Government of Karnataka
Department of Collegiate and Technical Education
Board of Technical Examinations, Bangalore

Course Code	20EC11T	**Semester**	I
Course Title	**DIGITAL ELECTRONICS**	**Course Group**	Core
No. of Credits	4	**Type of Course**	**Lecture** (Theory and Demonstration /practice)
Course Category	EC	**Total Contact Hours**	4Hrs Per Week 52Hrs Per Semester
Prerequisites	Arithmetic, basic of electronics	**Teaching Scheme**	(L:T:P)= 4:0:0
CIE Marks	50	**SEE Marks**	50

i) RATIONALE

Innumerable logical and complex problems prevail in the real world which need quick and accurate solutions at low cost. The examples include: Counting number of people entering cinema hall; digital clock; playing video; phone call; transmission of document from one place to other; searching your unique ID in Aadhaar database; withdrawing money from ATM; booking railway ticket; and to check if a 25-digit number is a prime-number or not.

Inherent mapping of real-world problems to digital domain, ability of electronic circuits to process digital signals/binary signals and the support of Boolean algebra/relevant mathematical theories for simplification of circuits and reduction of time-complexity have made digital electronics the most suitable option for solving real-world problems. In fact, digital electronics can provide solutions at electronic-speed and low-cost owing to the enhancements in circuit design, fabrication technology and mass production. And the fact that the hardware of computer is digital electronic circuits elucidates the relevance of digital electronics and it learning. In this context, it is very essential to learn the basics of digital electronics to be a competent electronics professional.

ii) COURSE SKILL SET

The goal of the course is to help the student to attain the following industry-need competencies through various teaching-learning processes.

i) To understand the simple real-world logical problems and Learning to solve them through established methods.

ii) Perform analysis, design and troubleshoot well-known simple digital circuits in practical environment.
iii) To acquire the basic knowledge digital electronic integrated circuits and specifications.

iii) INSTRUCTIONAL STRATEGY

1. Teachers are suggested to take measures to create interest and enhance learning confidence in students.
2. Teachers should give examples from daily routine/realistic/real-world as well as relate to engineering/technology applications on various concepts and principles in each topic so that students are made to understand and grasp the concepts and principles. Wherever applicable SI units are followed.
3. Demonstration can make the subject interesting and develop scientific temper in the students. Student activities should be planned on all the topics.
4. Theory - Demonstrate/practice-Activity approach may be followed throughout the course so that learning may be outcome and employability based.
5. All demonstrations/Hand-on practices are under simulated environment (may be followed by real environment as far as possible).

iv) COURSE OUTCOMES (COs)

On successful completion of the course, the students will be able to

CO1	Identify and apply arithmetic and conversion operations on different number systems
CO2	Formulate, simplify and implement simple logic functions
CO3	Build/design and analyze various combinational circuits
CO4	Identify and select digital integrated circuits (ICs) for simple applications

v) COURSE TOPICS

Unit No	Unit Name	Hours
1	Number Systems and Codes	8
2	Basic Logic Circuits	14

3	Arithmetic Circuits	9
4	Multiplexers and Demultiplexer	8
5	Encoders and Decoders	7
6	Logic Families	6
	Total	**52 hrs**

vi) COURSE CONTENTS

The following topics/sub topics is to be taught and assessed in order to develop Unit Skill sets for achieving CO to attain identified skill sets

Course Content Delivery	Learning Method	Duration L:P (Hr)
UNIT –I: NUMBER SYSTEMS AND CODES (8Hr)		
1.1Comparison between analog and digital signals with real-world examples. Number systems: Binary, Octal, Decimal and Hexadecimal. Relevance and examples.	Teaching, examples and exercises	1:0
1.2 Conversion between number systems with examples	Teaching, examples and exercises	2:0
1.3 Arithmetic operations-Addition, Subtraction, Multiplication and Division on binary numbers with examples.	Teaching, examples and exercises	1:0
1.4 Addition and subtraction of Hexadecimal numbers. 1's & 2's complement of binary numbers with examples.	Teaching, examples and exercises	1:0
1.5 Application of Complement numbers: Representation of signed binary numbers and Example for realizing subtraction using addition.	Teaching, examples and exercises	1:0
1.6 Codes: Relevance, types (BCD, Gray, Excess-3, ASCII and EBCDIC) with examples and applications.	Teaching, examples and exercises	1:0

