GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-202)
Semester-IV

Course Title: Digital Electronics & Digital Instruments
(Course Code: 4340904)

Diploma programmer in which this course is offered	Semester in which offered
Electrical Engineering	4th semester

1. RATIONALE

Digital electronics has invaded all branches of engineering and electrical engineering in particular. Hence it is essential that the diploma electrical engineer have a sound understanding of the basic fundamentals of digital electronics. The tremendous power and usefulness of digital electronics can be seen from the wide variety of industrial and consumer products, such as automated industrial machinery, computers microprocessors, pocket calculators, toys, microwave ovens, cellular phones, digital watches, microcontrollers, digital life support machines, real time systems and clocks, TV games etc. which are based on the principles of digital electronics. The digital systems with some kind of human interface will perform highly complex tasks with very high reliability and speed, unattainable by any other means Similarly digital instruments are replacing the analog instruments. Therefore, this course has been designed so that basic skills to operate and maintain the basic digital circuits and digital instruments are developed in the students.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

Maintain digital electronic circuits and instruments.

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Perform computational activities using digital techniques.
ii. Use digital integrated circuit and logic family chips
iii. Build sequential and combinational logic circuits.
iv. Analyse working of A/D and D/A converters.
v. Select different digital meters for measurements.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the PrOs marked '*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Build a circuit to Convert 4-bit Gray to Binary Code using logic gates.	I	2
2	Build a circuit to Convert 4-bit Binary to Gray Code using logic gates.	I	2
3	Verify the truth table of the different Logic Gates**.**	II	4*
4	Build and test 2 input basic logic Gates using NAND Gate.	II	2*
5	Build and test 2 input basic logic Gates using NOR Gate.	II	2*
6	Verify Demorgan's theorems.	III	4*
7	Build and test the logic circuit for a given Boolean Expression.	III	2
8	Build and test Half Adder Circuit.	III	2*
9	Build and test Full Adder Circuit.	III	4
10	Build and test Half Subtractor Circuit.	III	2*
11	Build and test Full Subtractor Circuit.	III	4
12	Test Eight channel Multiplexer and Eight channel Demultiplexer.	III	4
13	Build/Test the 4 bit Decoder circuit for seven segment display	III	2
14	Build/Test the 4 bit encoder circuit for seven segment display	III	2
15	Build and test 3 to 8 line decoder circuit.	III	2
16	Build and test 8 to 3 line encoder circuit	III	2
17	Display various alphanumeric characters on BCD and Seven segment LED Display	III	4
18	Build and test the working of the R-S Flip-Flop	IV	2*
19	Build and verify the truth table of D Flip-Flop.	IV	2

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
20	Build and verify the truth table of J-K Flip-Flop.	IV	2
21	Build and verify the truth table of master – slave J-K Flip-Flop.	IV	4
22	Build and test the working of the Shift Register.	IV	4
23	Build and Test the working of the Decade counter	IV	2
24	Build 4-bit ripple counter in count-up mode using J-K flip-flop.	IV	4
25	Convert given analog signal to 4 bit Digital output using ADC	V	4
26	Convert the given digital signal to analog output using DAC.	V	4
27	Build and Test various digital circuits with the help of simulation software and digital instruments	VI	2
	Minimum 10 Practical Exercises		28

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices.	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	Digital logic trainer kit	1 to 7
2	Combinational circuit trainer kit	8 to 11

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
3	Multiplexer and Demultiplexer trainer kit	12
4	Encoder and decoder trainer kit	13 to 16
5	BCD to 7-segment LED display trainer kit	17
6	Flip-flop trainer kit	18 to 21
7	Register Trainer Kit	22
8	Universal Counter Trainer kit	23 & 24
9	ADC and DAC converter kit	25 & 26
10	Simulation software	27

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** psychomotor &Affective Domain Outcomes (Pos& ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member(while doing a micro-project)
b) Follow safety practices while using trainer kit.
c) Work as a group member (while performing experiments and taking readings)
d) Follow ethical practices.
e) Practice environmental friendly methods and processes. (Environmentrelated)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit-I Number Systems	1a. Convert numbers from one to another system 1b. Perform binary	1.1 Introduction 1.2 Number Systems: 1.2.1 Decimal Number System

