GUJARAT TECHNOLOGICAL UNIVERSITY
Biomedical Department

Fundamentals of Digital Design

SUBJECT CODE: 2130306

B.E. 3RD SEMESTER

Type of course: Core

Prerequisite: 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	ES	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr No.	Content	Total Hrs	% Weightage
1	**Introduction to Digital Design & Digital Logic**: Introduction, Difference between analogue & digital systems, Radix number systems, Conversion among radices, Numeric complements representation, Signed fixed point number representation, Floating point representation, Binary codes representation, Character representation, Exercise.	4	5
2	**Binary Logic & Boolean Algebra :** Introduction, Logic gates with truth tables (AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR), NAND & NOR implementations, Introduction to Integrated Circuits, Introduction to logic families (DL, RTL, DTL, TTL, ECL, CMOS), Definition of fan-in, fan-out, switching times, noise margin, Postulate & laws of boolean algebra, De Morgan's Theorem, Simplification of Expressions (SOP, POS, Minterm, Maxterm), Gate level minimization using K-maps (upto 3-4 variables) or Tabulation method (Quine McCluskey method), Don't care conditions, Two-level/Multi-level circuit optimization & design, Exercise	8	20
3	**Designing Combinational Circuits :** Use of 1's & 2's complement in adders/subtractors, Steps for the design of combinational circuits, Design of adders (Half, Full, Ripple, Serial, & Carry look ahead), Design of subtractors (Half, Full), Design of binary subtractor using adders, Design of encoders & decoders, Design of multiplexers & demultiplexers, Design of code converters & magnitude comparator, Exercise.	8	20
4	**Designing of programmable logic:** Introduction to programmable circuits, Circuit implementation using PLDs (ROM, PLA, PAL), Realization of Switching Functions Using PROM, PAL and PLA, Determine the equation for the logic function being implemented for a PAL logic diagram, Draw the fuse map needed to implement a simple function with a PAL, Use a PAL data sheet to determine the device needed to implement a specified logic function, Exercise.	8	20

5	**Designing Sequential Circuits:** Introduction to latches & flip-flops, Design of Sequential Modules – RS, JK, D, T flip-flops, Moore & Mealy model of sequential circuit, Steps for the design of sequential circuits, Sequential circuit design: unused states and verification (timing issues in Mealy machines), State machine diagrams and constraints, State diagrams of the four types of flip-flops, Flip-flop applications – Clock generation, Counters, Registers, Practical Considerations (debouncing, synchronizer, metastability); delay and timing, Exercise	**8**	**20**
6	**A/D & D/A converters:** Introduction, Different types of D/A converter, D/A accuracy and resolution , Different types of A/D converter, A/D accuracy and resolution	**4**	**10**
7	**Simulation and Synthesis with a Hardware Description Language:** Introduction to Hardware Description Language (HDL) (VHDL, Verilog, ABEL), Introduction to simulation & synthesis software (Xilinx, Quartus, Max+plus II), Introduction to FPGA & CPLD	**4**	**5**

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.
2. Digital ICs for verification of truth table of logic gates.
3. Configuring NAND and NOR logic gates as universal gates.
4. Implementation of Boolean Logic Functions using logic gates and combinational circuits.
5. Study and configure of various digital circuits such as adder, subtractor, decoder, encoder, code converters.
6. Study and configurations of multiplexer and demultiplexer circuits.
7. Study and configure of flip-flop, registers and counters using digital ICs. Design digital system using these circuits.
8. Perform an experiment which demonstrates function of 4 bit or 8 bit ALU.
9. 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.

Suggested 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. Measurement of logic family specifications.
5. Design project for example digital clock, digital event counter, timers, and various multi-vibrator Circuits, small processor, ports or scrolling display, one lane traffic controller.

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. FPGA Board.
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.