

**DIGITAL TECHNIQUES****Course Code : 313303**

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Programme Name/s</b> | : Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Computer Technology/<br>Computer Engineering/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/<br>Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/<br>Electronics & Communication Engg./ Electronics Engineering/<br>Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Instrumentation/<br>Medical Electronics/ Computer Science/ Electronics & Computer Engg. |
| <b>Programme Code</b>   | : AI/ AN/ AO/ CM/ CO/ CW/ DE/ DS/ EJ/ EK/ ET/ EX/ HA/ IC/ IE/ IS/ MU/ SE/ TE                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Semester</b>         | : Third                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Course Title</b>     | : DIGITAL TECHNIQUES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Course Code</b>      | : 313303                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

**I. RATIONALE**

Digitization implies use of digital circuits in most of automation and industrial systems. The knowledge of logic gates, combinational and sequential circuits using discrete gates and digital ICs will enable students to interpret working of digital equipment and test their functionality.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:

Student will able to test the functionality of the digital circuits/system.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply number system and codes concept to interpret working of digital systems.
- CO2 - Apply Boolean laws to minimize complex Boolean function.
- CO3 - Develop combinational logic circuits for given applications.
- CO4 - Develop sequential logic circuits using Flip-flops.
- CO5 - Interpret the functions of data converters and memories in digital electronic systems.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

| Course Code | Course Title       | Abbr | Course Category/s | Learning Scheme          |     |     |       |       | Credits | Assessment Scheme |                |        |     |       |    |                  |     |    |    |             |     | Total Marks |
|-------------|--------------------|------|-------------------|--------------------------|-----|-----|-------|-------|---------|-------------------|----------------|--------|-----|-------|----|------------------|-----|----|----|-------------|-----|-------------|
|             |                    |      |                   | Actual Contact Hrs./Week |     |     | SL    | HL    |         | NLH               | Paper Duration | Theory |     |       |    | Based on LL & TL |     |    |    | Based on SL |     |             |
|             |                    |      |                   |                          |     |     |       |       |         |                   |                |        |     |       |    | Practical        |     |    |    |             |     |             |
|             |                    |      |                   | CL                       | TL  | LL  | FA-TH | SA-TH |         | Total             |                | FA-PR  |     | SA-PR |    | SLA              |     |    |    |             |     |             |
|             |                    |      |                   |                          |     |     |       |       |         |                   |                |        |     |       |    |                  |     |    |    |             |     |             |
| Max         | Max                | Max  | Min               | Max                      | Min | Max | Min   | Max   | Min     | Max               | Min            |        |     |       |    |                  |     |    |    |             |     |             |
| 313303      | DIGITAL TECHNIQUES | DTE  | DSC               | 3                        | -   | 2   | 1     | 6     | 3       | 3                 | 30             | 70     | 100 | 40    | 25 | 10               | 25# | 10 | 25 | 10          | 175 |             |

**DIGITAL TECHNIQUES****Course Code : 313303****Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

**V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT**

| Sr.No | Theory Learning Outcomes (TLO's) aligned to CO's.                                                                                                                                                                                                                                                                                                                                                                                                                   | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.                                                                                                                                                                                                                                                                                                                                                                                                                         | Suggested Learning Pedagogies. |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 1     | <p>TLO 1.1 Convert the given number from one number system to another number system.</p> <p>TLO 1.2 Perform arithmetic operations on binary numbers.</p> <p>TLO 1.3 Subtract given binary numbers using 1's and 2's complement method.</p> <p>TLO 1.4 Convert the given coded number into the other specified code.</p> <p>TLO 1.5 Write the application of the given code.</p> <p>TLO 1.6 Perform BCD addition and subtraction for the given Decimal numbers .</p> | <p><b>Unit - I Number Systems</b></p> <p>1.1 Number Systems: Types of Number Systems (Binary, Octal, Decimal, Hexadecimal), conversion of number systems</p> <p>1.2 Binary Arithmetic: Addition, Subtraction, Multiplication and Division</p> <p>1.3 Subtraction using 1's and 2's complement method</p> <p>1.4 Codes: BCD, Gray code, Excess-3 and ASCII code, Code conversions, Applications of codes.</p> <p>1.5 BCD Arithmetic: BCD Addition, Subtraction using 9's and 10's complement</p> | Lecture Using Chalk-Board      |

