



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

w. e. f. Academic Year:	2025-26
Semester:	4 th
Category of the Course:	PCC

Prerequisite:	A Basic knowledge of digital electronics concept, number system and codes.
Rationale:	Digital electronics plays a vital role in all branches of engineering, particularly in electrical engineering. As digital systems continue to replace analog ones, the diploma engineering pass-outs are required to effectively engage with modern digital technology used across various industries, including consumer electronics, automation and control systems etc. Therefore, the fundamental knowledge of Number Systems, logic gates, basic combinational and sequential logic circuits as well as digital ICs will enable the students to design, interpret and maintain these digital systems. Therefore, this course is intended to provide this fundamental knowledge of digital electronics so that students will be able to tackle the increasing digital landscape of modern technology.

Course Outcomes:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Use number systems and codes for interpreting the working of digital systems.	R, U,A
02	Use logic gates and Boolean Expressions to realize logic circuits.	R, U, A
03	Apply Karnaugh map for optimized circuit implementation.	U, A
04	Build simple combinational and sequential logic circuits.	U, A
05	Analyze working of A/D and D/A converters.	R,U

*Revised Bloom's Taxonomy (RBT)



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Unit 1 – Number Systems 1.1 Analog Vs Digital, Introduction of Number Systems – Binary, Octal, Decimal, Hexadecimal Numbers. 1.2 Conversion of Number from One Number System to Another Number System: Decimal to Other Number Systems and vice versa. 1.3 Conversion of Number between Binary, Octal, Hex. and vice versa. 1.4 Perform binary arithmetical operations -Binary Addition, Binary Subtraction, Binary Multiplication, Binary Division with Examples. 1.5 1’s and 2’s Complement of Binary numbers. 1.6 Binary subtraction using 1’s and 2’s Complement method. 1.7 Concepts of Digital codes, Weighted, Non-weighted codes, Alphanumeric Codes.	7	14 %
2.	Unit 2 – Logic Gates & Boolean Algebra 2.1 Differentiate different logic levels - Concept of Positive Logic and negative Logic Levels. Logic gates -NOT, AND, OR, NAND, NOR, EX-OR & EX-NOR: Symbol, Equivalent Circuit & Truth-table. 2.2 NAND as Universal gates - Develop basic gates using NAND gate. 2.3 NOR as Universal gates - Develop basic gates using NOR gate. 2.4 Boolean Logic Operations, Laws of Boolean Algebra. 2.5 De-Morgan’s Theorems. 2.6 Simplification of given Boolean equations. 2.7 Converting Boolean expressions to logic circuits.	7	21%
3.	Unit 3 – Boolean Function Implementation 3.1 Boolean Expression: Need for simplification. 3.2 Sum of Product (SOP) expressions and examples. 3.3 Product of Sum (POS) expressions and examples. 3.4 Simplification by Karnaugh map method: 2 variable K-map, 3 variable K-map. 3.5 4-variable K-map and Don’t-Care conditions	05	15 %



