GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3131102
Semester III
Digital System Design

Type of course: Design and Analysis of Digital Circuits

Prerequisite: Basic Electronics and Number Systems.

Rationale: The students need to learn basic concepts of digital circuits and system which leads to design of complex digital system such as microprocessors. The students need to know combinational and sequential circuits using digital logic fundamentals. The students will learn the design of combinational and sequential circuit. This is the first course by which students get exposure to digital electronics world.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE Viva (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Sr. No.	Content	Total hours	% Weightage
1	Review of number systems, logic gates, Boolean algebra - postulates and theorems, SOP & POS forms, canonical forms, logic minimization using Karnaugh Map and tabulation methods up to 6 variables, Realizing logic functions using gates.	7	15
2	Combinational logic circuit design: half adder full adder, BCD adder, code converters, magnitude comparator, multiplexers and decoders, MSI digital circuit design problems.	8	15
3	Sequential logic circuit design: Flip Flops-SR, JK, T, D and master-slave FF, ripple and synchronous counters, shift registers.	7	15
4	Introduction to Finite State Machines (FSM): The need for state machines, The state machine, basic concepts in state machine analysis.	5	10
5	Synchronous state machine design: Sequential counters, state changes referenced to clock, number of state flip-flops, input forming logic, output forming logic, generation of a state diagram from a timing chart, redundant states, general state machine architecture. Concept of asynchronous state machine and comparison to synchronous state machine.	9	15
6	Logic families: Specifications, noise margin, propagation delay, fan-in, fan-out, Transistor-Transistor Logic (TTL), Emitter-Coupled Logic (ECL), CMOS Logic, TTL and CMOS Gates,Introduction to basics of FINFET	5	10
7	Programmable Logic Devices: Introduction to Programmable Logic Devices, Read-Only Memory, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), Combinational PLD-Based State Machines, State Machines on a Chip.	5	10
8	VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in Verilog: Behavioral and Structural Modeling, Data types and objects, Synthesis and Simulation Verilog constructs and codes for combinational and sequential circuits.	5	5
9	A to D Converter and D to A Converter: Introduction, Digital to Analog	**5**	**5**

	Conversion : Weighted Resistor D/A Converter, R-2R Ladder D/A Converter, Specifications for D/A Converters,An Example of D/A Converter IC: Digital Input Codes, Analog output, Calibration, Sample and Hold, Analog to Digital Converters: Quntization and Encoding, Parallel Comparator A/D Converter, Counting A/D Converter, Dual Slope A/D Converter, A/D Converter Using Voltage to frequency conversation, A/D Converter Using Voltage to time conversation, Specification of A/D Converters An Example of A/D Converter IC: Operation , Digital Output, Analog Input, Calibration		
	Total	**56**	**100**

Suggested Specification table* with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**10**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

**This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.*

Reference Books:

1. Digital Logic & State Machine Design By David J. Comer, Third Indian Edition, Oxford University Press
2. Digital Logic and Computer Design By M Morris Mano, Fourth Edition, Prentice Hall Publication
3. Digital Principles and Applications By Malvino & Leach, Seventh Edition, McGraw-Hill Education
4. Modern Digital Electronics By R.P.Jain, Fourth Edition, Tata McGraw-Hill Education.
5. Digital Electronics: Principles and Integrated Circuits By A.K. Maini, Wiley India Publications
6. Digital Design M. Morris Mano and Michael D. Ciletti, Pearson Education
7. A Verilog HDL Primer by J. Bhaskar, Third Edition, BS Publication
8. Fundamentals of Digital Logic with Verilog Design by Brown and Vrenesic, Second Edition, McGrawHill publication.

Course Outcomes:

After learning the course the students should be able to

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	apply the knowledge of digital number systems, Boolean algebra, and logic gates for logic function minimization.	25
CO-2	design and analysis combinational and sequential circuits	30
CO-3	design synchronous and asynchronous circuits FSM.	20
CO-4	comprehend the digital logic families and PLDs	10
CO-5	implement digital circuits using Verilog based VLSI design flow	15

List of Experiments:

1. Getting familiar with various digital integrated circuits of different logic families. Study of data sheet of these circuits and see how to test these circuits using Digital IC Tester.
2. Digital IC Testers and Logic State Analyzer as well as digital pattern generators should be demonstrated to the students.

3. Configure transistor as logic gates and Digital ICs for verification of truth table of logic gates
4. Configuring NAND and NOR logic gates as universal gates.
5. Implementation of Boolean Logic Functions using logic gates and combinational circuits. Measure digital logic gate specifications such as propagation delay, noise margin, fan in and fan out.
6. Study and configure various digital circuits such as adder, subtractor, decoder, encoder, code converters.
7. Study and configure multiplexer and demultiplexer circuits.
8. Study and configure flip-flop, registers and counters using digital ICs. Design digital system using these circuits.
9. Perform an experiment which demonstrates function of 4 bit or 8 bit ALU.
10. Introduction to HDL. Use of Verilog HDL in simulation of digital circuits studied in previous sessions using integrated circuits. Illustrative examples using FPGA or CPLD boards.

Design based Problems (DP)/Open Ended Problem:

1. Design of combinational lock circuits with varying number of bits (For example 4, 8 …..)
2. Design of various types of counters.
3. Design of Arithmetic and Logic Unit using digital integrated circuits.
4. Design of digital integrated circuit tester
5. Measurement of logic family specifications.
6. Design project for example digital clock, digital event counter, timers, and various multi-vibrator Circuits, small processor, ports or scrolling display.

A student and faculty may choose any other such problem which includes the concept used in the course.

Major Equipments:

1. Pattern Generators
2. Logic State Analyzers
3. Digital Storage Oscilloscopes
4. Digital Integrated Circuits Tester.
5. Complete Bread Board Systems, switches and I/O indicators, multimeters, pulse, square wave generators and display facility.

List of Open Source Software/learning website:

1. Web packages for HDL, GHDL, Free HDL
2. PSpices and NGSpice
3. Xcircuit and Scilab
4. NPTEL website and IITs virtual laboratory