

The Bombay Salesian Society's  
**Don Bosco Institute of Technology**  
(An Autonomous Institute affiliated to University of Mumbai)



**Bachelor of Engineering**  
in  
**Information Technology Engineering**

(Scheme DB25-V1)  
Effective from Academic Year 2025 – 2026

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**Department of Information Technology  
Engineering**

**Curriculum Structure of Second Year Engineering**

**(Scheme DB25-V1)  
Effective from Academic Year 2025 – 2026**

# 1. Preamble

Don Bosco Institute of Technology, Kurla, Mumbai, proudly celebrates the achievement of autonomous status—an academic milestone that reaffirms our steadfast commitment to excellence, holistic development, and student-centric learning. This autonomy empowers us to craft and implement a curriculum that is forward-looking, contextually relevant, and deeply rooted in our institutional values and the aspirations of our nation.

As an autonomous institution affiliated with the University of Mumbai, DBIT embraces the opportunity to restructure its academic framework in alignment with the University Grants Commission (UGC) guidelines and the National Education Policy (NEP) 2020. This curriculum framework outlines the undergraduate engineering programs for the EXTC, COMP, IT, and MECH branches. It reflects NEP's emphasis on multidisciplinary learning, flexibility, and outcome-based education, while staying true to the Don Bosco educational philosophy.

The curriculum adopts a top-down approach, beginning with the institutional Vision and Mission, which guides the definition of Program Educational Objectives (PEOs) and Program Outcomes (POs). These outcomes are used to shape Course Outcomes (COs) and the content and assessment methods of each course. This ensures that all academic efforts remain aligned with the broader goals of transforming learners into technically sound, ethically responsible and socially aware citizens. Importantly, this curriculum has been shaped through extensive consultations with stakeholders, including industry experts, academic peers, alumni, and students—to ensure that it remains aligned with contemporary industry requirements and societal expectations. Their inputs have been instrumental in designing a framework that bridges the gap between academic learning and practical applicability.

## **Key Objectives in developing syllabus are:**

- 1. Develop Strong Technical Foundations:** Equip students with robust knowledge and skills in core engineering domains to solve real-world problems through design, analysis, and innovation.
- 2. Foster Research, Innovation, and Entrepreneurship:** Cultivate a spirit of inquiry, critical thinking, and entrepreneurial mindset to promote research-based problem-solving and startup culture.
- 3. Enhance Interdisciplinary and Industry-Ready Competencies:** Integrate emerging technologies, multidisciplinary learning, and practical exposure to prepare students for dynamic industry requirements and lifelong learning.
- 4. Promote Ethical, Sustainable, and Socially Responsible Engineering Practice:** Inculcate ethics, human values, and environmental consciousness to enable students to contribute meaningfully to society and sustainable development.
- 5. Empower Communication, Leadership, and Teamwork Abilities:** Strengthen students' soft skills, collaboration, and leadership to perform effectively in diverse professional and global environments.

### **Academic design includes:**

- A Choice-Based Credit System (CBCS) for flexibility
- A range of Minor and Honors options to encourage specialization and research
- Opportunities for field engagement, internships, and experiential learning
- Emphasis on skill enhancement and future workforce needs
- Integration of ethical reasoning, social awareness, and environmental consciousness

As an institution inspired by the values of Saint John Bosco, we strive to create a joyful and inclusive learning environment that fosters creativity, curiosity, and compassion. Through this curriculum framework, we renew our pledge to produce graduates who are not only professionally competent but also committed to the greater good of society.

## **2. Vision and Mission**

### **Vision:**

DBIT will be known to have an innovative, enjoyable and holistic learning environment that transforms individuals into socially conscious citizens the Don Bosco way, and will lead in research and entrepreneurship in the area of sustainable technologies.

### **Mission:**

1. To create future engineers who work with honesty and integrity and excel in the use of technology for the benefit of the underprivileged.
2. To train engineers to be innovative problem-solvers and entrepreneurs who engage in research and lifelong learning.
3. To provide a diverse and stimulating environment for staff and students to grow holistically.

## **3. Curriculum Design Philosophy**

The curriculum is structured in alignment with the National Education Policy (NEP) 2020 and UGC guidelines. It follows a top-down approach wherein the institutional Vision and Mission guide the Program Educational Objectives (PEOs) and Program Outcomes (POs). These then shape the Course Outcomes (COs) and form the foundation for course structure, delivery, and assessments.

### **Key design principles include:**

- Emphasis on Outcome-Based Education (OBE) with clear mappings of COs to POs
- Integration of core technical knowledge with interdisciplinary electives
- Inclusion of vocational skills, internships, and community engagement
- Development of entrepreneurship and research aptitude through minor and honors pathways
- Encouragement of ethical, sustainable, and socially responsible engineering practices

This approach ensures that the curriculum remains academically rigorous, industry-relevant, and value-driven.

#### 4. Credit Allocation Guidelines

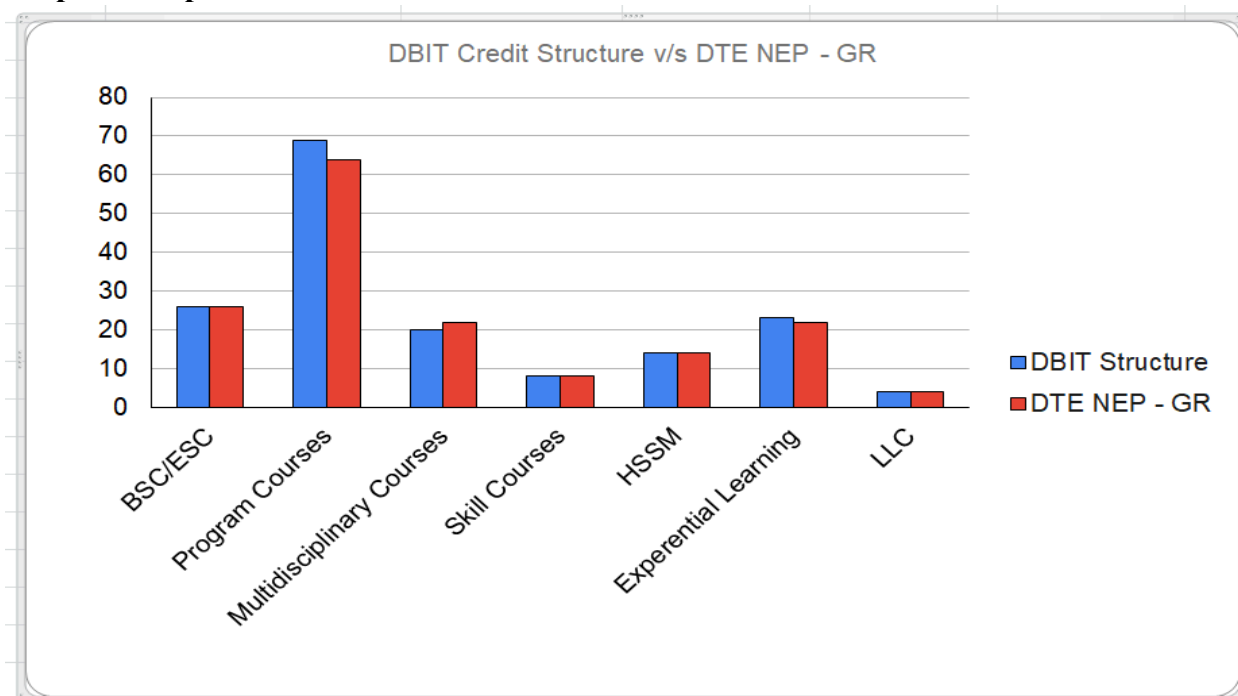
The curriculum is delivered through a structured credit system as follows:

Activity Type	Credit Definition
Theory Course	1 Credit = 15 Contact Hours
Laboratory / Studio / Workshop	1 Credit = 30 Contact Hours
Internship / Field Work	1 Credit = 40 Hours or 2 weeks
Seminar / Group Discussions	1 Credit = 15 Hours
Community Engagement / Field Project	1 Credit = 30 Contact

#### DBIT Curriculum Credit Structure: (FE to BE)

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits	DTE Credits
Basic Science Course	BSC/ESC	9	6							15	14-18
Engineering Science Course		7	4							11	12 - 16
Programme Core Course (PCC)	Program Courses		3	16	14	6	6	6		51	44-56
Programme Elective Course (PEC)						3	3	6	6	18	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses				3	4	4	3		14	14
Open Elective (OE) Other than a particular program						2	2	2		6	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	3	3	2						8	8
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)		2			2				4	4
Entrepreneurship/Economics/ Management Courses					2		2			4	4
Indian Knowledge System (IKS)			2							2	2
Value Education Course (VEC)		2		2						4	4
Research Methodology	Experiential Learning Courses					2				2	4
Community. Engagement. Project (CEP)/ Field Project (FP) (Mini - Project)				1	1	1				3	2
Project							3	3		6	4
Internship/ OJT									12	12	12
Co-curricular Courses (CC)	Liberal Learning Courses		1		1		1		1	4	4
<b>Total Credits (Major)</b>		<b>21</b>	<b>21</b>	<b>21</b>	<b>21</b>	<b>20</b>	<b>21</b>	<b>20</b>	<b>19</b>	<b>164</b>	<b>160- 176</b>

## Graphical Representation :



## 5. Degree Options and Exit Pathways

Students are offered flexible learning pathways through the following options:

### Undergraduate Degree Options:

- B.E (Major) – Minimum 160 credits
- B.E with Double Minor/Honors (Multidisciplinary + Specialization) –178-180 credits
- B.E with Double Minor/Honors with Research – 178 -180 credits

### Multiple Entry-Exit Options (Aligned with NEP 2020)

Exit Options	Credits Structure
Certificate after Year 1:	● 42 Credits + 08 credits (04 credit Exit course + 04 Summer internship).
Diploma after Year 2:	● 84 credits + 08 credits (04 credit Exit course + 04 Summer internship).
B. Vocational Degree after Year 3:	● 125 credits + 08 credits (04 credit Exit course + 04 Summer internship).
Final Degree after Year 4:	● 164 credits

Credits earned are banked in the Academic Bank of Credits (ABC) for lifelong learning flexibility.

**Abbreviations Used:**

AEC	Ability Enhancement Course
AEL	Ability Enhancement Laboratory
BSC	Basic Science Course
BSL	Basic Science Laboratory
CEP	Community Engagement Project
CC	Co-curricular Courses
CIE	Continuous Internal Evaluation
EEM	Entrepreneurship, Economics and Management
ELC	Experiential Learning Courses
ESC	Engineering Science Course
ESE	End Semester Examination
ESL	Engineering Science Laboratory
FP	Field Project
HSSM	Humanities Social Science and Management
IKS	Indian Knowledge System
L	Lecture
LLC	Liberal Learning Courses
MDM	Multidisciplinary Minor
MSE	Mid Semester Exam
OE	Open Elective
OJT	On Job Training
P	Practical
PCC	Program Core Course
PCL	Program Core Laboratory
PEC	Program Elective Course
T	Tutorial
VEC	Value Education Course

## UG Second Year IT Program

Curriculum Scheme and Structure: Semester IV									
Course-code	Course Vertical	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
			L	P	T	L	P	T	Total
25IT4PCC01	PCC	Automata Theory	3	--	1	3	--	1	4
25IT4PCC02	PCC	Computer Network Design	3	2	--	3	1	--	4
25IT4PCC03	PCC	Advanced Database Management	3	2	--	3	1	--	4
25IT4PCC04	PCC	Operating System	--	2*+2	--	--	2	--	2
25XX4MDMY	MDM	Multidisciplinary Minor@	2	2	--	2	1	--	3
25IT4CEP01	CEP	Community Engagement Project	--	2	--	--	1	--	1
25IL4EEM01	EEM	Entrepreneurship Essentials	2	--	--	2	--	--	2
25IL4LLCXX	LLC	Liberal Learning Course	--	2 <sup>s</sup>	--	--	1	--	1
<b>Total</b>			<b>13</b>	<b>10</b>	<b>2</b>	<b>13</b>	<b>6</b>	<b>2</b>	<b>21</b>

\* Two hours of practical class shall be conducted for the entire class in the form of demonstration and/or discussion.

@ Students must select one Multidisciplinary Minor (MDM) course offered by an Engineering department other than their own.

\$ Two hours of activity shall be conducted for the entire class, relevant to the respective Liberal Learning Course (LLC).