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| Sr.No | Theory Learning Outcomes (TLO's) aligned to CO's.                                                                                                                                                                                                                                                                                                                                                                             | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Suggested Learning Pedagogies.                                  |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| 2     | <p>TLO 2.1 Define the given characteristics parameters of the digital logic families.</p> <p>TLO 2.2 Draw symbol and truth table of given logic gates.</p> <p>TLO 2.3 Explain the concept of Buffer and Tristate logic .</p> <p>TLO 2.4 Implement basic gates and other gates with the help of universal gate.</p> <p>TLO 2.5 Simplify the given expression using Boolean laws and develop logic circuits .</p>               | <p><b>Unit - II Logic Gates and Boolean Algebra</b></p> <p>2.1 Logic Families: Characteristics Parameters of logic Families- Noise margin, Power dissipation, Figure of merit ,Fan in, Fan out, Speed of operation, maximum clock frequency supply voltage requirement ,power per gate , Comparison of TTL, CMOS and ECL logic family</p> <p>2.2 Introduction to positive and negative logic systems, Logic Gates: Symbol ,Truth table of Basic logic gates(AND,OR,NOT),Universal gates(NAND,NOR) and Special purpose gates(EX-OR,EX-NOR)</p> <p>2.3 Buffer: Tristate logic, Unidirectional and Bidirectional</p> <p>2.4 Boolean algebra : Laws of Boolean algebra, Duality Theorem ,De-Morgan's theorem</p>                                                                                                                                                      | Flipped Classroom<br>Lecture Using Chalk-Board                  |
| 3     | <p>TLO 3.1 Develop logic circuits for standard SOP/POS form of the given logic expression.</p> <p>TLO 3.2 Minimize the given logic expression using K-map (up to 4 variables).</p> <p>TLO 3.3 Design Adder and subtractor using K-map.</p> <p>TLO 3.4 Describe working of specified Encoder and Decoder with help of block diagram and truth table.</p> <p>TLO 3.5 Describe the working of Multiplexer and Demultiplexer.</p> | <p><b>Unit - III Combinational Logic Circuits</b></p> <p>3.1 Standard Boolean expression: Sum of products [SOP] and Products of Sum [POS], Min-term and Max-term, SOP-POS form conversion, realisation using NAND/NOR gates</p> <p>3.2 Boolean Expression reduction using K-map: Minimization of Boolean expressions (upto 4 variables) using SOP and POS form</p> <p>3.3 Arithmetic circuits : design Half and Full Adder using K-maps, design Half and Full Subtractor using K-maps , n bit adder and n bit subtractor .</p> <p>3.4 Encoder and Decoder: Functions of Encoder and Decoder, Block Diagram and Truth table, Priority Encoder (4:2, 8:3), BCD to 7 segment Decoder/Driver, Keyboard Encoder / decoder</p> <p>3.5 Multiplexer and Demultiplexer: Working, Truth table and applications of MUX and DEMUX. MUX tree, DEMUX tree, DEMUX as Decoder</p> | Flipped Classroom<br>Presentations<br>Lecture Using Chalk-Board |

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| Sr.No | Theory Learning Outcomes (TLO's) aligned to CO's.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Suggested Learning Pedagogies.                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| 4     | <p>TLO 4.1 Differentiate between Latch and Flip Flop.</p> <p>TLO 4.2 Explain basic memory cell and use relevant triggering technique for the given digital circuit.</p> <p>TLO 4.3 Describe the truth tables for the given Flip flops, applications of Flip flops.</p> <p>TLO 4.4 Use the given type of flip flop and its excitation table to design specific type of counter.</p> <p>TLO 4.5 Describe the working of specified shift register with the help of timing diagram.</p> <p>TLO 4.6 Design specified modulo-N counter using Flip flops .</p> <p>TLO 4.7 Design Ring /Twisted ring counter using given Flip-Flop.</p> | <p><b>Unit - IV Sequential Logic Circuits</b></p> <p>4.1 Difference between Combinational and Sequential Logic circuits, Time independent (un-clocked )and Time dependent ( Clocked ) logic system , Flips- Flops and Latch, Basic memory cell ,RS-Latch using NAND and NOR, Triggering methods- Edge trigger and Level Trigger</p> <p>4.2 Flip-Flops: S-R, J-K, T and D, Truth table and logic circuits of each flip-flop, Excitation table, applications</p> <p>4.3 Race around condition in JK flip-flop, Master- Slave JK Flip Flop</p> <p>4.4 Shift registers- Serial In Serial Out, Serial In Parallel Out, Parallel In Serial Out ,Parallel In Parallel Out,Bi-directional Shift register, 4-bit Universal Shift register</p> <p>4.5 Counters- Synchronous and Asynchronous counters, Modulus of counter, Ripple counter, Ring Counter, Twisted Ring Counter, Up – down counter, Decade Counter, MOD-N counter, Timing Diagram</p> | <p>Video Demonstrations Lecture Using Chalk-Board Simulation</p> |
| 5     | <p>TLO 5.1 Describe the working of the given type of DAC.</p> <p>TLO 5.2 Calculate the output voltage for the given digital input for specified DAC.</p> <p>TLO 5.3 Describe the working of the given type of ADC.</p> <p>TLO 5.4 Compare working of ROM,EPROM, EEPROM and Flash Memory .</p>                                                                                                                                                                                                                                                                                                                                   | <p><b>Unit - V Data Converters and Memories</b></p> <p>5.1 Digital to Analog Data Converter (DAC)- circuit diagram and working of Weighted resistor DAC and R-2R Ladder DAC, DAC Specification/Selection factors</p> <p>5.2 Analog to Digital Data Converter (ADC) : Block Diagram, Types and Working of Dual Slope ADC, Successive Approximation, Flash Type ADC, ADC selection factors/ specifications</p> <p>5.3 Memories: Types- Primary memory , Secondary Memory, Organization, Dimension, Memory Bank, Features , Applications: RAM (SRAM, DRAM), Volatile and Non-Volatile, ROM (PROM, EPROM, EEPROM), Flash Memory, Comparison of RAM and ROM,EPROM and Flash Memory, SIMM: Features, SSD memory: Features,</p>                                                                                                                                                                                                                  | <p>Video Demonstrations Lecture Using Chalk-Board</p>            |

**VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.**

| Practical / Tutorial / Laboratory Learning Outcome (LLO)                                                              | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles                                                                     | Number of hrs. | Relevant COs |
|-----------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------|----------------|--------------|
| <p>LLO 1.1 Test the functionality of basic gates.</p> <p>LLO 1.2 Test the functionality of special purpose gates.</p> | 1     | * Test the functionality of AND, OR, NOT, Ex-OR and EX-NOR logic Gates using equivalent 74 series or CMOS Devices [CD] series. | 2              | CO1<br>CO2   |

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| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                            | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 2.1 Test the functionality of NAND and NOR gate using breadboard.                          | 2            | * Test the functionality of the given Universal Gates using equivalent 74 series /CD series. | 2                     | CO2                 |
| LLO 3.1 Test the functionality of the constructed Basic gates using universal gates.           | 3            | * Construct Basic Gates using Universal Gates.                                               | 2                     | CO2                 |
| LLO 4.1 Construct Ex-OR, EX-NOR gates using universal gates.                                   | 4            | Construct Exclusive Gates using Universal Gates.                                             | 2                     | CO2                 |
| LLO 5.1 Build the logic circuit on breadboard to verify the De - Morgan's theorems.            | 5            | * Verify De-Morgan's Theorem (1 and 2).                                                      | 2                     | CO2                 |
| LLO 6.1 Verify the truth table of Half and Full adder circuits for the given input.            | 6            | * Implement 2 input, 3 input Adder Circuit.                                                  | 2                     | CO3                 |
| LLO 7.1 Verify the truth table of Half and Full subtractor using Boolean expressions.          | 7            | Implement 2 input, 3 input Subtractor Circuit.                                               | 2                     | CO3                 |
| LLO 8.1 Construct and test BCD to 7 segment decoder using Digital IC.                          | 8            | Test the output of BCD to 7 Segment Decoder using Digital IC for the given inputs.           | 2                     | CO3                 |
| LLO 9.1 Build/Test 2 or 4 bit Magnitude comparator using Digital IC.                           | 9            | Check the output of comparator circuit consisting of Digital IC.                             | 2                     | CO3                 |
| LLO 10.1 Build / test function of MUX Digital IC.                                              | 10           | * Build and test the functionality of 4:1/8:1 Multiplexer.                                   | 2                     | CO3                 |
| LLO 11.1 Build / test function of DEMUX Digital IC.                                            | 11           | Build and test the functionality of 1:4/1:8 De-Multiplexer.                                  | 2                     | CO3                 |
| LLO 12.1 Test functionality of RS flip flop using NAND Gate .                                  | 12           | Implement and verify the truth table of RS Flip flop.                                        | 2                     | CO4                 |
| LLO 13.1 Test functionality of Master Slave (MS) JK flip-flop using Digital IC.                | 13           | Implement and test the functionality of master slave- JK Flip Flop using Digital IC.         | 2                     | CO4                 |
| LLO 14.1 Test functionality and truth table for D and T Flip flop.                             | 14           | Use Digital IC to construct and test the functionality of D and T flip flop.                 | 2                     | CO4                 |
| LLO 15.1 Interpret timing diagram of 4 bit Universal Shift Register.                           | 15           | Build 4- bit Universal Shift register and observe the timing diagram.                        | 2                     | CO4                 |
| LLO 16.1 Interpret timing diagram of 4-bit ripple counter using Digital IC.                    | 16           | Implement Ripple Counter using Digital IC.                                                   | 2                     | CO4                 |
| LLO 17.1 Interpret timing diagram of Decade counter (Mod-10).                                  | 17           | * Implement Decade Counter Using Digital IC.                                                 | 2                     | CO4                 |
| LLO 18.1 Build R-2R resistive network on breadboard to convert given digital data into analog. | 18           | * Test the output of given R-2R type Digital to Analog Converter for the given input.        | 2                     | CO5                 |