Unit	Major Learning Outcomes	Topics and Sub-topics
	arithmetical operations. 1c. State 1's complement and 2's complement numbers for a given binary number and perform addition and subtraction. 1d. Explain various types of binary codes and its applications.	1.2.2 Binary Number System 1.2.3 Octal Number System 1.2.3 Hexadecimal Number System. 1.3 Conversion of Number from one Number system to Another Including decimal points. 1.4 Arithmetic operations with binary numbers: 1.4.1 Binary Addition 1.4.2 Binary Subtraction 1.4.3 Binary Multiplication 1.4.4 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, BCD, Gray Code,Excess-3 Code and Alphanumeric Codes.
Unit– II Logic Gates And Logic Families	2a. Differentiate different logic levels 2b. List the logic gates. 2c. Explain the operations of different types of gates in digital circuits. 2d. Prepare the truth table of Different types of gates OR,AND,NOT,NAND,NOR, EX-OR AND EX-NOR. 2e. Develop basic gates using Universal gates. 2f . Explain the features of various logic families and Characteristics of Digital ICs.	2.1 Concept of Positive Logic and negative Logic Levels. 2.2 Definition, symbols and truth tables of NOT, AND, OR, NAND,NOR,EX-OR and EX-NOR Gates. 2.3 NAND and NOR as Universal gates. 2.4 Various scales of Integration: SSI, MSI, LSI, VLSI and ULSI. 2.5 Classification of logic families. 2.6 Characteristics of Digital ICs : Logic Voltage level, Fan in, Fan out, Noise margin, Propagation Delay, Power Dissipation, Figure of Merit with reference to logic families. 2.7 Introduction to Resistor Transistor Logic and Diode Transistor Logic. 2.8 Basic logic gates using NMOS, PMOS and CMOS.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit– III Boolean Algebra and Combinational circuits.	3a. Create truth tables and Boolean expressions for basic logic gates. 3b. Apply laws of Boolean Algebra to logic diagrams and truth table to minimize the circuit size necessary to solve a design problem. 3c. State the need for De-Morgan's theorems & Apply De-Morgan's theorems and other postulates to simplify Boolean expressions to reduce resources used in the design and production of circuits. 3d. Build logic circuit for a given Boolean expression. 3e. Construct truth tables from logic expressions and vice versa. 3f. Build various combinational circuits. 3g. Design, construct and test adder circuits using logic gates to perform basic addition and subtraction using a binary numbering system. 3h. Explain the operation of multiplexer, De-multiplexer and Encoder. 3j.Describe the working of 3 to 8 decoder and BCD to Seven segment decoder	3.1 Laws of Boolean algebra. 3.2 Demorgan's theorems. 3.3 Simplification of given Boolean equation. 3.4 Converting Boolean expressions to logic circuits and vice versa. 3.5 Converting Boolean expression to truth tables and vice versa. 3.6 Block diagram of combinational circuits. 3.7 Adders: Definition and Types. 3.8 Half Adder: Block diagram, Logic diagram, truth table and working. 3.9 Full Adder: Block diagram, Logic Diagram ,truth table and it's working. 3.10 Types of subtractors. 3.11 Half Subtractor: Block diagram, Logic diagram, truth table and working 3.12 Full Subtractor: Block diagram, truth table and working. 3.13 Multiplexers: Definition, block diagram. 3.13.1 Classification of Multiplexer. 3.13.2 Basic 2:1 Multiplexer. 3.13.3 4:1 Multiplexer. 3.13.4 8:1 Multiplexer 3.13.5 Applications of MUX. 3.14 Demultiplexers: Block diagram. 3.14.1 Classification of Demultiplexer. 3.14.2 Basic 1:2 Demultiplexer. 3.14.3 1:4 Demultiplexer. 3.14.4 1:8 Demultiplexer 3.15 Encoders: 3.15.1 Octal to Binary Encoder, 3.15.2 Decimal to BCD Encoder 3.16 Decoders: 3.16.1 3-Line-to-8-Line Decoder, 3.16.2 BCD-to-Seven Segment Decoders.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit- IV Sequential	4a. Understand the working of	4.1 Block diagram of sequential