### Examination and Assessment Structure

Examination Marking Scheme: Semester IV									
Course Code	Course Vertical	Course Name	Examination Scheme						
			CA	MSE	ESE	TW	Or	Pr	Total
25IT4PCC01	PCC	Automata Theory	20	30	50	25	--	--	125
25IT4PCC02	PCC	Computer Network Design	20	30	50	25	--	25	150
25IT4PCC03	PCC	Advanced Database Management	20	30	50	25	25	--	150
25IT4PCC04	PCC	Operating System	50	--	--	25	--	25	100
25XX4MDMY	MDM	Multidisciplinary Minor@	20	30	50	25	--	--	125
25IT4CEP01	CEP	Community Engagement Project	--	--	--	25	25	--	50
25IL4EEM01	EEM	Entrepreneurship Essentials	50	--	--	--	--	--	50
25IL4LLCXX	LLC	Liberal Learning Course	50	--	--	--	--	--	50
<b>Total</b>			<b>230</b>	<b>120</b>	<b>200</b>	<b>150</b>	<b>50</b>	<b>50</b>	<b>800</b>

## Multidisciplinary Minor (MDM) Courses

25XX4MDMY Y	MultiDisciplinary Minor
25CE4MDM01	Web Development
25IT4MDM01	Data Structure & Algorithm
25ET4MDM01	Embedded Systems
25ET4MDM02	Sensor Technology
25ME4MDM01	Logistics and Supply Chain Management
25ME4MDM02	Prototyping with CAD Modeling

## LIST OF LIBERAL LEARNING COURSES (LLC)

Track - Performing Arts	Course Code	Course Name
1	25IL4LLC01	Rhythm & Motion: A Journey Through Dance
2	25IL4LLC02	Introduction to Dramatics: Exploring Theatre Arts
3	25IL4LLC03	Swaranjali: Introduction to Vocal Music
4	25IL4LLC04	Strings & Strokes: An Introduction to Musical Instruments
<b>Track - Visual Arts</b>		
5	25IL4LLC05	Traditional Rangolis of India
6	25IL4LLC06	Foundations of Photography
7	25IL4LLC07	Tradition & Craft: Hands-On Indian Art
<b>Track - Sports</b>		
8	25IL4LLC08	Sports and Fitness

<b>Assessment Methodology</b>		
<b>Type of Course</b>	<b>Assessment Tool</b>	<b>Marks Distribution</b>
<b>Theory</b>	<b>CA-20</b>	Certification: NPTEL (20 Marks) (Approved by instructor) OR Any two Pedagogies (10 marks each) MCQ /Class Test Case study/Assignment GATE based Assignment Certification: Udemy/Coursera (Approved by instructor) Open Book Test Working model / simulation of a course-based concept.
<b>Theory (VEC)</b>	<b>CA-50</b>	Active Participation = 5 marks MCQ /Class Test= 10 marks Instructor Assessment of the Activity carried out by student = 25 marks Assignment = 10 marks
<b>Workshop</b>	<b>CA-50</b>	Active Participation = 5 marks Trade 1# = 15 marks Trade 2# = 15 marks Trade 3# = 15 marks # Based on the performance and satisfactory completion of trade wise tasks.
<b>Liberal Learning Courses (LLC)</b>	<b>CA-50</b>	Active Participation = 5 marks Mentor Assessment of the Activity carried out by student = 25 marks Cultural Event (Euphoria) Participation = 10 marks Technical Event (Colosseum) Participation = 10 marks
<b>Theory</b>	<b>MSE</b>	Question Paper Pattern is as follows: All Questions are compulsory. Q1 A or B - 10 marks Q2 A or B - 10 marks Q3 A or B - 10 marks For each question, A and B should be based on the same CO. MSE should be based on 50% syllabus. Time: 90 minutes (1 hour 30 minutes) Total Marks: 30

**Guideline for All Assessment\***

Course Outcomes	Percentage
CO-1, CO-2	20-30
CO-3, CO-4	40-50
CO-5, CO-6	20-30

**\*Note:** Total Weightage of All CO's should be 100%

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25DBIT4PCC01	Automata Theory	3	--	1	3	--	1	4
		<b>Examination Scheme</b>						
		Theory	CA		MSE	ESE	Total	
			20		30	50	100	
		Lab	TW		OR	PR	Total	
			25		-	-	25	
		<b>Total</b>	<b>125</b>					

<b>Pre-Requisite Courses:</b>	25IT3PCC01: Computational Logic & Structures
<p><b>Course Overview</b></p> <p>This course provides a comprehensive foundation in Automata Theory and Formal Languages, focusing on the mathematical models that define computation. It introduces students to finite automata, regular languages, context-free grammars, pushdown automata, and Turing machines. The course emphasizes understanding the capabilities and limitations of different computational models, formal language theory, and decidability. Through theoretical concepts and problem-solving, students gain the analytical skills required for compiler design, programming language theory, and advanced areas of computer science.</p> <p><b>Module 1: Finite Automata</b></p> <p>This module introduces finite automata as fundamental computational models for recognizing regular languages. It covers deterministic and nondeterministic finite automata, their equivalence, and methods for converting NFA to DFA. The module also discusses regular languages, their closure properties, and the inherent limitations of finite automata in solving complex problems.</p> <p><b>Module 2: Regular Languages</b></p> <p>This module focuses on the structure and representation of regular languages using alphabets, strings, and regular expressions. It explores conversions between regular expressions and finite automata and explains regular grammars, including right-linear and left-linear grammars. The relationship between different formal representations of regular languages is emphasized.</p> <p><b>Module 3: Context-Free Languages</b></p> <p>This module introduces context-free grammars (CFGs) and their role in defining programming language syntax. It covers derivation techniques, ambiguity in grammars, and grammar simplification. Normal forms such as Chomsky Normal Form (CNF) and Greibach Normal Form (GNF) are studied</p>	

to support syntax analysis and compiler design.

**Module 4: Pushdown Automata**

This module presents pushdown automata (PDA) as an extension of finite automata using stack memory. It explains deterministic and non-deterministic PDAs and their operational mechanisms. The equivalence between context-free grammars and pushdown automata is discussed, along with their computational capabilities and limitations.

**Module 5: The Church-Turing Thesis**

This module introduces Turing Machines as powerful abstract models of computation. It covers deterministic Turing machines, their role as language acceptors and generators, and various machine variants. The module also explains the Chomsky Hierarchy and highlights the expressive power of Turing Machines in solving computational problems.

**Module 6: Decidability and Reducibility**

This module focuses on the theoretical limits of computation. It explores decidable and undecidable problems, including those related to regular and context-free languages. The concepts of diagonalization, reducibility, and the Halting Problem are studied to understand why certain problems cannot be solved algorithmically.

**This course introduces foundational models of computation including finite automata, grammars, pushdown automata, and Turing machines for understanding formal languages and language recognition. It also explores the limits of computation through decidability, reducibility, and undecidable problems such as the Halting Problem.**

<b>Course Outcomes</b>	After successful completion of the course, the students will be able to	
	CO1	Recall fundamental concepts related to alphabets, strings, formal languages, grammars, and basic computational models used in Automata Theory.
	CO2	Explain the working principles and relationships among regular languages, regular expressions, grammars, and finite automata.
	CO3	Apply concepts of finite automata and regular expressions to construct language acceptors, verifiers, and simple translators for given problems.
	CO4	Analyze context-free grammars and pushdown automata to identify ambiguity, derive strings, and examine language recognition capabilities.
	CO5	Evaluate the computational power and limitations of finite automata, pushdown automata, and Turing machines for solving different classes of problems.
	CO6	Design suitable computational models such as finite automata, pushdown automata, or Turing machines to solve language recognition and basic computation problems, including real-world applications like compiler design.