**Note : Out of above suggestive LLOs -**

- '\*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

**VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)****Micro project****MSBTE Approval Dt. 02/07/2024****Semester - 3, K Scheme**

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- Implement 1:8 DEMUX using 1:4 /1:2 DE-MUX.
- Build a circuit to implement 4 Bit adder.
- Build a 4bit parity generator and parity tester.
- Implement 16:1 MUX using 8:1/4:1 MUX.
- Build a circuit to test 7 bit segment display.
- Build a LED display bar.
- Develop a project on Burglar alarm.
- Light Detector circuit using NAND gate.

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

| Sr.No | Equipment Name with Broad Specifications                                                                                                                                                                                                                                                                                                                                                   | Relevant LLO Number |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 1     | Digital Storage Oscilloscope<br>25MHz/60MHz/70MHz/100MHz Dual Channel, 4 Trace CRT / TFT based X10 magnification<br>20 nS max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out, USB interface. Any other Oscilloscope with additional features is also suitable with magnifying probe at least two probes, if possible isolated probe | 15,16,17            |
| 2     | Trainer kit for 4 bit Counter using Flip Flops<br>4 bit ripple counter synchronous counter IC 7476 based circuit, Input given by switches and output indicated on LED, Facility to select MOD 8 or MOD 16 mode, Built in DC power supply and manual pulser with indicator                                                                                                                  | 16,17               |
| 3     | Trainer kit IC DAC IC 0800<br>Trainer based on IC 0800, 8 bit digital input selected by switches and provision for measurement of analog output. Facility to study effect of change in reference voltage, Built in buffer amplifier, Built in DC power supply                                                                                                                              | 18                  |
| 4     | Digital multimeter<br>3.5 digit with R, V, I measurements, diode and BJT testing                                                                                                                                                                                                                                                                                                           | All                 |
| 5     | Digital IC Tester<br>Tests a wide range of Analog and Digital ICs such as 74 series /CD series                                                                                                                                                                                                                                                                                             | All                 |
| 6     | Bread Board Development System<br>Bread Board system with DC power output 5V,+/-12V and 0-5V variable, digital voltmeter, ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator                                                                                                                                                                 | All                 |
| 7     | Trainer kits for digital ICs<br>Trainer kit should consist of digital ICs for logic gates, flop flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply                                                                                                                                                                   | All                 |

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

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| Sr.No              | Unit | Unit Title                      | Aligned COs | Learning Hours | R-Level   | U-Level   | A-Level   | Total Marks |
|--------------------|------|---------------------------------|-------------|----------------|-----------|-----------|-----------|-------------|
| 1                  | I    | Number Systems                  | CO1         | 5              | 2         | 4         | 2         | 8           |
| 2                  | II   | Logic Gates and Boolean Algebra | CO2         | 8              | 2         | 4         | 6         | 12          |
| 3                  | III  | Combinational Logic Circuits    | CO3         | 12             | 4         | 6         | 8         | 18          |
| 4                  | IV   | Sequential Logic Circuits       | CO4         | 12             | 4         | 6         | 8         | 18          |
| 5                  | V    | Data Converters and Memories    | CO5         | 8              | 4         | 6         | 4         | 14          |
| <b>Grand Total</b> |      |                                 |             | <b>45</b>      | <b>16</b> | <b>26</b> | <b>28</b> | <b>70</b>   |

**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.
- For formative assessment of laboratory learning 25 marks

**Summative Assessment (Assessment of Learning)**

- End semester assessment is of 70 marks.
- End semester summative assessment of 25 marks for laboratory learning