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

	(Basic Problems).		
4.	<p>Unit 4 – Basic Combinational Circuits Arithmetic and Logical Combinational Circuits: Block diagram, Logic diagram, truth table and working: 4.1 Half Adder, Full Adder 4.2 Half Subtractor, Full Subtractor Data Transmission Combinational Circuit: 4.3 Multiplexers (Data Selectors) - 2 to 1 Mux, 4 to 1 Mux, 4.4 Multiplexers (Data Selectors) - 8 to 1 Mux, Applications. 4.5 Demultiplexer (Data Distributors): 1-2, 1-4, 1-8 Demultiplexer. 4.6 Encoder: Octal to Binary (8 to 3) & Decimal to BCD Encoder. 4.7 Decoder: 2 to 4 Decoder, 3 to 8 Decoder. 4.8 Decoder: BCD to Seven Segment Decoder.</p>	9	28%
5.	<p>Unit 5 – Sequential Circuits 5.1 Introduction to Sequential Circuits, Comparison between Combinational and Sequential Circuit. 5.2 Types of Flip-flops :- SR,D,T,JK, Master Slave JK Flip Flop 5.3 Explain the working of various Flip Flops with the help of truth table. 5.4 Applications of Flip-flops. Use of flip-flops or latches to store data, act as a memory device or transfer data through a shift register. 5.5 Describe the working of various types of shift registers. 5.6 4-bit Shift Register: Serial-In, Serial-Out Shift Register, 5.7 Serial-In, Parallel-Out Shift Register, 5.8 Parallel-In, Serial-Out shift Register, Parallel-In, Parallel-Out Shift Register using D flip flops. 5.9 Applications of Shift Registers. 5.10 Counters: Classification of Counters, Comparison between Asynchronous and Synchronous counters. 5.11 Four-bit Decade counter: Block diagram using JK flip-flops, truth table, timing diagram and working.</p>	11	15 %
6.	<p>Unit 6 – A to D And D to A Converters 6.1 Understand Analog to Digital and Digital to Analog Converters. 6.2 List the different types of A to D and D to A converters. 6.3 A to D converter specifications: Resolution, accuracy, settling time. 6.4 Describe the working of various types of A to D Converters & necessity of A to D converters. 6.5 D to A converter specifications: Resolution, accuracy, settling time. 6.6 Describe the working of various types of D to A converters & necessity of D to A converters.</p>	6	7%
	Total	45	100%



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
25 %	40 %	35 %	00	00	00

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) Reference Books:

- 1 "Fundamentals of Digital Circuits", A. Anand Kumar, PHI Learning Pvt. Ltd., 4th edition or latest edition, ISBN-13: 978-81-203-5268-1
- 2 "Digital Circuits", Dr. Menka Yadav, All India Council for Technical Education (AICTE), latest edition, ISBN-13: 978-81-959863-0-9 [E-book Available on AICTE e-KUMBH Website]
- 3 "Modern Digital Electronics", R. P. Jain, McGraw-Hill Education, 4th edition or latest edition, ISBN-13: 978-0070669116
- 4 "Digital Principles & Applications", Albert Paul Malvino & Donald P. Leach, McGraw Hill Education, 8th edition or latest edition, ISBN-13: 978-9339203405
- 5 "Digital Design", M. Morris Mano and Michael D. Ciletti, Pearson Education, 6th edition or latest edition, ISBN-13: 978-1292231167
- 6 "Digital Electronics: Principles and Applications", Albert Paul Malvino and Jerald A. Bates, McGraw-Hill Education, 8th edition or latest edition, ISBN-13: 978-0073373775
- 7 "Digital Systems: Principles and Applications", Ronald J. Tocci, Neal S. Widmer, and Gregory L. Moss, Pearson Education, 12th edition or latest edition, ISBN-13: 978-0134220137
- 8 "Digital Fundamentals", Thomas L. Floyd, Pearson Education, 11th edition or latest edition, ISBN-13: 978-0132737965
- 9 "Principles of Digital Electronics", K. Meena, PHI Learning Pvt. Ltd., Fourth Printing, 2013
- 10 "Digital Electronics", Sanjay Sharma, S.K. Kataria & Sons, latest edition
- 11 "Digital Electronics", Dr. B.R. Gupta & V. Singhal, S.K. Kataria & Sons, latest edition
- 12 "Digital Electronics (for Polytechnics)", Pratima Manhas & Shaveta Thakral, S.K. Kataria & Sons, latest edition

(b) Open-source software and website:



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

1. Circuit Simulation Websites:

- a. <https://www.tinkercad.com/>
- b. <https://wokwi.com/>
- c. <https://circuitverse.org/>
- d. <https://www.circuitlab.com/editor/>

2. Various Software: Psim, Matlab 2011a, Logic.ly, Logisim, Digital-Works, Multisim, Proteus, AMD Xilinx Vivado (Standard Edition), eSim (Oscad), Electronics Workbench etc.

