EE313 Digital Logic Design and Microprocessors
Course Objectives

LESSON #1. Course Introduction and Overview
- Understand the contents of the EE313 Course Policy Statement.
- Outline key topics in the EE313 syllabus.

LESSON #2. Interfacing with the Analog World
- Distinguish between analog and digital representations.
- Understand the need for analog-to-digital converters (ADC) and digital-to-analog converters (DAC).
- List the advantages and disadvantages of a digital system.
- Identify the differences between serial and parallel transmission.
- Understand the theory of operation and the circuit limitations of several types of digital-to-analog converters (DAC).

LESSON #3. Numbering Systems and Codes
- Convert numbers between hexadecimal, octal, binary, and decimal numbering systems.
- Identify advantages of the hexadecimal and octal systems.
- Distinguish between Binary Coded Decimal (BCD) and straight binary codes.
- Explain the need for alphanumeric codes such as the ASCII Code.
- Describe the parity method for error detection.
- Calculate the parity (odd or even) of digital data.

LESSON #4. Waveforms
- Explain the basic parameters of a Clock Pulse Waveform.
- Explain the concept of active HIGH and active LOW logic signals.
- Convert between frequency and periods for a periodic clock waveform.

LESSON #5. Digital Systems
- Explain the basic functioning of Diodes when forward and reversed biased.
- Explain the basic characteristics of transistors when they are either “ON” or “OFF”
- Given a simple transistor circuit, be able to determine Vout.
- Explain the basic characteristics of transistors when it is used as a switch.
- Explain the basic characteristics of transistors as it pertains to digital systems.

LESSON #6. Logic Gates I
- Describe the operation of AND, OR, NAND, NOR gates.
- Construct truth tables for AND, OR, NAND, NOR gates.
- Explain the NOT Operation or Inverter Circuit.
- Describe the operation of XOR and XNOR gates

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LESSON #7. Logic Gates II
- Draw timing diagrams for the AND, OR, NAND, NOR logic circuit gates.
- Write Boolean Expressions for AND, OR, NAND, NOR gates and combinations of each.
- Create logic circuits using the AND, OR, and NOT gates.

LESSON #8. Boolean Algebra I
- Apply various rules of Boolean algebra to simplify complex logic circuits.
- Apply DeMorgan's Theorem to simplify Boolean expressions.
- Understand Universality as it applies to Complete Sets.
- Create a logic circuit represented by a Boolean expression using either NAND gates alone or NOR gates alone.

LESSON #9 Boolean Algebra II
- Explain the advantages of constructing a logic circuit using alternate gate symbols verses using the standard AND, OR, NAND, NOR.
- Interpret logic circuits that use the new IEEE/ANSII standard symbols.

LESSON #10. Combinational Logic
- Express an arbitrary Boolean expression in Sum of Products form.
- Design a combinational logic circuit from a Sum of Products expression.
- Apply the Boolean Algebra theorems to simplify a logic circuit expression.
- Understand Universality as it applies to NAND and NOR gates.
- Describe the steps involved in the complete design procedure for a logic circuit.

LESSON #11. Karnaugh Maps I
- Understand and use Karnaugh Maps to simplify 2, 3, and 4 variable Boolean expressions.
- Apply the Karnaugh Map process to simplify and design logic circuits.

LESSON #12. Karnaugh Maps II
- Apply the Karnaugh Map process to determine minimized logical expressions for complex design problems.

LESSON #13. XOR/XNOR Circuits
- Explain the operation of both the Exclusive OR and Exclusive NOR circuits.
- Outline the operation of a Parity generator.
- Design an odd- and even- parity generator and checker system.

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LESSON #14. Digital Arithmetic

- Perform binary addition, subtraction, multiplication, and division on two binary numbers.
- Add and subtract hexadecimal numbers.
- Know the difference between binary addition and OR addition.
- Describe the advantages and disadvantages of three different systems for representing signed binary numbers.
- Manipulate signed binary numbers using the 2's-complement system.
- Understand the BCD adder circuit and the BCD addition process.

LESSON #15. Arithmetic Circuits

- Describe the basic operation of an arithmetic logic unit (ALU).
- Design a parallel binary adder using full adders.
- Interpret the function of a full adder with look-ahead carry capability.
- Outline the operations performed by an arithmetic processing unit.
- Interpret the IEEE/ANSI symbol for a parallel adder.

MIDTERM EXAM #1.

LESSON #16. Comparators/Decoders/ Encoders/Mux/DeMux

- Describe the logical construction of, and functioning of, Comparators
- Describe the logical construction of, and functioning of,Decoders
- Describe the logical construction of, and functioning of,Encoders
- Compare two binary numbers using the magnitude comparator circuit.
- Use decoders and encoders in various types of circuit applications.
- Explain the procedure involved in Binary, BCD, and Gray code converting.
- Given a problem statement, effectively employ the appropriate comparator, encoder, and/ or decoder, including circuit design and implementation.
- Describe the logical construction of, and functioning of, Multiplexers
- Describe the logical construction of, and functioning of, Demultiplexers
- Determine the operation of Multiplexers and Demultiplexers by analysis of circuit applications.