**Syllabus:**

Module No.	Unit No.	Topics	Hrs.
1	<b>Finite Automata</b>		10
	<b>After the completion of the module, the student will be able to ..</b> 1. Identify and explain the basic concepts of alphabets, strings, languages, and finite automata. 2. Differentiate between deterministic and nondeterministic finite automata. 3. Construct DFA and NFA for given regular languages and convert NFA to equivalent DFA. 4. Analyze regular languages and apply closure properties to solve Language related problems. 5. Recognize the limitations of finite automata in solving complex computational problems.		
	1.1	Finite Automata: FA as language acceptor or verifier, DFA, NFA, NFA to DFA.	
	1.2	Reduced DFA, NFA-DFA equivalence.	
	1.3	Regular Languages. Closure Properties.	
	1.4	Limitations of FA.	
<b>Self-Study Topics: Non-Regular Languages.</b>			
2	<b>Regular Languages</b>		5
	<b>After the completion of the module, the student will be able to ..</b> 1. Define alphabets, strings, and regular expressions used to describe regular languages. 2. Convert regular expressions into finite automata and vice versa. 3. Distinguish between right-linear and left-linear grammars. 4. Apply regular grammars and expressions to model simple pattern recognition problems. 5. Compare theoretical regular expressions with practical regex implementations used in programming.		
	2.1	Languages: Alphabets and Strings. Regular Expressions.	
	2.2	RE to FA, FA to RE.	

	2.3	Regular Grammars, RL and LL grammars.	
<b>Self-Study Topics:</b> Study differences between theoretical regular expressions and engine-based regex (backtracking vs. DFA-based engines).			
3	<b>Context Free Languages</b>		8
	<b>After completing this module, students will be able to ..</b> 1. Describe context-free grammars and their role in language specification. 2. Perform leftmost and rightmost derivations for given grammars. 3. Identify ambiguity in grammars and analyze its implications. 4. Convert grammars into Chomsky Normal Form and Greibach Normal Form. 5. Relate context-free grammars to syntax analysis in programming languages.		
	3.1	Context Free Grammars.	
	3.2	Leftmost and Rightmost derivations, Ambiguity.	
	3.3	Simplification and Normalization (CNF & GNF).	
	3.4	Context Free Languages.	
<b>Self-Study Topics:</b> How are CFGs implemented in real compilers for syntax analysis.			
4	<b>Push Down Automata</b>		6
	<b>After completing this module, students will be able to ..</b> 1. Explain the structure and working of push-down automata. 2. Distinguish between deterministic and non-deterministic pushdown automata. 3. Construct pushdown automata for given context-free languages. 4. Establish the equivalence between pushdown automata and context-free grammar. 5. Evaluate the computational power and limitations of pushdown automata.		
	4.1	Push Down Automata, Deterministic (single stack) PDA.	
	4.2	Non-Deterministic PDA.	
	4.3	Equivalence between PDA and CFG.	
4.4	Power and Limitations of PDA.		

	<b>Self-Study Topics:</b> Deterministic vs. Non-Deterministic Pushdown Automata in Programming Language Parsing		
5	<b>The Church–Turing Thesis</b>		8
	<b>After completing this module, students will be able to ..</b> 1. Describe the structure and functioning of a Turing Machine. 2. Differentiate between deterministic Turing machines and their variants. 3. Explain the role of Turing machines as language acceptors and generators. 4. Classify languages using the Chomsky Hierarchy. 5. Assess the computational power of Turing machines in solving algorithmic problems.		
	5.1	Turing Machines, Deterministic TM, TM as Acceptors, TM as Generators.	
	5.2	Variants of TM.	
	5.3	Chomsky Hierarchy (Types 0 to 3).	
	5.4	Power of TM.	
<b>Self-Study Topics:</b> Study the concept of the Universal Turing Machine (UTM).			
6	<b>Decidability and Reducibility</b>		8
	<b>After completing this module, students will be able to ..</b> 1. Explain the concepts of decidable and undecidable problems. 2. Analyze decision problems related to regular and context-free languages. 3. Apply the diagonalization technique to prove undecidability. 4. Explain the concept of reducibility and its role in problem classification. 5. Evaluate the implications of the Halting Problem on computability theory.		
	6.1	Decidable Languages: Decidable problems concerning regular languages, Decidable problems concerning context-free languages.	
	6.2	Undecidability: The diagonalization method, An undecidable language.	
	6.3	Reducibility: The Halting Problem.	
<b>Self-Study Topics:</b> Study Rice’s Theorem.			
		<b>Total</b>	<b>45</b>

### Suggested Tutorial List:

Tutorial No.	List of Tutorials
1	<p>Construct a DFA for a given language. (Using JFlap)</p> <p><b>Objective:</b> To enable students to design and construct a Deterministic Finite Automaton (DFA) for a specified formal language.</p> <p><b>Outcome:</b> Students will be able to systematically model and implement DFAs that correctly recognize given patterns or languages.</p>
2	<p>Construct an NFA for a given language. (Using JFlap)</p> <p><b>Objective:</b> To construct a Non-deterministic Finite Automaton (NFA) for a given formal language using principles of Automata Theory.</p> <p><b>Outcome:</b> Students will be able to design and represent NFAs that recognize specified languages and analyze their correctness.</p>
3	<p>Give REs for a given language.</p> <p><b>Objective:</b> To enable students to construct regular expressions for formally defined languages using principles of Automata Theory.</p> <p><b>Outcome:</b> Students will be able to design and validate regular expressions that accurately represent given languages and problem constraints.</p>
4	<p>Convert a RE to an equivalent DFA.</p> <p><b>Objective:</b> Convert a given Regular Expression (RE) into an equivalent Deterministic Finite Automaton (DFA) using systematic construction methods.</p> <p><b>Outcome:</b> Students will be able to construct a DFA from a Regular Expression and verify its correctness through formal state transition representation.</p>
5	<p>Construct a RE from a given DFA.</p> <p><b>Objective:</b> Apply state elimination and Arden's Theorem to construct an equivalent regular expression from a given DFA.</p>

