D. Bilateral Switch
   E. IC Interfacing
VIII. MSI Logic Circuits
   A. Decoders
   B. Encoders
   C. Multiplexers
   D. Demultiplexers
   E. Tristate Registers
   F. Data Basing
IX. Interfacing with Analog
   A. DAC
   B. ADC
X. Memory Devices
   A. Terminology
   B. Types
   C. IC Memories
   D. Expanding Word Size
   E. Expanding Capacity

Course Requirements

Grading/exams: Grading procedures will be determined by the individual faculty member but will include tests, lab exercises and a term paper (semester project).
Writing: Each student will write a formal lab report for their semester project.
Oral: Each student will orally present their semester project in the form of a demonstration presentation.
Math: Number system conversions, Boolean algebra and binary/hexadecimal arithmetic are utilized to analyze digital circuits.

Other Course Information

This course is a course in Biomedical, Computer, Electronic, and Telecommunications Technology programs.