GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS (10) / ELECTRONICS & COMMUNICATION (11) /COMPUTER ENGINEERING (07) / INFORMATION TECHNOLOGY (16) / INFORMATION & COMMUNICATION TECHNOLOGY (32)

DIGITAL ELECTRONICS

SUBJECT CODE: 2131004

B.E. 3RD SEMESTER

Type of course: Analysis and Design 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. 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
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Binary Systems and Logic Circuits: The Advantage of Binary, Number Systems, The Use of Binary in Digital Systems, Logic Gates, Logic Family Terminology.	**3**	**5**
2	Boolean Algebra and Mapping Methods: Boolean Algebra, Karnaugh Maps, Variable Entered Maps, Realizing Logic Function with Gates, Combinational Design Examples.	**7**	**15**
3	Logic Function Realization with MSI Circuits: Combinational Logic with Multiplexers and Decoders, Standard Logic Functions with MSI Circuits, Design Problem Using MSI Circuits.	**7**	**15**
4	Flip Flops, Counters and Registers: Flip Flops and its Applications	**8**	**15**
5	Introduction to State Machines: The Need for State Machines, The State Machine, Basic Concepts in State Machine Analysis.	**3**	**5**
6	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	**8**	**15**
7	Asynchronous State Machines: The Fundamental-Mode Model, Problems of Asynchronous Circuits Basic Design Principles, An Asynchronous Design Example.	**7**	**15**
8	Logic Families: Transistor-Transistor Logic(TTL), Emitter-Coupled Logic(ECL), MOSFET Logic, TTL Gates.	**4**	**5**
9	Programmable Logic Devices: Introduction to Programmable Logic Devices,	**5**	**10**

	Read-Only Memory, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), Combinational PLD-Based State Machines, State Machines on a Chip.		
Total		**52**	

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. Digital Electronics and Design with With VHDL, Volnei A. Pedroni, Elsevier (Morgan Kaufmann Publishers)

Course Outcome:

After learning the course the students should be able to explain about digital number systems and logic circuits. The student should be able to solve logic function minimization. The students should be able to differentiate between combinational and sequential circuits such as decoders, encoders, multiplexers, demultiplexers, flip-flops, counters, registers. They should be able to design using FSM. In the laboratory, they should be able to verify the functions of various digital integrated circuits. The students should be able state the specifications of logic families. They should be able to start writing HDL codes for various digital circuits. The student should be able to compare the design using digital circuits and PLDs. At the end they should be able to develop a course project using digital integrated circuits.

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 diodes and 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 of various digital circuits such as adder, subtractor, decoder, encoder, code converters.
7. Study and configurations of multiplexer and demultiplexer circuits.
8. Study and configure of 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 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 faciltity.

List of Open Source Software/learning website:

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

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.