

Digital Logic Design

Module Objectives

The objective of this subject is to provide the foundation in the core fundamentals of digital technology. After completing this course students will be able to design simple digital devices and implement them. Laboratory work is essential in this module.

Contents

Number System, Digital Design Fundamentals, Understand and Design Functions of Combinational Logic, Sequential Logic (Counters, Registers and Finite State Machine), Memories, Programmable Logic Devices, Integrated Circuit Technologies, VHDL language and Design using manual techniques and CAD tools.

Detailed Course

Unit 1: Number Systems, Operations and Codes **LH 5**

- a. Decimal, Binary, Octal, Hexadecimal Number Systems
- b. Conversion from one number system to another
- c. Complements of Binary Numbers
- d. Addition and Subtraction of Binary Numbers
- e. Digital Codes
- f. Error Detection Codes

Unit 2: Digital Design Fundamentals **LH 8**

- a. Digital and Analog Quantities
- b. Binary Digits, Logic Operations, Logic Levels and Digital Waveforms
- c. Introduction to the System Concept
- d. Logic Gates (Basic Gates, Derived Gates, Universal Gates)
- e. Boolean Algebra and Logic Simplification
- f. Minimizing SOP and POS expression using K-Map (up to 4 variables only)

Unit 3: Functions of Combinational Logic **LH 7**

- a. Adders and Subtractors
- b. Parallel Binary Adders
- c. Multiplexers and Demultiplexers
- d. Encoders and Decoders
- e. Seven segment decoder
- f. Code Converters

After Completion of Chapter 1, 2 and 3:

Student should be able to design circuits like: Arithmetic Unit (Addition, Subtraction) circuit, number system converter circuits, various decision making circuits.

Unit 4: Latches and Flip- Flops **LH 4**

- a. Latches
- b. Edge-Triggered Flip-Flops
- c. Flip-Flop Operating Characteristics
- d. Flip-Flop Application

Unit 5: Counters**LH 5**

- a. Asynchronous Counters
- b. Synchronous Counters
- c. Up/Down Counters
- d. Cascaded Counters
- e. Counter Applications

Unit 6: Shift Registers**LH 5**

- a. Basic Shift Register Operations
- b. Shift Register Types
- c. Bidirectional Shift Registers
- d. Shift Register Counters

Unit 7: Sequential Machine Design**LH 6**

- a. State Diagrams and State Tables
- b. Design of Synchronous Counters
- c. Design of Sequence Recognizer(up to 5 bits)
- d. Analysis of Synchronous Circuits

After Completion of Chapter 4, 5, 6 and 7:

Student should be able to design circuits like: digital clock, voting system, counting machine, storage device, traffic control system, frequency division circuits, and analyze circuits.

Unit 8: Memories**LH 1**

- a. Basic Memory Operations
- b. Types of memories
 - i. RAM and ROM (no circuit details)

Unit 9: Programmable Logic Devices**LH 2**

- a. Introduction to various programmable devices
 - i. PLA
 - ii. PAL
 - iii. CPLD
 - iv. FPGA

Unit 10: Integrated Circuit Technologies**LH 2**

- a. Basic Operational Characteristics and Parameters
- b. CMOS, TTL, ECL
- c. Levels of Integration (SSI, MSI, LSI, VLSI, ULSI)

After Completion of Chapter 8, 9 and 10:

Student should be able to interface with various types of logic families and integrated circuits.

Laboratory Works:

VHDL language should be taught to specify the logic circuits. Instructor should illustrate how VHDL can be used to specify the desired functionality and how CAD tools (eg. Altera Quartus II) provide a mechanism for developing the required circuits. Instructor should assign design projects to each individual using both methodologies: manual design and CAD tools to design logic circuits.

After Completion of Lab Works:

Student can able to design circuits manually and using CAD tools.

Course Book:

- Floyd T. L., **Digital Fundamentals**, 10th edition, Pearson

References:

- Brown S. and Vranesic Z., ***Fundamentals of Digital Logic with VHDL Design***, 3rd edition, Mc Graw Hill
- Rafiquzzaman M., ***Fundamentals of Digital Logic and Microcomputer Design***, 5th edition, John Wiley & Sons, Inc.
- Holdsworth B. and Woods C., ***Digital Logic Design***, 4th edition
- Mano M.M, ***Digital Design***, 3rd edition
- Mano M. M, Kime C. R , ***Logic and computer design fundamentals***, 2nd edition