DIGITAL ELECTRONICS 3-0-0

Pre-requisites *(if any)*: Knowledge of Basic Mathematics & Basic Electrical and Electronics Engineering.

Course Objectives:

- To understand digital logic fundamentals, including binary systems and Boolean algebra.
- To design and analyze combinational and sequential circuits, including logic gates, flip-flops, and counters.
- To apply digital electronics in real-world applications, using simulation tools and programmable logic devices (PLDs).

Course Content

Unit 1 **(10 Hours)**

Number Systems and Codes: Binary, Octal, Hexadecimal, and Decimal Number System and their Conversion; Representation of Signed Binary and Floating-Point Number; Binary Arithmetic using 1's and 2's Complements, Binary Codes - BCD Code, Gray Code, ASCII Character Code.

Boolean Algebra and Logic Gates: Axioms and Laws of Boolean Algebra; Reducing Boolean Expressions; Logic Levels and Pulse Waveforms; Logic Gates; Boolean Expressions and Logic Diagrams; Canonical and Standard Forms.

Unit 2 **(12 Hours)**

Gate-level Minimization: K-maps - Two, Three, and Four Variable K-maps, Don't-Care Conditions; NAND and NOR Implementation; Other Two-Level Implementations, Exclusive-OR Function.

Combinational Logic: Combinational Circuits; Analysis Procedure; Design Procedure; Adders; Subtractors; Parallel Binary Adders; Binary Adder-Subtractor; Binary Multiplier; Magnitude Comparator; Decoders; Encoders; Multiplexers; De-multiplexers.

Unit 3 **(8 Hours)**

Synchronous Sequential Logic: Sequential Circuits; Storage Elements: Latches, Flip-Flops, Master-Slave Flip-Flop; Conversion of Flip-Flops; Analysis of Clocked Sequential Circuits; Mealy and Moore Models of Finite State Machines; Design Procedure.

Unit 4 **(8 Hours)**

Registers and Counters: Shift Registers; Data Transmission in Shift Registers; SISO, SIPO, PISO, and PIPO Shift Registers; Counters; Asynchronous Counters; Design of Asynchronous Counters; Synchronous Counters; Design of Synchronous Counters; Ring Counter.

Unit 5 **(6 Hours)**

Memory and Programmable Logic: Introduction; Random-Access Memory; Memory Decoding; Error Detection and Correction; Read-Only Memory; Programmable Logic Array; Programmable Array Logic; Sequential Programmable Devices.

Text Books:

[1] M. Morris Mano, and Michael D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog*. Pearson Education, Sixth Edition, 2017.

[2] A. Anand Kumar, *Fundamentals of Digital Circuits*. PHI Learning Pvt. Ltd., New Delhi, Fourth Edition, 2016.

[3] R. P. Jain, *Modern Digital Electronics*. Tata McGraw-Hill Education Pvt. Ltd., Fourth Edition, 2009.

Reference Books:

[1] John P. Uyemura, *A First Course in Digital Systems Design: An Integrated Approach*. Thomson Press (India) Ltd., India Edition, 2002.

[2] William H. Gothmann, *Digital Electronics: An Introduction to Theory and Practice*, PHI Learning Pvt. Ltd., New Delhi, Second Edition, 2006.

[3] D.V. Hall, *Digital Circuits and Systems*. Tata McGraw-Hill Education Pvt. Ltd., 1989.

[4] Charles H. Roth, *Digital System Design using VHDL*. Tata McGraw-Hill Education Pvt. Ltd., Second Edition, 2012.

Course Outcomes:

At the end of this course, students will be able to

CO1: Define and analyze the number systems and conversions.
CO2: Perform binary arithmetic with 1's and 2's complements and understand binary codes.
CO3: Apply Boolean algebra laws to simplify expressions and design logic circuits.
CO4: Use K-maps for logic minimization and design combinational circuits.
CO5: Analyze and design synchronous sequential circuits.
CO6: Design shift registers, and counters, and understand RAM, ROM, and PLDs.

CO-PO & PSO matrices of Course

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	-											
CO2	2	2	-											
CO3	2	-	3											
CO4	-	2	3											
CO5	2	-	3											
CO6	2	-	3											
Average	2	2	3											

DIGITAL ELECTRONICS LABORATORY 0-0-2

Pre-requisites *(if any)*: Knowledge of Basic Electrical and Electronics Engineering.

Course Objectives:

- To gain hands-on experience with basic logic gates and combinational circuits.
- To implement and test combinational and sequential circuits.
- To utilize simulation tools for circuit design and testing.

Course Content

List of Experiments:

(At least 10 experiments should be done, Experiments No. 1 and 2 are compulsory, and out of the balance 8 experiments at least 3 experiments have to be implemented through both Verilog/VHDL and hardware implementation as per the choice of the student totaling to 6 and the rest 2 can be either through Verilog/VHDL or hardware implementation.)

1. Digital Logic Gates: Investigate the logic behavior of AND, OR, NAND, NOR, EX-OR, EXNOR, Inverter, and Buffer Gates, use of Universal NAND/NOR Gate.
2. Gate-Level Minimization: Two-level and multi-level implementation of Boolean functions.
3. Combinational Circuits: Design, assemble, and test: adders and subtractors, code converters, gray code to binary, and 7-segment displays.
4. Design, implement, and test a given design example with (i) NAND Gates only, (ii) NOR Gates only, and (iii) using the minimum number of Gates.
5. Design with Multiplexers and De-multiplexers.
6. Flip-Flop: Assemble, test, and investigate the operation of SR, D & JK flip-flops.
7. Shift Registers: Design and investigate the operation of all types of shift registers with parallel load.
8. Counters: Design, assemble, and test various ripple and synchronous counters - decimal counter, Binary counter with the parallel load.
9. Memory Unit: Investigate the behavior of the RAM unit and its storage capacity - 16×4 RAM: testing, simulating, and memory expansion.
10. Clock-Pulse Generator: Design, implement, and test.
11. Parallel Adder and Accumulator: Design, implement, and test.
12. Binary Multiplier: Design and implement a circuit that multiplies 4-bit unsigned numbers to produce an 8-bit product.
13. Verilog/VHDL simulation and implementation of Experiments listed in Sl. No. 3 to 12.

Course Outcomes:

At the end of this course, students will be able to

CO1: Investigate the behavior and application of various digital logic gates.

CO2: Implement two-level and multi-level Boolean function minimization using universal gates like NAND and NOR.

CO3: Design, assemble, and test combinational circuits.

CO4: Assemble, test, and investigate flip-flops and shift registers, and design various types of counters

CO5: Investigate RAM behavior and design memory units.

CO6: Use Verilog/VHDL for simulation and implementation of combinational and sequential circuit designs.

CO-PO & PSO matrices of Course

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	-		-									
CO2	2	-	3		-									
CO3	-	3	3		-									
CO4	2	-	3		-									
CO5	2	-	3		-									
CO6	-	-	2		2									
Average	2	2.5	2.8		2									