	<p><b>Outcome:</b> Students will be able to systematically convert any DFA into an equivalent regular expression and justify each transformation step.</p>
6	<p>Construct a LL grammar for a given language.</p> <p><b>Objective:</b> To enable students to construct an LL (predictive) grammar for a given language by eliminating ambiguity, left recursion, and applying left factoring.</p> <p><b>Outcome:</b> Students will be able to design and validate LL grammars suitable for top-down parsing techniques in Automata Theory.</p>
7	<p>Construct a RL grammar for a given language.</p> <p><b>Objective:</b> Construct a right-linear (regular) grammar for a given language by applying the concepts of regular languages and finite automata.</p> <p><b>Outcome:</b> Students will be able to design and represent regular languages using right-linear grammars and validate them with equivalent automata models.</p>
8	<p>To convert a given CFG into Chomsky Normal Form.</p> <p><b>Objective:</b> To understand and apply the systematic procedure for converting any given Context-Free Grammar (CFG) into Chomsky Normal Form (CNF).</p> <p><b>Outcome:</b> Students will be able to transform a CFG into an equivalent CNF and justify each transformation step for correctness.</p>
9	<p>To convert a given CFG into Greibach Normal Form.</p> <p><b>Objective:</b> To apply systematic transformations to convert any given Context-Free Grammar (CFG) into Greibach Normal Form (GNF).</p> <p><b>Outcome:</b> Students will be able to construct an equivalent GNF grammar from a CFG, ensuring all productions begin with a terminal symbol.</p>
10	<p>Construct a PDA for a given language.</p> <p><b>Objective:</b> To design and construct a Pushdown Automaton (PDA) for a given context-free language by applying stack-based transition rules.</p> <p><b>Outcome:</b> Students will be able to model context-free languages using PDAs and</p>

	analyze their behavior through state transitions and stack operations.
11	<p>Construct a TM for a given language. (TM as acceptors)</p> <p><b>Objective:</b> To design and construct a Turing Machine as an acceptor for a given formal language.</p> <p><b>Outcome:</b> Students will be able to analyze a language and systematically develop a Turing Machine that correctly recognizes (accepts) strings belonging to that language.</p>
12	<p>Construct a TM for a given language. (TM as generators)</p> <p><b>Objective:</b> To enable students to design and construct Turing Machines (TM as generators) for formally specified languages.</p> <p><b>Outcome:</b> Students will be able to model, analyze, and generate languages using Turing Machines, demonstrating problem-solving skills in Automata Theory.</p>
13	<p>To prove that a certain algorithm is decidable.</p> <p><b>Objective:</b> To understand and apply formal techniques to prove that a given algorithm is decidable in Automata Theory.</p> <p><b>Outcome:</b> Students will be able to construct and justify proofs of decidability for computational problems using standard models and methods.</p>
14	<p>To prove that the halting problem is undecidable.</p> <p><b>Objective:</b> To understand and prove that the Halting Problem is undecidable using contradiction and self-reference.</p> <p><b>Outcome:</b> Students will be able to explain why no algorithm can universally decide program termination and apply this concept to reason about limits of computation in Automata Theory.</p>

### Assessment Methodology:

<p><b>CA-20</b></p>	<p>Certification: NPTEL (20 Marks) (Approved by instructor) OR Any two Pedagogies (10 marks each)</p> <ul style="list-style-type: none"> <li>* MCQ /Class Test</li> <li>* Case study/Assignment</li> <li>* GATE based Assignment</li> <li>* Certification: Udemy/Coursera (Approved by instructor)</li> <li>* Open Book Test</li> <li>* Working model / simulation of a course-based concept.</li> </ul>
<p><b>MSE</b></p>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>* Q1 A or B - 10 marks</li> <li>* Q2 A or B - 10 marks</li> <li>* Q3 A or B - 10 marks</li> <li>* For each question, A and B should be based on the same CO.</li> <li>* MSE should be based on 50% syllabus.</li> <li>* Time: 90 minutes (1 hour 30 minutes)</li> <li>* Total Marks: 30</li> </ul>
<p><b>ESE</b></p>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>* Q1 A or B - 10 marks</li> <li>* Q2 A or B - 10 marks</li> <li>* Q3 A or B - 10 marks</li> <li>* Q4 A or B - 10 marks</li> <li>* Q5 A or B - 10 marks</li> <li>* For each question, A and B should be based on the same CO.</li> <li>* ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE.</li> <li>* Time: 120 minutes (2 hours)</li> <li>* Total Marks: 50</li> </ul>
<p><b>TW-25</b></p>	<ul style="list-style-type: none"> <li>* Active Participation = 5 marks</li> <li>* Tutorial Submission = 20 marks</li> </ul> <p>Tutorial based on the entire syllabus</p>

**Text Books:**

1. M.Sipser, Introduction to the Theory of Computation, 3rd ed. Boston, MA, USA: Cengage Learning, 2013.
2. J.C. Martin, "Introduction to languages & theory of computation", TMH.
3. Kavi Mahesh, "Theory of computation: A problem-solving approach", Wiley India.
4. Aho, Sethi, Ullman, "Compilers: Principles, Techniques & Tools", Pearson.
5. Vivek Kulkarni, "Theory of computation", Oxford University.

**Reference Books:**

1. J. E. Hopcroft, R. Motwani, and J. D. Ullman, Introduction to Automata Theory, Languages, and Computation, 3rd ed. Boston, MA, USA: Pearson Education, 2007.
2. D. C. Kozen, Automata and Computability. New York, NY, USA: Springer, 1997.
3. K. Krithivasan and R. Rama, Introduction to Formal Languages, Automata Theory and Computation. Chennai, India: Pearson Education India, 2006.

**Useful Links:**

1. MIT OpenCourseWare <https://ocw.mit.edu/courses/18-404j-theory-of-computation-fall-2020/>
2. Coursera - <https://www.coursera.org/learn/automata-and-computability-odc/home/welcome>
3. NPTEL - <https://nptel.ac.in/courses/106105196>

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IT4PCC02	Computer Network Design	3	2	–	3	1	–	4
		<b>Examination Scheme</b>						
		Theory	CA		MSE	ESE	Total	
			20		30	50	100	
		Tutorial	TW		OR	PR	Total	
			25		–	25	50	
		Total	<b>150</b>					

<b>Pre-Requisite Courses:</b>	25IT3PCC04 - Digital Logic & Computer Organization Architecture
	25IT3PCC02 - Advance Data Structure and Algorithms

### Course and Module Overview:

The Computer Network & Design (CNND) course provides a comprehensive foundation in computer networking concepts, protocols, and design principles. It introduces students to network architectures, OSI and TCP/IP reference models, and essential networking devices. The course systematically covers physical and data link layer concepts such as transmission media, switching techniques, error detection and correction, and Ethernet standards. At higher layers, students explore IPv4 and IPv6 addressing, subnetting, routing algorithms, transport layer protocols (UDP and TCP), and their mechanisms for reliable data transmission. The course also covers session, presentation, and application layer protocols supporting modern network services. Emerging networking paradigms such as Software Defined Networking (SDN) are introduced to highlight programmability and centralized control. The course concludes with network design and planning, focusing on scalable, redundant LAN/WAN architectures and real-world enterprise and campus network case studies.