3. Datasheets Websites: www.alldatasheet.com , www.datasheetcafe.com

4. Virtual Labs:

Virtual Labs Phase I: www.vlab.co.in

- a. DE-1 Lab: <https://de-iitr.vlabs.ac.in/List%20of%20experiments.html>
 - b. DE-2 Lab: <https://de-iitg.vlabs.ac.in/List%20of%20experiments.html>
 - c. DE Circuits Lab: <https://dec-iitkgp.vlabs.ac.in/List%20of%20experiments.html>
 - d. DE Logic Design Lab: <https://dld-iitb.vlabs.ac.in/List%20of%20experiments.html>
 - e. Hybrid Electronics Lab: <https://he-oep.vlabs.ac.in/List%20of%20experiments.html>
 - f. Digital Applications Lab: <https://daiitb.vlabs.ac.in/List%20of%20experiments.html>
 - g. ADE I Lab: <https://ade-iitr.vlabs.ac.in/List%20of%20experiments.html>
 - h. ADE II Lab: <https://ade2-iitr.vlabs.ac.in/List%20of%20experiments.html>
- Virtual Labs Phase II: <http://vlabs.iitkgp.ac.in/vlt/project.html>
- i. DE Circuits Lab: <http://vlabs.iitkgp.ac.in/dec/#>
- Virtual Labs Phase III: http://vlabs.iitkgp.ac.in/vlt/phase3_newlab.html
- j. Digital Logic Circuit Design Lab: <http://vlabs.iitkgp.ac.in/dlcd/loe.html>

5. E-books: AICTE e-KUMBH Books: <https://ekumbh.aicte-india.org/allbook.php>

6. NPTEL Course and Video Channels:

- a. NPTEL Courses Home: <https://nptel.ac.in/courses> , www.youtube.com/nptelhrd
- b. DE Circuits: <https://nptel.ac.in/courses/108105132> , <https://tinyurl.com/4myfp3vx>
- c. NPTEL Course - Digital Circuits: <https://nptel.ac.in/courses/108105113>
- d. AICTE mapped courses on SWAYAM: https://nmeict.ac.in/?page_id=1466, https://nmeict.ac.in/?page_id=3937, NMEICT: <https://nmeict.ac.in/#>
- e. GTU Lectures: <https://lectures.gtu.ac.in/listview.aspx?br=09&course=DI>

7. Other Learning Websites:

- a. <https://www.tutorialspoint.com/digital-electronics/index.htm>



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

- b. <https://www.electronicshub.org/tutorials/>
- c. <https://www.javatpoint.com/digital-electronics>
- d. <https://www.electrically4u.com/category/digital-logic-circuits/>
- e. <https://www.daenotes.com/electronics/digital-electronics>
- f. <https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/#blg/?ref=ghm>
- g. <https://archive.nptel.ac.in/courses/108/106/108106177/>
- h. <https://learn.circuitverse.org/>
- i. <https://www.khanacademy.org/computing/computers-and-internet>
- j. www.instructables.com/search/projects/circuits?q=Digital+Electronics&projects=all
- k. <https://ocw.mit.edu/>
- l. <https://www.electronics-tutorials.ws/>
- m. <https://www.allaboutcircuits.com/>
- n. <https://study.com/> , <https://www.sparkfun.com/>
- o. www.slideshare.net/
- p. www.asic-world.com/digital/tutorial.html
- q. <https://electrical-engineering-portal.com/technical-articles/categories>

Suggested Course Practical List:

