GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000071
Subject Name: Digital Fundamentals

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite:	Basic Electronics and Number Systems
Rationale:	The students need to learn basic concepts of digital circuits and systems which lead to the design of complex digital systems 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 the digital electronics world.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Solve the given problem using fundamentals of Number systems and Boolean algebra and design the simple circuits using various gates for a given problem	10
CO-2	Design and implement various Combinational logic circuits and verify its working in a simulator	25
CO-3	Design and implement Sequential logic circuits and verify its working in a simulator	30
CO-4	To understand memory types, organization, and operations, along with the application of programmable logic devices in modern systems.	20

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Module 1: Computer Operation:** Electronic digital computer, Basic components of a digital computer, Programming overview	**02**	05
2	**Module 2: Digital System & Number System** Fundamentals of Digital Systems and logic families, Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital ICs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.	**08**	20
3	**Module 3: Combinational Logic Design** Combinational Digital Circuits Standard representation for logic functions, K-map representation, and simplification of logic functions using K-map, Minimization of logical functions using Tabulation Method and Variable Entered Mapping Method along with Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q- M method of function realization	**10**	25

4	**Module 4: Sequential Logic Design** Sequential circuits and systems A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters, State Diagrams and State Tables, Counter Design using state diagrams and state tables, Design of sequential circuits using state diagrams and state tables.	**12**	30
5	**Module 5: Memory Element** Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).	**08**	20

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**15**	**15**	**10**	**10**	**05**

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

Note: 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 slightly from above table.

Reference Books:

1. "Digital logic and Computer design", M. M. Mano, Pearson Education India, 2016.
2. "Fundamentals of Digital Circuits", A. Kumar, Prentice Hall India, 2016.
3. "Digital Principles and Applications" Malvino & Leach, McGraw-Hill Education
4. "Modern Digital Electronics", R. P. Jain, McGraw Hill Education, 2009.

List of Experiments:

1. Getting familiar with various digital integrated circuits of different logic families. Study the data sheet of these circuits and see how to test these circuits using Digital IC Tester.
2. Configure diodes and transistors as logic gates and Digital ICs for verification of the 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. Measure digital logic gate specifications such as propagation delay, noise margin, fan in and fan out.
5. Study and configure various digital circuits such as adder, subtractor, decoder, encoder, code converters.
6. Study and configurations of multiplexer and demultiplexer circuits.
7. Study and configure flip-flops, registers and counters using digital ICs. Design digital systems using these circuits.
8. Perform an experiment which demonstrates the function of 4 bit or 8 bit ALU.

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 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 Equipment:

1. Digital Integrated Circuits Tester.
2. Digital Electronics Trainer kit.

List of Open Source Software/learning website:

1. LogiSim software
2. Xcircuit and Scilab
3. NPTEL website and IITs virtual laboratory

- **Activities suggested under self-learning:**
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Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Assignment writing. Numerical based assignment is preferable.	5 assignments of 3h each. Total = 15h	Based on the assignment submitted.
2	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based problems of 3h each. Total = 15h	Based on the coding solution submitted.
3	Technical Video based learning related to the subject	Duration of video = 5h Report preparation & Presentation = 10h Total = 15h	Report /presentation based on the video learning outcomes.
4	Discussion on research paper based on relevant subject	3 research paper = 15h	Summarize research paper and evaluation critical parameters
5	Poster/chart/power point preparation on technical topics	Duration = 10 h	Based on poster/chart preparation and presentation skills
6	Application/Software development	Duration = 15 h	Depending on the complexity of the Application/Software
7	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion,

			technical depth, knowledge etc.
8	Seminar / Presentation	Duration for study and preparation=5h Report writing=3h Presentation=2h Total=10h	Topic can be selected technical content beyond syllabus
9	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 10h Total = 15h	Based on in-depth study, technical depth, data collected, fact finding, etc.
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Self-learning on-line course	Minimum duration of the course should be 15h.	Examination based assessment at the end of course. Based on the certificate produced.
12	Complex problem solving	Maximum 3 problem. Study of the problem and solution finding, Total = 15h	Based on the depth of the solution submitted.
13	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
14	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
15	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment /health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions

Note:

- All the suggested activity should be related to the subject.
- Min 3 activities must be carried out as per the availability of faculties and students.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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