#### Module 1: Introduction to Computer Networks

This module introduces the fundamentals of computer networks, including their uses, hardware and software components. It explains protocol layering and compares the OSI and TCP/IP reference models. Students gain an understanding of network architecture, standardization, and common networking devices, forming the conceptual base for advanced networking topics.

#### Module 2: Physical Layer & Data Link Layer

This module focuses on the lower layers of the OSI model. It covers guided and unguided transmission media, wireless communication, and switching techniques such as circuit and packet switching. Data link layer functions including framing, flow control, and error control are explained, along with error detection and correction techniques like parity, CRC, checksum, and Hamming code.

Data link protocols and Ethernet standards up to Gigabit Ethernet are also discussed.

**Module 3: Network Layer & Transport Layer**

This module addresses core networking functions such as IP addressing, subnetting, supernetting, DHCP, NAT, and routing algorithms. It introduces routing protocols including RIP, OSPF, and BGP, along with IPv6 addressing and transition mechanisms. Transport layer concepts are explored through UDP and TCP, emphasizing services, flow and congestion control, error handling, and reliable end-to-end communication

**Module 4: Session, Presentation & Application Layers**

This module examines upper-layer operations. It introduces session management using RPC, presentation layer services such as data representation and compression, and compares lossy and lossless compression techniques. Application layer protocols including HTTP, FTP, Email, DNS, and SNMP are studied to demonstrate how network services are delivered to end users.

**Module 5: Network Design and Planning**

This module focuses on practical network design principles such as scalability, redundancy, and performance. It covers hierarchical LAN/WAN models, campus network design, IP address planning, and VLAN strategies. The module culminates in a real-world college network design case study, reinforcing theoretical concepts through practical application.

**Module 6: Network Design and Planning**

This module introduces network perimeter security and evolving threat landscapes. It covers firewalls, IDS/IPS, DDoS protection, NAT/PAT, geo-blocking, and selecting defense strategies. Learners explore VPN concepts and types, along with firewall logging, audit practices, and structured incident-response actions for detecting, analyzing, and mitigating perimeter breaches.

**The CNND course provides a comprehensive foundation in networking architectures and protocols, spanning the entire OSI model from physical transmission to application services. It bridges theoretical concepts with practical expertise in Software Defined Networking, scalable network design, and robust perimeter security strategies for real-world enterprise environments.**

<b>Course Outcomes</b>	After successful completion of the course, the students will be able to	
	CO1	List the networking terminologies, transmission media, and protocols, as well as essential hardware components, cabling standards, and basic Linux diagnostic commands.
	CO2	Explain the foundational computer network concepts, including the OSI and TCP/IP reference models, network design considerations, and the purpose of various network monitoring and management tools.

	CO3	Apply networking principles to implement IPv4/IPv6 addressing schemes, subnetting, and NAT, and be able to configure network devices (switches, routers) using VLANs and routing protocols (RIP/OSPF) to establish functional topologies.
	CO4	Analyze the routing algorithms, network protocols, and captured network traffic to interpret headers, protocol interactions, and communication patterns across the Ethernet, Data Link, Network, Transport, and Application layers.
	CO5	Evaluate the performance of protocols through simulation, alongside compression techniques and client-server models, to justify and select appropriate solutions for real-life network challenges.
	CO6	Design scalable and redundant LAN/WAN architectures, along with comprehensive IP address planning and VLAN strategies, and create end-to-end network solutions tailored to specific case studies.

**Syllabus:**

Module No.	Unit No.	Topics	Hrs.
1	<b>Introduction to Computer Networks</b>		5
	<b>After completion of the module the student will be able to :</b>		
	1. Identify and define basic computer networking terminologies, hardware, and software components.		
	2. Explain the concept of protocol layering and the functions of each layer in the OSI and TCP/IP models.		
	3. Compare OSI and TCP/IP reference models based on structure, functionality, and practical usage.		
	4. Classify and describe the roles of common networking devices used in local and wide area networks.		
	1.1	Uses Of Computer Networks, Network Hardware, Network Software	
	1.2	Protocol Layering, Reference Models: OSI, TCP/IP	
	1.3	Comparison of OSI & TCP/IP, Network Devices.	
<b>Self Study Topics:</b> Identify the different devices used in Network connection on college campuses.			
<b>Physical Layer &amp; Data Link Layer</b>			

	<p><b>After completion of the module the student will be able to :</b></p> <ol style="list-style-type: none"> <li>1. Differentiate between guided, unguided, and wireless transmission media and select appropriate switching techniques.</li> <li>2. Explain data link layer design issues including framing, flow control, and error control.</li> <li>3. Apply error detection and correction techniques such as parity, CRC, checksum, and Hamming code to networking problems.</li> <li>4. Analyze data link protocols including Stop-and-Wait, Sliding Window, and Piggybacking mechanisms.</li> <li>5. Describe Ethernet standards and evaluate their performance characteristics.</li> </ol> <table border="1" data-bbox="354 667 1357 1171"> <tr> <td data-bbox="354 667 435 808">2.1</td> <td data-bbox="435 667 1357 808">Physical layer: Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum. Switching: Circuit-Switched Networks, Packet Switching</td> </tr> <tr> <td data-bbox="354 808 435 949">2.2</td> <td data-bbox="435 808 1357 949">DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, Parity, CRC, Checksum)</td> </tr> <tr> <td data-bbox="354 949 435 1060">2.3</td> <td data-bbox="435 949 1357 1060">Data Link protocols : Stop and Wait, Sliding Window(Go Back N, Selective Repeat), Piggybacking</td> </tr> <tr> <td data-bbox="354 1060 435 1171">2.4</td> <td data-bbox="435 1060 1357 1171">Ethernet Protocol: Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet.</td> </tr> </table> <p><b>Self Study Topics:</b> Study of ARP and RARP protocol</p>	2.1	Physical layer: Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum. Switching: Circuit-Switched Networks, Packet Switching	2.2	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, Parity, CRC, Checksum)	2.3	Data Link protocols : Stop and Wait, Sliding Window(Go Back N, Selective Repeat), Piggybacking	2.4	Ethernet Protocol: Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet.	
2.1	Physical layer: Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum. Switching: Circuit-Switched Networks, Packet Switching									
2.2	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, Parity, CRC, Checksum)									
2.3	Data Link protocols : Stop and Wait, Sliding Window(Go Back N, Selective Repeat), Piggybacking									
2.4	Ethernet Protocol: Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet.									
<b>3</b>	<p><b>Network Layer &amp; Transport Layer</b></p> <p><b>After completion of the module the student will be able to :</b></p> <ol style="list-style-type: none"> <li>1. Implement IPv4 and IPv6 addressing schemes including subnetting, supernetting, DHCP, and NAT.</li> <li>2. Compare routing algorithms and protocols such as RIP, OSPF, and BGP based on performance and scalability.</li> <li>3. Explain IPv6 features and transition mechanisms from IPv4 to IPv6.</li> <li>4. Distinguish between connectionless and connection-oriented transport protocols.</li> <li>5. Analyze TCP mechanisms including flow control, error control, Congestion control, and timers.</li> </ol> <table border="1" data-bbox="354 1755 1357 1871"> <tr> <td data-bbox="354 1755 435 1871">3.1</td> <td data-bbox="435 1755 1357 1871">IPv4 Addressing (classful and classless), Subnetting, Supernetting ,IPv4 Protocol, DHCP, Network Address Translation (NAT).</td> </tr> </table>	3.1	IPv4 Addressing (classful and classless), Subnetting, Supernetting ,IPv4 Protocol, DHCP, Network Address Translation (NAT).	<b>12</b>						
3.1	IPv4 Addressing (classful and classless), Subnetting, Supernetting ,IPv4 Protocol, DHCP, Network Address Translation (NAT).									