1.7 BCD Addition, Conversion between BCD and Decimal, Binary and Gray Numbers, Decimal and Excess-3 with examples.	Teaching, examples and exercises	1:0
UNIT –2: BASIC LOGIC CIRCUITS (14Hr)		
2.1 Boolean algebra: Constants, variables, functions, Logic-gates (NOT, OR, AND, NOR, NAND, EX-OR and EX-NOR): Symbol, function,expression and truth-table.	Teaching, examples and exercises. Hands-on demonstration/practic e for all logic gates	1:1
2.2. Boolean identities and laws with proof and examples.	Teaching, examples and exercises	1:0
2.3 De Morgan's and Duality Theorem with proof and examples.	Teaching, examples and exercises Hands-on demonstration/practic e for De Morgan's theorem	1:1
2.4 Universal gates: Concept, examples, relevance and realization of all logic gates using NAND gate.	Teaching, examples and exercises	1:0
2.5 Realization of all logic gates using NOR gate.	Teaching, examples and exercises	1:0
2.6 Simplification of Boolean expressions using Boolean algebra and build the logic circuit.	Teaching, examples and exercises	1:0
2.7 SOP and POS forms, Conversion into standard SOP and POS forms.	Teaching, examples and exercises	1:0
2.8 Translate SOP and POS expressions into truth-table, Convert truth-table to SOP and POS expressions (maximum 4 variables).	Teaching, examples and exercises	1:0
2.9 SOP to POS & POS to SOP conversion	Teaching, examples and exercises	1:0

2.10 Karnaugh Map: Need, K-map for 2 variable, 3 variable and 4 variable Boolean expression.	Teaching, examples and exercises	1:0
2.11 Simplification of Boolean expression using K- map and realization of logic circuit for 2 and 3 variable.	Teaching, examples and exercises	1:0
2.12 Simplification of Boolean expression using K- map and realization of logic circuit for 4 variable	Teaching, examples and exercises	1:0
UNIT –3: ARITHMETIC CIRCUITS (9Hr)		
3.1 Features of combinational circuits and examples. Half adder (HA): Concept, truth-table, logical expression, gate-level implementation and application.	Teaching, examples and exercises	1:0
3.2 Full adder (FA): Concept, truth-table, logical expression, gate-level implementation and application. List of FA ICs.	Teaching, examples and exercises. Hands-on demonstration/practice FA using gates	1:1
3.3 Half Subtractor (HS): Concept, truth-table, logical expression, gate-level implementation and application.	Teaching, examples and exercises	1:0
3.4 Full Subtractor (FS): Concept, truth-table, logical expression, gate-level implementation and application.	Teaching, examples and exercises	1:0
3.5 Serial & Parallel adders: Concept, comparison & applications.	Teaching, examples and exercises.	1:0
3.6 Three-bit parallel adder circuit: Given the circuit, analyze it's working.	Teaching, examples and exercises.	1:0
3.7 Two-bit magnitude comparator: Concept, truth-table, logical expression, gate-level implementation and application. Identify ICs	Teaching, examples and exercises. Hands-on demonstration/practice of 2-bit Magnitude Comparator using IC or gate-levelcircuit.	1:1

UNIT –4: MULTIPLEXERS AND DEMULTIPLXERS (8 Hr)		
4.1Multiplexers (Mux): Concept, relevance and applications, 2:1 Mux: Symbol, truth-table, logical expression, gate-level implementation and application. Identify ICs	Teaching, examples and exercises	1:0
4.2High-order Mux: Concept, examples (4:1, 8:1, and 16:1), Relation between number of inputs and control lines.	Teaching, examples and exercises. Hands-on demonstration/practice: 4:1 using 2:1 Mux or 8:1 using 4:1 Mux, using ICs.	1:1
4.3 Realization of high-order (4:1) Mux using low-order (2:1) Mux. List Mux ICs.	Teaching, examples and exercises	1:0
4.4Realization of logic gates and simple logic equations using multiplexers. (Max. 3variables)	Teaching, examples and exercises	1:0
4.5Demultiplexer (Demux): Concept, relevance and applications. 1:2 Demux: Symbol, truth-table, logical expression, gate-level implementation and application.	Teaching, examples and exercises	1:0
4.6High-order Demux: Concept and examples (1:4, 1:8, 1:16), relation between number of outputs and control lines. Analysis of Demux: Given 1:4 Demux, write logical expressions and truth table.	Teaching, examples and exercises Hands-on practice for 1:8 using 1:4 Demux, using ICs	1:1
UNIT –5: ENCODERS AND DECODERS (7 Hr)		
5.1 Encoders and Decoders: Relevance and applications.	Teaching, examples and exercises	1:0
5.2 Decimal-to-BCD encoder: Logic diagram, working, truth-table and applications. List ICs	Teaching, examples and exercises. Hands-on demonstration/practice of an Decimal to BCD encoder	1:1