Unit	Major Learning Outcomes	Topics and Sub-topics
Circuits	Sequential Logic circuits. 4b. Explain the working of various Flip Flops with the help of truth table. 4c. Use of flip-flops or latches to store data, act as a memory device or transfer data through a shift register. 4d. Describe the working of various types of shift registers. 4e. Draw the waveform of Asynchronous and Synchronous counter 4f. Demonstrate the differences associated with asynchronous and synchronous circuits. 4g. Illustrate the decade counter and its waveforms. 4h. Compare and evaluate how sequential logic determines the operation of a circuit waveform and how a truth table can be used to predict an outcome.	circuits. 4.2 Comparison of Sequential Circuits with Combinational circuits 4.3 Concept of level and edge triggering. 4.4 Types of Flip-flop. 4.5 R-S flip-flop and clocked R-S flip-flop: Block diagram, truth table, logic diagram using NAND gates and working. 4.6 D flip-flop: Block diagram, truth table, logic diagram and working. 4.7 JK flip-flop: Block diagram, truth table, logic diagram using NAND gates and working 4.8 Master slave JK flip flop with preset and clear input: block diagram only, truth table and working. 4.9 Applications of Flip-flops. 4.10 Shift Register: 4-bit Shift Register: Serial-In, Serial-Out Shift Register, Serial-In,Parallel-Out ShiftRegister, Parallel-In,Serial-Out ShiftRegister, Parallel-In, Parallel-Out Shift Register using D flip flops. 4.11 Applications of Shift Registers. 4.12 Counters: Classification of Counters, Comparison between Asynchronous and Synchronous counters. 4.13 Four-bit Decade counter : Block diagram using JK flip-flops, truth table, timing diagram and working.
Unit-V **A to D And D to A Converters**	5a. Understand Analog to Digital and Digital to Analog Converters. 5b. List the different types of A to D and D to A converters. 5c. Describe the working of various types of A to D Converters & necessity of A to D converters 5d. Describe the working of	5.1 Necessity of A to D and D to A converters.. 5.2 D to A converter specifications: Resolution, accuracy, settling time. 5.3 Digital to Analog conversion: 5.3.1 Weighted Resistor Network type 5.3.2 Binary Ladder Network type 5.4 Analog to Digital conversion:

Unit	Major Learning Outcomes	Topics and Sub-topics
	various types of D to A converters & necessity of D to A converters.	5.4.1 Successive approximation type 5.4.2 Counter OR Staircase type 5.5 Applications of A to D and D to A Converters.
Unit-VI Digital Instruments	6a. State the features of digital instruments over Analog instruments. 6b. Draw the block diagram of digital instruments and explain each block. 6c. Explain the working of various Digital instruments with block Diagram.	6.1 Comparison of digital instrument with analog instrument. 6.2 Basic building blocks of digital instruments. 6.3 Types of Digital Voltmeter. 6.4 Ramp Type Digital Voltmeter. 6.5 Digital Multimeter. 6.6 Digital frequency Meter. 6.7 Digital watt meter 6.8 Digital energy meter .

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Number Systems	6	2	4	4	10
II	Logic Gates and Logic families	8	3	4	6	13
III	Boolean Algebra and Combinational Circuits	10	5	4	8	17
IV	Sequential Circuits	9	5	6	4	15
V	A to D and D to A Converters	4	2	2	3	07
VI	Digital Instruments	5	3	3	2	08
	Total	**42**	**20**	**23**	**27**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare solutions of different assignments given by subject faculty.

ii. Report writing on various topics from syllabus and beyond syllabus.
iii. Solve the numerical related to course contents.
iv. Prepare a report of different IC packages and mention different scale of integration.
v. List the ICs used for different logic gates with their pin diagram details.
vi. List the ICs used for Flip-flops, Shift registers, Counters with their pin diagrams.
vii. Build various combinational and sequential circuits using virtual lab/simulator softwares.
viii. Solve real life problems using binary logic theory and implement it using digital logic circuits.
Explore working of Digital Clock/Digital Panel.
ix. Student may validate the experimental results with that of results obtained using various simulation soft ware's.
x. Student may present seminar on a given topic from course content.
xi. Students may develop counters for practical use.
xii. Identification and checking ICs using IC Tester.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Visit to nearby electronic component manufacturing factories
c) Display of animation/video films on functioning of digital instruments.
d) Virtual Lab may be used to perform various practicals.
e) Introduce E-waste recycling technology among the students.
f) Guide students on how to address issues on environment and sustainability