**XI. SUGGESTED COS - POS MATRIX FORM**

| Course Outcomes (COs) | Programme Outcomes (POs)                     |                       |                                       |                        |                                                                        |                         |                         | Programme Specific Outcomes* (PSOs) |       |       |
|-----------------------|----------------------------------------------|-----------------------|---------------------------------------|------------------------|------------------------------------------------------------------------|-------------------------|-------------------------|-------------------------------------|-------|-------|
|                       | PO-1 Basic and Discipline Specific Knowledge | PO-2 Problem Analysis | PO-3 Design/ Development of Solutions | PO-4 Engineering Tools | PO-5 Engineering Practices for Society, Sustainability and Environment | PO-6 Project Management | PO-7 Life Long Learning | PSO-1                               | PSO-2 | PSO-3 |
| CO1                   | 2                                            | -                     | 1                                     | -                      | -                                                                      | -                       | 3                       |                                     |       |       |
| CO2                   | 2                                            | -                     | 2                                     | -                      | -                                                                      | -                       | 2                       |                                     |       |       |
| CO3                   | 3                                            | 2                     | 3                                     | 2                      | -                                                                      | 1                       | 2                       |                                     |       |       |
| CO4                   | 3                                            | 2                     | 3                                     | 2                      | -                                                                      | 1                       | 2                       |                                     |       |       |
| CO5                   | 2                                            | -                     | 2                                     | 2                      | 1                                                                      | 1                       | 2                       |                                     |       |       |

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
 \*PSOs are to be formulated at institute level

**XII. SUGGESTED LEARNING MATERIALS / BOOKS**

| Sr.No | Author                        | Title                            | Publisher with ISBN Number                                 |
|-------|-------------------------------|----------------------------------|------------------------------------------------------------|
| 1     | Jain R.P                      | Modern Digital Electronics       | McGraw-Hill Publishing, New Delhi,2009 ISBN:9780070669116  |
| 2     | Anand Kumar                   | Fundamentals of Digital Circuits | PHI learning Private limited, ISBN:978-81-203-5268-1       |
| 3     | Salivahanan S, Arivazhagan S. | Digital Circuits and Design      | Vikas Publishing House, New Delhi,2013 ISBN: 9789325960411 |
| 4     | Puri.V.K                      | Digital Electronics              | McGraw-Hill Publishing, New Delhi,2016 ISBN:97800746331751 |

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| Sr.No | Author                          | Title                                                        | Publisher with ISBN Number                                 |
|-------|---------------------------------|--------------------------------------------------------------|------------------------------------------------------------|
| 5     | Malvino A.P Donald<br>.P. Leach | Digital Principles                                           | McGraw-Hill Education, New Delhi<br>ISBN:9789339203405     |
| 6     | Anil.K.Maini                    | Digital Electronics: Principles,<br>Devices and Applications | Wiley India, Delhi, 2007,<br>ISBN:9780470032145            |
| 7     | Floyd, Thomas                   | Digital Fundamentals                                         | Pearson Education India, Delhi<br>2014,ISBN:9780132737968  |
| 8     | G.K.Kharate                     | Digital Electronics                                          | Publisher: Oxford University Press, ISBN:<br>9780198061830 |

**XIII . LEARNING WEBSITES & PORTALS**

| Sr.No | Link / Portal                                                                                                                                                                                   | Description                                                                        |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 1     | <a href="https://studytronics.weebly.com/digital-electronics.html">https://studytronics.weebly.com/digital-electronics.html</a>                                                                 | Basics of Digital Electronics                                                      |
| 2     | <a href="https://www.udemy.com/course/basics-of-digital-techniques/">https://www.udemy.com/course/basics-of-digital-techniques/</a>                                                             | Introduction To Digital Number System &<br>Logic Gates                             |
| 3     | <a href="https://www.geeksforgeeks.org/synchronous-sequential-circuits-in-digital-logic/">https://www.geeksforgeeks.org/synchronous-sequential-circuits-in-digital-logic/</a>                   | Boolean Algebra and Logic Gates,<br>Combinational and Sequential Logic<br>Circuits |
| 4     | <a href="https://onlinecourses.nptel.ac.in/noc19_ee51/preview">https://onlinecourses.nptel.ac.in/noc19_ee51/preview</a>                                                                         | Digital Circuits                                                                   |
| 5     | <a href="https://de-iitr.vlabs.ac.in/">https://de-iitr.vlabs.ac.in/</a>                                                                                                                         | Virtual Labs for Digital Systems                                                   |
| 6     | <a href="https://www.tutorialspoint.com/digital_circuits/digital_circuits_sequential_circuits.htm">https://www.tutorialspoint.com/digital_circuits/digital_circuits_sequential_circuits.htm</a> | Sequential Circuits                                                                |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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