5.3 Priority Encoder: Relevance, Logic diagram, working and Truth Table. Identify IC	Teaching, examples and exercises	1:0
5.4 BCD-to-Decimal decoder: Logic diagram, working and truth-table	Teaching, examples and exercises	1:0
5.5 Seven-segment display: Principle and types. Identify ICs for 7-segment display and Decoder.	Teaching, examples and exercises.	1:0
5.6 BCD-to-seven segment decoder: Logic diagram, working and truth table	Teaching, examples and exercises. Hands-on demonstration/ practice on BCD to Seven Segment decoder	0:1
UNIT –6: LOGIC FAMILIES (6Hr)		
6.1 ICs: Concept, advantages and disadvantages. IC classification: Based on scale of integration. Concept, need and types of logic families	Teaching, examples and exercises	1:0
6.2 Logic family specifications: Propagation delay, fan-out, fan-in, power dissipation, noise margin, speed and speed-power product. 6.3 IC data sheet: Identify the specifications in typical standard TTL IC	Teaching, examples and exercises. Demonstration of IC datasheet interpretation	1:0 0:1
6.4 Features of Standard TTL, CMOS & ECL. Identify TTL/CMOS/ECL NAND gate ICs and compare their specifications.	Teaching, examples and exercises.	1:0
6.5 Interfacing between TTL and CMOS: Need, concept and precautions. Handling of ICs and ESD.	Teaching, examples and exercises. Demonstration of ICs' handling / placement /removal on IC base/ sockets with anti-ESD gloves	1:1

➢ SUGGESTED SPECIFICATION TABLE WITH CO'S, HOURS & MARKS.

Sl No.	COURSE OUTCOME	UNITS LINKED	TEACHING HOURS	DISTRIBUTION (THEORY MARKS)			
				R LEVEL	U LEVEL	A LEVEL	TOTAL
1	Identify and apply arithmetic and conversion operations on different number systems	1	08	5	10	15	**30**
2	Formulate, simplify and implement simple logic functions	2	14	15	20	15	**50**
3	Build/design and analyze various combinational circuits	3,4,5	24	25	35	40	**100**
4	Identify and select digital ICs for simple applications	6	06	10	5	5	**20**
Cognitive-level marks share (Total) →			**52**	**55**	**70**	**75**	**200**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy).

➢ MAPPING OF COS, POS, COGNITIVE LEVELS, LECTURES AND PRACTICES.

CO No.	Course Outcome	POs Mapped	Units Linked	Cognitive Level R/U/A	Lecture Sessions in Hrs	Demonstration/ Hands-on practice in Hrs	TOTAL
CO1	Identify and apply arithmetic and conversion operations on different number systems	1,2,5	1	R/U/A	08	0	08
CO2	Formulate, simplify and implement simple logic functions	1,2,3,4	2	R/U/A	12	2	14
CO3	Build/design and analyze various combinational circuits	1,2,3,4	3,4,5	R/U/A	18	6	24
CO4	Identify and select digital ICs for simple applications	1,5	6	R/U/A	04	2	06
				Total	42	10	**52**

vii) UNIT SKILL-SETS

Unit	Unit Name	Skill Set
1	Number Systems and codes	Comprehend the number systems, operate (conversion, addition and subtraction) on different number systems, identify and select the codes for different applications
2	Boolean Algebra	Translate the problem to truth-table, simplify thelogical expressions using Boolean identities/ laws/K-maps, and implement the logical functions.
3	Arithmetic Circuits	Given simple arithmetic problems, solve using digital circuits and vice-versa (analysis). Identify arithmetic circuits ICs for simple applications.
4	Multiplexers and Demultiplexer	Solve simple multiplexing and demultiplexing problems, vice-versa (analysis). Identify multiplexing ICs for simple multiplexing applications.
5	Encoders and Decoders.	Solve simple coding/decoding problems, and identify coding ICs for simple coding applications.
6	Logic Families	Identify and select the ICs from different IC families based-on application specifications.

