GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Biomedical Engineering
Subject Code : BE03003031
Course / Subject Name : Fundamentals of Digital Electronics

w. e. f. Academic Year:	2025-26
Semester:	3
Category of the Course:	PCC

Prerequisite:	Basic Electronics, Mathematics
Rationale:	This course will provide students with knowledge of the fundamentals and design principles of digital circuits, including the logic operations of gates and their implementations across various logic families, as well as the representations of Boolean algebra and its various minimizing techniques. The design concepts of various combinational circuits utilizing programmable logic devices and sequential circuits are included as well.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understand and evaluate various Number System and binary codes with their arithmetic operations in digital design.	R,U, E
02	Understand the fundamental logic operations of gates and their various implementations, the principles of Boolean Algebra, and various techniques for minimizing switching functions.	R, U, N, E
03	Design and understand the construction and operation of various combinational circuits and their applications, as well as utilizing programmable logic devices such as PAL, PLA, and PROM.	R,U, A, C
04	Understand and design various sequential logic circuits, including their operations, types of flip-flops, and applications.	R, U, A, C
05	Understand and design various types of registers and counters, including their functions.	R, U, A, C

**Revised Bloom's Taxonomy (RBT)*

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	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End- Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction of Digital Circuits**: Introduction of Digital system Introduction of Digital integrated circuits, Digital IC Specification Terminology. **Number systems**: Decimal number system and Arithmetics, Binary Number system and Arithmetics, octal Number system and Arithmetics and hexadecimal Number system and Arithmetics, 1's and 2's Complement, 9's and 10's Complement method. **Binary Codes**: Classification of Binary codes, BCD code Arithmetics, XS-3 code Arithmetics, Gray code, Error detection and correction codes.	9	15
2.	**Logic Gates**: Basic Gates Operation, TTL realization of AND, OR, NOT Gate, Universal Gates, TTL Realization of Universal Gates, Logic operation of X-OR and X-NOR gate, Inhibit Circuits, Pulsed Operation of Logic Gates. **Boolean Algebra**: Axioms and Laws of Boolean Algebra, Duality, Reducing Boolean Expressions, Boolean Functions and their Representation, Conversion between Canonical Forms, Boolean Expressions and logic Diagrams, NAND/NOR implementation of logic circuits. Minimization of Switching functions: K-Map (Two, Three, four variables), Don't Care Conditions, and Tabulation Method.	10	20
3.	**Combinational Logic Design**: Half Adder, Full Adder, Half Subtractor, Full subtractor, Binary parallel adder and subtractor, Code Converters, Magnitude Comparator (1- bit, 2-bit, 4-bit), Encoders, Priority Encoders, Decoders, Multiplexers, Demultiplexers. **Programmable Logic Devices**: Introduction of Programmable Array logic (PAL), Introduction of Programmable Logic Array (PLA), Introduction of Programmable ROM (PROM).	10	25
4.	**Sequential Logic Design I**: Classification of sequential circuits, Latches and Flip-Flops, Master-Slave Flip-Flops, Flip-Flop Excitation tables, Conversion of Flip Flops, Applications of FlipFlops.	8	20
5.	**Sequential Logic Design II**: Shift Registers; Buffer shift register, SERIAL-IN, SERIAL-OUT Shift Register, SERIAL-IN, PARALLEL-OUT Shift Register, PARALLEL-IN, SERIAL-OUT Shift Register, PARALLEL-IN, PARALLEL-OUT Shift register, Counters, Design of Asynchronous and Synchronous Counters, Ring Counter, Johnson Counter.	8	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
10 %	20%	20%	20%	20%	10%

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:
(a) Books:

1. A. Anand Kumar, " Fundamentals of Digital Electronics", PHI Learning Publications.
2. M. Morris Mano, "Digital Logic and Computer Design", Pearson Education India.
3. R. P. Jain, "Modern Digital Electronics", Tata McGraw-Hill Education.
4. Anil K. Maini, "Digital Electronics: Principles and Integrated Circuits", Wiley.
5. Malvino & Leach, "Digital Principles and Applications", McGraw-Hill Education

(b) Open source software and website:

1. https://nptel.ac.in/courses/117105080
2. https://onlinecourses.nptel.ac.in/noc21_ee39
3. https://de-iitr.vlabs.ac.in/
4. https://www.ni.com/en/support/downloads/software-products/

Suggested Course Practical List: If any

List of Laboratory/Learning Resources Required:

1. To study & implement the logic operation of AND OR & NOT gates and their TTL Realization.
2. To study & implement the logic operation of Universal gates using AOI logic.
3. To study & implement the EX-OR & EX-NOR gates using AOI logic.
4. To Implement Boolean Logic Functions using AOI logic and Gate ICs.
5. To study & implement Half Adder and Full Adder using Digital Trainer Kit.
6. To study & implement Half Subtractor and Full Subtractor using Digital Trainer Kit
7. To study & implement Gray to binary & binary to Gray code conversion using Digital Trainer Kit.
8. To study & implement 1-bit & 2-bit Magnitude Comparator using AOI logic.
9. To study & implement Encoder and Decoder using Digital Trainer Kit.
10. To study & implement Multiplexer and Demultiplexer using Digital Trainer Kit.
11. To study about different Flip-Flops, their Excitation tables, and implementation using Digital Trainer Kit.

12. To study about the design of types of Counters and shift registers.

Suggested Project List:

Suggested Activities for Students: If any

Students are to be assigned the task of implementing simulations of various digital circuits using NI LabVIEW or alternative simulation tools.

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	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.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation

11	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
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
3. 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.
4. 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.
5. 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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