Introduction to Digital Design and Computer Organization

Module-1

Introduction to Digital Design: Binary Logic, Basic Theorems And Properties Of Boolean Algebra, Boolean Functions, Digital Logic Gates, Introduction, The Map Method, Four-Variable Map, Don't-Care Conditions, NAND and NOR Implementation, Other Hardware Description Language – Verilog Model of a simple circuit.

Text book 1: 1.9, 2.4, 2.5, 2.8, 3.1, 3.2, 3.3, 3.5, 3.6, 3.9

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Module 2

Combinational Logic: Introduction, Combinational Circuits, Design Procedure, Binary Adder- Subtractor, Decoders, Encoders, Multiplexers. HDL Models of Combinational Circuits – Adder, Multiplexer, Encoder. Sequential Logic: Introduction, Sequential Circuits, Storage Elements: Latches, Flip-Flops.

Text book 1: 4.1, 4.2, 4.4, 4.5, 4.9, 4.10, 4.11, 4.12, 5.1, 5.2, 5.3, 5.4.

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Module 3

Basic Structure of Computers: Functional Units, Basic Operational Concepts, Bus structure, Performance – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement. Machine Instructions and Programs: Memory Location and Addresses, Memory Operations, Instruction and Instruction sequencing, Addressing Modes.

Text book 2: 1.2, 1.3, 1.4, 1.6, 2.2, 2.3, 2.4, 2.5

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Module 4

Input/output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Direct Memory Access: Bus Arbitration, Speed, size and Cost of memory systems. Cache Memories – Mapping Functions.

Text book 2: 4.1, 4.2.1, 4.2.2, 4.2.3, 4.4, 5.4, 5.5.1

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Module 5

Basic Processing Unit: Some Fundamental Concepts: Register Transfers, Performing ALU operations, fetching a word from Memory, Storing a word in memory. Execution of a Complete Instruction. Pipelining: Basic concepts, Role of Cache memory, Pipeline Performance.

Text book 2: 7.1, 7.2, 8.1

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Practical Component of IPCC

Experiments Simulation packages preferred: Multisim, Modelsim, PSpice or any other relevant

1. Given a 4-variable logic expression, simplify it using appropriate technique and simulate the same using basic gates.
2. Design a 4 bit full adder and subtractor and simulate the same using basic gates.
3. Design Verilog HDL to implement simple circuits using structural, Data flow and Behavioural model.
4. Design Verilog HDL to implement Binary Adder-Subtractor – Half and Full Adder, Half and Full Subtractor.
5. Design Verilog HDL to implement Decimal adder.
6. Design Verilog program to implement Different types of multiplexer like 2:1, 4:1 and 8:1.
7. Design Verilog program to implement types of De-Multiplexer.
8. Design Verilog program for implementing various types of Flip-Flops such as SR, JK and D.

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Text Books

1. M. Morris Mano & Michael D. Ciletti, Digital Design With an Introduction to Verilog Design, 5e, Pearson Education.
2. Carl Hamacher, ZvonkoVranesic, SafwatZaky, Computer Organization, 5th Edition, Tata McGraw Hill.

Web links and Video Lectures (e-Resources):

https://cse11-iiith.vlabs.ac.in/

Introduction to Digital Design and Computer Organization

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Assign the group task to Design the various types of counters and display the output accordingly

Assessment Methods

- Lab Assessment (25 Marks)
- GATE Based Aptitude Test

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CIE for the theory component of the IPCC (maximum marks 50).

- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for 25 marks).
- The student has to secure 40% of 25 marks (12) to qualify in the CIE of the theory component of IPCC.

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Course objectives

- To demonstrate the functionalities of binary logic system
- To explain the working of combinational and sequential logic system
- To realize the basic structure of computer system
- To illustrate the working of I/O operations and processing unit.

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Course outcome

At the end of the course the student will be able to:

CO1: Apply the K–Map techniques to simplify various Boolean expressions.

CO2: Design different types of combinational and sequential circuits along with Verilog programs.

CO3: Describe the fundamentals of machine instructions, addressing modes and Processor performance.

CO4: Explain the approaches involved in achieving communication between processor and I/O devices.

CO5:Analyze internal Organization of Memory and Impact of cache/Pipelining on Processor Performance.

Introduction to Digital Design and Computer Organization

Applications of Digital Electronics

- **Computing:** Digital electronics are used in computers to store, process, and transmit data. They are used in the central processing units (CPUs) of computers, as well as in other components such as memory, storage, and input/output devices.
- **Communication:** Digital electronics are used in a variety of communication systems, including cell phones, satellite systems, and the internet. They are used to transmit and receive data, as well as to process and decode signals.
- **Entertainment:** Digital electronics are used in a variety of entertainment devices, including TVs, video game consoles, and music players. They are used to process and display images, as well as to store and playback audio and video content.
- **Transportation:** Digital electronics are used in transportation systems, including vehicles and traffic control systems. They are used to control the operation of engines and other systems, as well as to navigate and communicate with other vehicles.
- **Industrial control:** Digital electronics are used in industrial control systems to automate and control manufacturing processes. They are used to monitor and control the operation of machines, as well as to process and transmit data.

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Applications of Digital Electronics

- **Medical equipment:** Digital electronics are used in medical equipment, such as x-ray machines and patient monitoring systems. They are used to process and display medical images, as well as to monitor and analyze patient data.
- **Military:** Digital electronics are used in military systems, such as radar systems and missile guidance systems. They are used to detect and track objects, as well as to communicate and control military operations.
- **Home appliances:** Digital electronics are used in a variety of household appliances, such as refrigerators, washing machines, and thermostats. They are used to control the operation of the appliance, as well as to monitor and display data such as temperature and energy usage.
- **Environmental monitoring:** Digital electronics are used in environmental monitoring systems to measure and analyze data on air quality, water quality, and other environmental factors. They are used to collect and transmit data, as well as to analyze and display the results.
- **Security:** Digital electronics are used in security systems, such as alarm systems and surveillance cameras. They are used to detect and monitor activity, as well as to communicate and respond to security threats.