viii) MAPPING BETWEEN COs AND POs

Course	COs	Programme Outcomes (POs)						
		1	2	3	4	5	6	7
Digital Electronics	CO1	3	2	0	0	1	0	0
	CO2	3	2	1	1	0	0	0
	CO3	3	2	1	2	0	0	0
	CO4	3	0	0	0	1	0	0

Legends:
Level 3- Highly Mapped, **2-**Moderately Mapped, **1-**Low Mapped, **0-** Not Mapped

ix) SUGGESTED LEARNING RESOURCES:

Reference Books

i) Digital fundamentals Thomas L. Floyd, PEARSON EDUCATION publication, Eleventh edition Global Edition, ISBN 10: 1-292-07598-8, ISBN 13:978-1-292-07598-3.
ii) Digital Electronics principles and integrated circuits. Anil K. Maini. Wiley publications, first edition. ISBN:978-81-265-1466-3.
iii) Digital principles and applications. Donald P Leach, Albert Paul Malvino, GoutamSaha, McGraw Hill Publisher, 7th edition, ISBN:978-0-07-014170-4.
iv) Digital Systems-principles and applications. Ronald J. Tocci, Neal S.Widmer, Gregory L. Moss, Prentice Hall Publications, 8th edition, ISBN:0-13-085634-7.
v) Digital Computer Fundamentals,-Thomas C Bartee, McGraw-Hill Publisher,4th edition. ISBN 0-07-003892-9.

Web-based/onlineResources

1. https://www.electronics-tutorials.ws/
2. https://learn.sparkfun.com/
3. https://www.allaboutcircuits.com/textbook/digital/
4. http://electronicstheory.com/COURSES/ELECTRONICS/e101-1.htm
5. https://www.gadgetronicx.com/electronic-circuits-library/
6. https://www.electronics-lab.com/
7. https://learn.adafruit.com/
8. https://www.instructables.com/circuits/
9. https://www.digitalelectronicsdeeds.com/
10. https://www.electrical4u.com/digital-electronics/
11. https://www.tutorialspoint.com/digital_circuits/index.htm

x) Major Equipment/Instruments

1. Digital trainer kits.
2. Electronics simulation software's.
3. Computers.
4. IC tester, logic probes.

xi) SUGGESTED LIST OF STUDENTS ACTIVITYS for CIE

Note: The following activities or similar activities (as suggested by teacher/ identified by student in co-ordination with teacher) for assessing CIE (IA) for 20 marks (any one)

1. Simulate the working of a logic circuit using a suitable software tool.
2. Performing hands-on practice on design and simulation of digital circuits.
3. Motivate students to take case study on different ASICs (Application specific ICs) digital circuits to inculcate self and continuous learning.
4. Open end activities like
   Simulate a realistic digital circuit containing combination of logic gates.
   Collect the specification sheets of various logic ICs & prepare a Report.
   Record the best practices used in the disposal of E-waste and
   Precautions in the operation of digital systems.
5. Draw the pin diagram of IC's used for (a) Basic Gates (b) Combinational circuits.
6. Realize higher order Multiplexers/Demultiplexerusing lower order Multiplexers/Demultiplexer and experiment them under simulated environment.
7. Collect the real-world applications where combinational digital circuits are involved.