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Build model to demonstrate logic gates
b) Build model of universal gates.
c) Build model of De-morgan's theorem.

d) Build model of various types adders and subtractors
e) Build model of encoder and decoder.
f) Build model of multiplexer and demultiplexer.
g) Build model of 3 to 8 line decoder using IC74LS138.
h) Build model of flip flops, shift registers and different counters.
i) Build model of A to D and D to A converter.
j) Build model of Decade Counter.
k) Prepare chart for various digital instruments.
l) Prepare chart for various combinational and sequential circuits.
m) Prepare chart of number systems.
n) Prepare chart for code conversion.
o) Rig up common anode 7 segment display circuit using Breadboard and display 0-9.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Digital Electronics	Sanjay Sharma	S.K.Kataria & sons.
2.	Digital Electronics	Dr.B.R.Gupta & V.Singhal	S.K.Kataria & sons.
3.	Digital Electronics (for Polytechnics)	Pratima Manhas Shaveta Thakral	S.K.Kataria & sons.
4.	Trouble shooting & Maintenance of Electronic equipments	K. Sudeep singh	S.K.Kataria & sons.
5.	Digital design : with an introduction to the verilog hdl	M. Morris Mano, Michael D. Ciletti	Pearson, 5th edition.
6.	Morden Digital Electronics	R P Jain	TMH
7.	Fundamentals of Digital circuits	A. Anand Kumar	PHI
8.	Digital Electronics	K. Meena	PHI
9.	Digital principles & Applications	Malvino. A. P., Leach D. P., Saha Goutam	Tata Mcgraw Hill Education Private Limited (2010), 7th Edition
10.	Pulse digital & switching wave forms	Millman & Taub	Mc. Graw Hill
11.	Electronic devices & circuits	Allen Mottershed.	Prentice Hall of India
12.	Principles of digital Electronics	Malvino & Leach	Tata Mc. Graw Hill
13.	Digital circuits & systems	Douglass V. Hall	Mc. Graw Hill
14.	Digital Electronics	B.R.Gupta	Dhanpat Rai & Co., New Delhi.

15.	Digital Systems,Principles and Applications	Ronald J. Tocci	Prentice Hall of India, New Delhi.
16.	Digital Electronics	Dr. R.S.Sedha	S. Chand
17.	Digital Circuits Design	S. Salivahanan, S. Arivazhagan	VIKAS Pub. House.
18.	Digital Electronics	P. RAJA	SCITECH Publication.
19.	Digital Electroncis Principles, Devices and Applications	Anil K. Maini	Wiley Publications
20.	Digital Integrated Electronics	Taub & Schilling	TMH

14. SOFTWARE/LEARNING WEBSITES

WEBSITES

1) www.nptel.iitm.ac.in
2) www.ocw.mit.edu
3) www.slideshare.net/
4) www.alldatasheet.com
5) www.nptl.iitm.ac.in
6) www.slideshare.net
7) www.authorstream.com
8) www.daenotes.com
9) www.youtube.com/nptelhrd
10) https://de-iitr.vlabs.ac.in/
11) https://dld-iitb.vlabs.ac.in/
12) http://vlabs.iitkgp.ac.in/dec/#

15. PO-COMPETENCY-CO MAPPING:

Semester I	**D.E. & D. I. (Course Code:4340904)**						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solution	PO4 Engineerig Tools, Experimen-tation&Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	**Maintain digital electronic circuits and instruments.**						

Course Outcomes							
CO1 Perform computational activities using digital techniques.	3	-	-	-	-	-	-
CO2 Use digital integrated circuits and logic family chips.	3	-	-	2	-	-	-
CO3 Build sequential and combinational logic circuits.	3	2	2	2	-	2	-
CO4 Analyse working of A/D and D/A converters.	3	2	-	2	-	-	-
CO5 Select different digital meters for measurements.	3	-	-	2	-	-	-

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Shri Jasmin M. Patel Lecturer Electrical Engg.	SSGP Surat	9825719595	jasminp@ymail.com
2.	Ms. Dipa J. Kapupara Lecturer Electrical Engg	AVPTI, Rajkot	9409111405	dipakapupara.ee@gmail.com
3.	Mrs. Upasna M. Patel Lecturer Electrical Engg.	SSGP Surat	9428464009	Ups180191@gmail.com