LESSON #17. Flip-Flops I

- Explain the internal operation and construction of S-R and gated S-R Flip-Flops.
- Explain the internal operation and construction of D Flip-Flops and Latches.
- Construct and analyze the operation of a latch flip-flop made from NAND & NOR gates.
- Describe the difference between synchronous and asynchronous systems.
- Apply the Flip-Flop timing parameters specified by the manufacturer.

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LESSON #18. Flip-Flops II
- Explain the internal operation and construction of J-K Flip-Flops.
- Apply the Flip-Flop timing parameters specified by the manufacturer.
- Draw the output timing waveforms of several types of Flip-Flops in response to a set of input signals.
- Describe the affects on asynchronous inputs to an edge-triggered Flip-Flop.
- Identify the various IEEE/ANSII Flip-Flop symbols.
- Identify the timing problems associated with Flip-Flop circuits.

LESSON #19. Analyzing Sequential Circuits
- Use timing diagrams for the analysis of sequential logic circuits.

LESSON #20. Flip-Flop Applications
- Apply flip-flops in a synchronization circuit.
- Describe how flip-flops are utilized in input sequence detection, data storage and transfer, and frequency-division circuits.
- Explain the advantages and disadvantages of light-emitting diodes (LED) and liquid-crystal displays (LCD).

LESSON #21. Asynchronous Counters
- Identify the characteristics and operation of asynchronous counters.
- Understand the timing diagrams fro asynchronous counters.
- Explain MOD Counters with numbers < 2N.
- Identify IEEE/ANSI symbols used in IC counters and registers.

LESSON #22. Asynchronous Counter Design I
- Describe several types of schemes used to decode counters.
- Explain the operation of a BCD counter.
- Design and implement an asynchronous down-counter.

LESSON #23. Asynchronous Counter Design II
- Design and implement any modulus ripple counter and frequency divider using J-K Flip-Flops and basic logic gates.

LESSON #24. Synchronous Counters
- Identify the characteristics and operation of synchronous counters.
- Identify the various types of pre-settable counters.
- Explain the operation of multistage counters.
- Describe the effects of propagation delay on counter operation.

LESSON #25. Synchronous Counter Design
- Design an arbitrary-sequence synchronous counter.

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LESSON #26. Registers: P-S, S-P, Shift, & Recirculating
- Explain the operation of Serial-to-Parallel Registers
- Explain the operation of Parallel-to-Serial Registers
- Explain the operation of Shift Registers.
- Explain the operation of Recirculating Registers.

MIDTERM EXAM #2.

LESSON #27. ADC/DAC
- Explain the difference between binary-weighted and R/2R digital-to-analog converters.
- Explain the operation of parallel-encoded and successive approximation analog-to-digital converters.
- Understand the basic operation of a typical data acquisition system.

LESSON #28. Memories I
- Identify and correctly use the terminology associated with memory systems.
- Describe the difference between read/write memory and read-only memory.
- Distinguish the difference between volatile and non-volatile memory.
- Explain the basic concepts involved in memory addressing and data storage.
- Outline the steps that occur when the CPU reads from or writes to memory.
- Explain the organization and operation of static and dynamic RAMs.

LESSON #29. Memories II
- Distinguish between the various types of RAM and describe their applications.
- Calculate the capacity of a memory device from its inputs and outputs.
- Calculate the storage capacity of cascading memory.
- Compare the relative advantages and disadvantages of EPROMs, EEPROMs, and Flash memory.
- Distinguish among the various types of ROMs and describe some common applications.
- Identify the precautions that must be considered when connecting digital circuits using the data-bus concept.

LESSON #30. Troubleshooting
- Use the basic troubleshooting rules of digital systems.
- Deduce from measured results the faults of malfunctioning combinational logic circuits.
- Apply basic troubleshooting skills to various circuits.

LESSONS #31. Microprocessor Organization & Fundamentals I
- Understand the common terms used in computer, microprocessor, and microcontroller architectures.
- Describe the function and operation of each one of the five basic elements of a computer.

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LESSON #32. Instruction Execution within a Microprocessor

- Describe the various cycles associated with the execution of a machine language program.
- Describe the timing sequence on the address, data, and control buses required to perform a simple I/O operation.
- Explain the fetch and execute cycles of a machine language program.

LESSONS #33. Microcomputer Organization & Fundamentals II

- Describe the function of the address, data, and control buses.
- List the major functions performed by a microprocessor.
- Describe, and give examples of, the three basic levels of software languages.
- Understand the relationship between hardware and software in computer architecture.

LESSON #34. Microcontroller Organization

- Describe the various elements of a microcontroller.
- Explain the difference between microcontrollers and microprocessors.
- List the major functions performed by a microcontroller.

LESSON #35. ASICs, CPLDs, and FPGAs

- Describe the architecture of the basic types of programmable logic devices.
- State the advantages and disadvantages of using ASICs, CPLDs, and FPGAs in circuits.
- State common applications of ASICs, CPLDs, and FPGAs.