Execution Mode

- Maximum of 4 students in each batch.
- Write qualitative report not exceeding 8 pages; one report per batch.
- Each of the activity can be carried off class, and shall be presented to the teacher using suitable presentation mode
- Assessment shall be made based on quality of activity presentation/demonstration and report (Equal weightage for Information collection/Application, execution, report, and presentation and role in team) or the rubrics table may be followed for assessment purpose.

xii) COURSE ASSESSMENT AND EVALUATION CHART

Sl. No	Assessment	Mode	Schedule	Duration (Minutes)	Max. marks	Conversion of Max Marks
1.	CIE-IA1	Written-test	3 dWeek	80	30	**A**=(IA1+IA3+IA6)/3 Max. of A is 30 **B**=(IA2+IA4+IA5)/3 Max. of B is 20 A+B=50
2	CIE-IA2	MCQs/Quiz	5 Week	60	20	
3.	CIE-IA3	Written-test	7 Week	80	30	
4	CIE-IA4	Open-Book Written-	9 Week	60	20	

		test				
5	CIE-IA5	Activity/Assignment	11 Week	60	20	
6	CIE-IA6	Written-Test	13 Week	80	30	
				Total CIE	**50**	**50**
7.	**SEE**	Written	BTE Schedule	**3 hrs**	**100**	50
				Total(CIE+SEE)		100

Note:

i) Semester-end exam (SEE) is conducted for 100marks.
ii) Continuous internal evaluation (CIE) is for 50marks.
iii) IA1, IA3 and IA6 tests shall be conducted for 30 marks each; average of these IAs will b A.
iv) IA2 (Quiz/MCQs), IA4 (Open-book test) and IA5 (assignment/student activity) are conducted for 20 marks each; average of these IAs will be B. Appropriate rubrics may be used for evaluation. Open- book written test shall be to assess the analytical, reasoning, evaluation and creative skills/abilities of students.
v) Total CIE is average of A and B; any fraction shall be rounded-off to the next higher digit.
vi) Lecture: Practice sessions shall begin only after two weeks of Induction Program in First semester. The schedule of assessment week shall be counted only after 2 weeks of Induction Program.

RUBRICS FOR ACTIVITY

RUBRICS FOR ACTIVITY (10marks) (Example only) **Concerned faculty shall device appropriate rubrics as per the activity**						
Dimension	**Beginning**	**Developing**	**Satisfactory**	**Good**	**Exemplary**	**Student Score**
	4	**8**	**12**	**16**	**20**	
Collection of data	Does not collect any information relating to the topic	Collects very limited information ; some relate to the topic	Collect much information; but very limited relate to the topic	Collects some basic information; most refer to the topic	Collects a great deal of information; all refer to the topic	8
Fulfill team's roles & duties	Does not perform any duties assigned to the team role	Performs very little duties but unreliable.	Performs very little duties	Performs nearly all duties	Performs all duties of assigned team roles	6

Shares work equally	Always relies on others to do the work	Rarely does the assigned work; often needs reminding	Usually does the assigned work; rarely needs reminding	Normally does the assigned work	Always does the assigned work without having to be reminded.	8
Listen to other Team mates	Is always talking; never allows anyone else to speak	Usually does most of the talking; rarely allows others to speak	Talks good; but never show interest in listening others	Listens, but sometimes talk too much	Listens and speaks a fair amount	8
					Average / Total Marks: (8+6+8+8)/4	**7.5 = 8 marks**

xiii) Model Question Paper I A Test (CIE)

Programme:				**Semester: I**	
Course :				**Max Marks :30**	
Course Code :				**Duration : 1 Hr. 20minutes**	
Name of the course coordinator:				**Test :I/II/III**	
Note: Answer one full question from each section. One full question carries 10 marks.					
Qn. No	**Question**	**CL**	**CO**	**PO**	**Marks**
	Section -1				
1.a)					
b)					
c)					
2.a)					
b)					
c)					
	Section -2				
3.a)					
b)					
c)					
4.a)					
b)					
c)					

Section -3					
5.a)					
b)					
c)					
6.a)					
b)					
c)					

Model Question Paper

Model Question Paper
Semester End Examination

Programme:	**Semester: I**
Course :	**Max Marks: 100**
Course Code:	**Duration: 3 Hrs**

Instruction to the Candidate: Answer one full question from each section. One full question carries 20 marks.

Qn.No	Question	CL	CO	Marks
Section-1				
1.a)				
b)				
2.a)				
b)				
Section-2				
3.a)				
b)				
4.a)				
b)				
Section- 3				

5.a)				
b)				
6.a)				
b)				
Section-4				
7.a)				
b)				
8.a)				
b)				
Section-5				
9.a)				
b)				
10.a)				
b)				