Sr. No.	Practical Outcome/Title of experiment	Unit No.	CO	Approx. Hours required
1	Convert Number from One Number system to another and Implement Various Operations on it.	1	1	4
2	Build a circuit on breadboard to Convert 4-bit Binary to Gray Code using logic gates.	1	1	2
3	Analyze specifications of digital logic ICs from datasheets to understand pin configurations, truth tables, ratings and applications.	2	2	2
4	Build a circuit on breadboard and verify the truth tables of the different Logic Gates.	2	2	2
5	Build a circuit on breadboard and test basic Gates using NAND Universal Gate.	2	2	2
6	Build a circuit on breadboard and test basic Gates using NOR Universal Gate.	2	2	2



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

7	Build a circuit on breadboard to verify De Morgan's theorems.	2	2	2
8	Implement and realize Boolean Expressions with Logic Gates.	2	2	2
9	Simplify given Boolean expression using K-map and design Logic Circuit using basic logic gates.	3	3	4
10	Simplify given Boolean expression using K-map and design Logic Circuit using Universal gates.	3	3	4
11	Build a circuit on breadboard and test Half Adder Circuit.	4	4	2
12	Build a circuit on breadboard and test Full Adder Circuit.	4	4	2
13	Build a circuit on breadboard and test Half Subtractor Circuit.	4	4	2
14	Build a circuit on breadboard and test Full Subtractor Circuit.	4	4	2
15	Build a circuit on breadboard and test Eight channel Multiplexer and Demultiplexer.	4	4	2
16	Build a circuit on breadboard and test the 4-bit Decoder circuit.	4	4	2
17	Build a circuit on breadboard and test the 4-bit Encoder circuit.	4	4	2
18	Simulate any digital logic circuit with the help of simulation software.	4	4	2
19	Build a circuit on breadboard and test the working of the R-S Flip-Flop.	5	4	2
20	Build a circuit on breadboard and verify the truth table of D Flip-Flop.	5	4	2
21	Build a circuit on breadboard and verify the truth table of JK Flip-Flop.	5	4	2
22	Build a circuit on breadboard and verify the truth table of master-slave JK Flip-Flop.	5	4	2
23	Build and test the working of the Shift Register.	5	4	2
24	Build and test the working of the Decade counter.	5	4	2
25	Build 4-bit ripple counter in count-up mode using J-K flip-flop.	5	4	2

List of Laboratory / Learning Resources Required:

1. Digital Logic trainer Kit.
2. Bread board with connecting wires & various logic input/output facilities (2 Power, 2 ground rails, 2 circuit areas, contact points > 200, Volt > 15 V, Current > 1 A)
3. Batteries, Connecting Wires/ Jumper Wires, LEDs, Resistors, Inductors and Capacitors of various range and types.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

4. Digital IC tester.
5. Digital Storage Oscilloscope.
6. Digital Function Generators.
7. Digital Multi meter (3-1/2-digit display, 9999 counts digital multi meter measures: Vac, V_{dc} (1000V max), I_{dc}, I_{ac} (10-amp max), Resistance (0 - 100 MA), Capacitance and Temperature measurement).
8. Variable DC Power Supply (0- 30V, 0-2 A, 0-5 A, SC protection, display for voltage and current).
9. Electronic Work Bench: Bread Board 840-1000 contact points, Positive and Negative power rails on opposite side of the board, 0-30 V, 2 Amp Variable DC power supply, Function Generator, 0-2MHz, CRO 0-30MHz Digital Multi meter.
10. Various ICs like:
Logic Gate ICs like AND (7408), OR (7432), NOT (7404), NAND (7400), NOR (7402), EX-OR (7486), and EX-NOR (74266)
Combinational Circuit IC like Multiplexer (74151, 74153), Demultiplexer (74138, 74139), Encoder (74147, 74148), Decoder (7442, 7447), Adder/Subtractor (7483, 74283), Comparator (7485)
Sequential Circuit ICs Like Flip-Flops (7474, 7476), Counters (7490, 7493, 74160, 74163), Shift Registers (7495, 74164, 74165), Latches (7475, 74373)

Suggested Project List:

Suggested Project List as given below:

1. Prepare a Comparison Chart Illustrating All Number Conversion (with 1 Ex.) in Single Chart.
2. Prepare Number Conversion Solution Bank for All Practice Problem Given in Any book.
3. Make (1) Binary to Grey Code Conversion and (2) Grey to Binary Code Conversion Circuit.
4. Make (1) 3-byte odd parity generator, (2) 4-byte odd parity generator and Even parity generator circuit.
5. Make Chart on (1) Code Conversion (2) ASCII code and EBCDIC code.
6. Make a Chart showing Pulsed Operation of Logic Gates. [Outputs of different gates against different Inputs (Square wave, etc having different frequencies) waveforms are given as Input.] [You can also Analyze Drawback of Combinational Circuits and Need of Memory Element that can be Fulfilled using Flipflop.] (Reference Book 1,



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

Chapter 4)

7. Logic Gate Based Practical Application Circuits.
8. Simulate and/or Implement Logic Circuits to Verify Laws Boolean Algebra or De-Morgan's Theorems.
9. Simulate (On Tinker cad or Wokwi) and/or Implement Logic Circuit on Breadboard for Boolean expression. Ex. $Y = A\bar{B} + \bar{A}B + C$
10. Simulate (On Tinker cad or Wokwi) and/or Implement Logic Circuit on Breadboard using Universal gates Ex. (1) AND gates using NAND gates. (2) OR gates using NAND gates (3) AND gates using NOR gates. (4) OR gates using NOR gates.
11. Simulate (On Tinker cad or Wokwi) and/or Make Circuit on Breadboard of Different Combinational Circuits. Ex. (1) Adder, Subtractors using All Available Options (2) All Multiplexer (3) All Demultiplexer (4) Octal to Binary (8 to 3) Encoder (5) 2 to 4 decoder (6) common anode 7 segment display circuit to display 0-9 etc.
12. Prepare a Chart on Comparison of All Flip-Flops.
13. Prepare a Chart on Detailed Working / Operation of Each Flipflop showing Explanation with Detailed Table showing Current and Next State Values.
14. Simulate (On Tinker cad or Wokwi) and/or Make Circuit on Breadboard of Various Sequential Circuits. Ex. (1) All Shift Registers (2) All Up / Down Counters, (4) IC - 7490 Decade Counter and Many More.
15. Collection and Compilation Report on Different Digital ICs Datasheets. (ICs List Available in Appendix of Reference Book 1)
16. Prepare a report on different IC packages and mention different scales of integration. Also Compare Performance of TTL and CMOS based ICs and their Identification.
17. K-map based Logic Circuit Implementation Problem: A staircase light is controlled by two switches; one is at the top of the stairs and the other at the bottom of the stairs.
 - (a) Make a truth table for this system.
 - (b) Write the logic equation in the SOP form.
 - (c) Realize the circuit using AOI logic.Realize the circuit using minimum number of (i) NAND gates, (ii) NOR gates. (Example Problem is Given, Similar Problems in Reference Book 1 Chapter 6)

Suggested Activities for Students:

Beyond classroom and laboratory learning, the following co-curricular activities are recommended to enhance the achievement levels of various outcomes in this course.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Renewable Energy

Subject Code: DI04064011

Subject Name: Digital Electronics & Digital Instruments

Students are encouraged to undertake these activities either individually or in groups and prepare comprehensive reports of approximately five pages for each activity.

1. Make Practical Kit for Circuit Implementation and Undertake Micro-Projects in team/individually.
2. Chart and Project Model Presentations: Demonstrate project models or deliver seminars on various topics covered in the course content.
3. Numerical Problem Solving: Solve the numerical problems provided by the subject faculty in tutorial and Prepare their solutions Book.
4. Solve real life problems using logic theory and implement them using digital logic circuits.
5. List the ICs used for different logic gates, Flip-flops, Shift registers, Counters with their pin diagram.