	3.2	Routing algorithms & Protocols : Distance Vector Routing, Link state routing, Path Vector Routing, RIP, OSPF, BGP.	
	3.3	IPv6 Addressing, IPv6 Protocol, Transition from IPv4 to IPv6	
	3.4	Transport Layer : Connectionless & Connection-oriented Protocols, User Datagram Protocol: User Datagram Protocol: UDP Services, UDP Applications	
	3.5	Transmission Control Protocol: TCP Services, TCP Features, Segment, A TCP Connection, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers.	
<b>Self Study Topics:</b> Study of EIGRP protocol and IS-IS (Intermediate System to Intermediate System) protocol			
	<b>Session Layer, Presentation Layer &amp; Application Layer</b>		
	<b>After completion of the module the student will be able to :</b>		
	<ol style="list-style-type: none"> <li>1. Explain the role of the session layer and the working of Remote Procedure Call (RPC).</li> <li>2. Compare lossy and lossless compression techniques and apply appropriate compression methods for different data types.</li> <li>3. Describe the operation of application layer protocols such as HTTP, FTP, Email, DNS, and SNMP.</li> <li>4. Analyze how upper-layer protocols support client-server communication and network services.</li> </ol>		6
4	4.1	Session Layer: Session Layer protocol - Remote Procedure Call (RPC)	
	4.2	Presentation layer : Compression: Comparison between Lossy Compression and Lossless Compression, Huffman Coding, RLE, LZW, Image Compression – GIF.	
	4.3	Application layer: Standard Client-Server Protocols: HTTP, FTP, Electronic Mail, Domain Name System (DNS), SNMP	
<b>Self Study Topics:</b> Study SIP and RPC protocol			
	<b>Network Design and Planning</b>		

	<p><b>After completion of the module the student will be able to :</b></p> <ol style="list-style-type: none"> <li>1. Apply network design principles such as scalability, redundancy, and performance optimization.</li> <li>2. Design hierarchical LAN/WAN and campus network architectures.</li> <li>3. Develop IP address planning and VLAN strategies for enterprise networks.</li> <li>4. Design and justify a complete network solution for a real-world case study.</li> </ol>		
	5.1	Network Design Principles – Scalability, Redundancy, Performance	
	5.2	LAN/WAN Design – Hierarchical Models, Campus Design	
	5.3	IP Address Planning and VLAN Design	
	<b>Self Study Topics:</b> Designing a Network for college		
6	<b>Network Perimeter Security</b>		
	<p><b>After completion of the module the student will be able to :</b></p> <ol style="list-style-type: none"> <li>1. Explain core perimeter security concepts and justify suitable protection strategies.</li> <li>2. Distinguish VPN types and evaluate their use for secure remote connectivity.</li> <li>3. Interpret firewall logs and apply incident-response steps to address perimeter breaches.</li> </ol>		
	6.1	Introduction to Network Perimeter Security, Network Threat Landscape	
	6.2	Firewall, Types of Firewall, IDS, IPS, DDoS Protection, NAT, PAT, Geo-Blocking and choice of protection strategy.	
	6.3	VPN, Types of VPN	
	6.4	Firewall Logs and Log Audits. Perimeter breach Incident Response.	
	<b>Self Study Topics:</b> Study the perimeter security and Incident Response in Enterprise Network		
		<b>Total</b>	<b>45</b>

**Suggested List of Experiments:**

Expt. No.	List of Practicals
1	<p>Study of RJ45 and CAT6 Cabling and connection using crimping tools.</p> <p><b>Objective :</b> To understand the physical characteristics of CAT6 cables and demonstrate the procedure of terminating them with RJ45 connectors using crimping tools.</p> <p><b>Outcome:</b> Students will be able to successfully construct, terminate, and test straight-through and cross-over Ethernet cables for network connectivity.</p>
2	<p>Use basic networking commands in Linux (ping, tracer, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route )</p> <p><b>Objective:</b> To familiarize students with standard Linux command-line utilities used for network configuration, diagnostics, and troubleshooting.</p> <p><b>Outcome:</b> Students will be able to execute and interpret the output of essential Linux network commands to verify connectivity, trace routes, and resolve DNS queries.</p>
3	<p>Perform network discovery using discovery tools (eg. Nmap, mrtg)</p> <p><b>Objective:</b> To explore the capabilities of network discovery and monitoring software for mapping network topologies and observing traffic.</p> <p><b>Outcome:</b> Students will be able to perform host discovery and port scanning using Nmap, and understand the basics of traffic monitoring.</p>
4	<p>Use Wireshark to understand the operation of TCP/IP layers:</p> <ul style="list-style-type: none"> <li>● Ethernet Layer: Frame header, Frame size etc.</li> <li>● Data Link Layer: MAC address, ARP (IP and MAC address binding)</li> <li>● Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo)</li> <li>● Transport Layer: TCP Ports, TCP handshake segments etc.</li> <li>● Application Layer: DHCP, FTP, HTTP header formats</li> </ul> <p><b>Objective:</b> To capture and analyse live network traffic to understand the structure, headers, and functions of protocols across the TCP/IP stack.</p>

	<p><b>Outcome:</b> Students will be able to use Wireshark packet sniffer to inspect Ethernet frames, IP packets, and TCP segments, successfully analysing protocol interactions like the TCP handshake and ARP bindings.</p>
5	<p>Use a simulator (Eg. NS2) to understand the functioning of ALOHA, CSMA/CD.</p> <p><b>Objective :</b> To simulate and observe the behaviour and collision characteristics of Media Access Control (MAC) layer protocols in a controlled digital environment.</p> <p><b>Outcome:</b> Students will be able to deploy a network simulator to model ALOHA and CSMA/CD protocols and evaluate their performance.</p>
6	<p>Configure network devices using switches within a network topology and connect the computers (using IPv6).</p> <p><b>Objective:</b> To configure basic network switches and establish local area network connectivity between host machines using IPv6 addressing.</p> <p><b>Outcome:</b> Students will be able to deploy a physical or simulated switched network topology and successfully configure IPv6 addresses to enable node-to-node communication.</p>
7	<p>Create network topology to implement VLANs with trunking for a given scenario.</p> <p><b>Objective:</b> To segment a physical network into multiple logical broadcast domains using Virtual LANs (VLANs) and establish trunk links between switches.</p> <p><b>Outcome:</b> Students will be able to configure VLANs on managed switches and implement IEEE 802.1Q trunking to allow inter-switch communication for designated VLANs.</p>
8	<p>Create network topology and implement dynamic routing protocol such as RIP, OSPF etc. for given scenarios.</p> <p><b>Objective:</b> To configure, verify, and troubleshoot dynamic routing protocols within a multi-router network topology.</p> <p><b>Outcome:</b> Students will be able to implement RIP and OSPF routing protocols on network routers to achieve full network convergence and end-to-end reachability.</p>

9	<p>Implement FTP server for file transfers in the laboratory</p> <p><b>Objective:</b> To deploy and configure a File Transfer Protocol (FTP) server to facilitate reliable file sharing within a local area network.</p> <p><b>Outcome:</b> Students will be able to establish a functional client-server architecture by setting up an FTP server and demonstrating successful file uploads and downloads from client machines.</p>
10	<p>Socket programming using TCP or UDP</p> <p><b>Objective:</b> To develop a fundamental understanding of network programming by creating custom client and server applications using network sockets.</p> <p><b>Outcome:</b> Students will be able to write, compile, and execute basic TCP or UDP socket programs to establish bi-directional communication between a client and a server.</p>

### Assessment Methodology:

<b>CA-20</b>	<p>Certification: NPTEL (20 Marks) (Approved by instructor) OR Any two Pedagogies (10 marks each)</p> <ul style="list-style-type: none"> <li>* MCQ /Class Test</li> <li>* Case study/Assignment</li> <li>* GATE based Assignment</li> <li>* Certification: Udemy/Coursera (Approved by instructor)</li> <li>* Open Book Test</li> <li>* Working model / simulation of a course-based concept.</li> </ul>
<b>MSE</b>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>* Q1 A or B - 10 marks</li> <li>* Q2 A or B - 10 marks</li> <li>* Q3 A or B - 10 marks</li> <li>* For each question, A and B should be based on the same CO.</li> <li>* MSE should be based on 50% syllabus.</li> </ul>

	<p>* Time: 90 minutes (1 hour 30 minutes)</p> <p>* Total Marks: 30</p>
<b>ESE</b>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <p>* Q1 A or B - 10 marks</p> <p>* Q2 A or B - 10 marks</p> <p>* Q3 A or B - 10 marks</p> <p>* Q4 A or B - 10 marks</p> <p>* Q5 A or B - 10 marks</p> <p>* For each question, A and B should be based on the same CO.</p> <p>* ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE.</p> <p>* Time: 120 minutes (2 hours)</p> <p>* Total Marks: 50</p>
<b>TW-25</b>	<p>Active Participation = 5 marks</p> <p>Tutorial Submission = 20 marks</p>
<b>OR-25</b>	<p>Oral examination will be based on the experiments performed by the students during laboratory sessions.</p>

### Textbooks:

1. Data Communications and Networking, Behrouz A. Forouzan, 5th Edition, The McGraw-Hill Companies, Inc
2. A.S. Tanenbaum, Computer Networks, 4th edition Pearson Education
3. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, 6th edition, Addison Wesley

### References:

1. S.Keshav, An Engineering Approach To Computer Networking, Pearson
2. Natalia Olifer & Victor Olifer, Computer Networks: Principles, Technologies & Protocols for Network Design, Wiley India, 2011.
3. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Second Edition, The Morgan Kaufmann Series in Networking

### Useful Links

1. <https://www.netacad.com/courses/networking/networking-essentials>
2. <https://www.coursera.org/learn/computer-networking>
3. <https://nptel.ac.in/courses/106/105/106105081>
4. <https://www.edx.org/course/introduction-to-networking>

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IT4PCC03	Advanced Database Management System	3	2	--	3	1	--	4
		<b>Examination Scheme</b>						
		Theory	CA		MSE	ESE	Total	
			20		30	50	100	
		Lab	TW		OR	PR	Total	
			25		25	--	50	
		Total	150					

<b>Pre-Requisites Courses:</b>	25IT3PCC03 - Database Management System
<p><b>Course and Module Overview:</b>  This course aims to provide learners with an in-depth understanding of advanced database management systems, focusing on efficient query processing and optimization, secure and controlled data access, emerging and distributed database models, enterprise data warehousing and analytical processing, ETL methodologies, and modern technologies to manage distributed storage and processing. The course equips students with the knowledge required to manage, analyze, and retrieve large-scale, complex, and heterogeneous data in contemporary data-driven applications.</p> <p><b>Module 1: Query Processing and Optimization</b>  This module introduces the internal mechanisms of query processing in DBMS, including query execution stages, cost estimation, relational operator evaluation, and optimization techniques. Students gain analytical skills to compare execution plans and solve optimization problems based on cost models.</p> <p><b>Module 2: Data Warehousing, Dimensional Modeling, and OLAP</b>  This module explains the role of data warehousing in enterprise analytics, covering warehouse architectures, dimensional modeling techniques, and schema design. It introduces business intelligence concepts and OLAP operations to support multidimensional analytical processing.</p> <p><b>Module 3: ETL Process</b>  This module covers the ETL process used in enterprise data management, including extraction strategies, transformation tasks, data quality handling, and loading techniques. It also introduces cloud-based ETL services and emphasizes the importance of metadata, auditing, and reconciliation.</p>	

#### **Module 4: Distributed Databases**

To equip students with a comprehensive understanding of distributed database systems by introducing distributed architectures, design issues, and data processing challenges, and by explaining data fragmentation, replication, allocation, and security considerations, along with distributed transaction management and query processing techniques to address performance, scalability, and availability in distributed environments.

#### **Module 5: NoSQL Data Model and MongoDB**

To introduce students to NoSQL database concepts and data models by comparing SQL and NoSQL systems and explaining distribution models, transaction handling, consistency mechanisms, and theoretical foundations such as CAP theorem and ACID–BASE trade-offs, and to familiarize them with document-oriented databases through hands-on exposure to MongoDB operations, querying techniques, and distributed features such as replication and horizontal scaling.

#### **Module 6: Trends in Advanced Databases**

To introduce students to advanced non-traditional database models by explaining temporal concepts and time representation in relational databases, spatial data models and query operations for location-based data, and graph database principles including transactions, consistency, availability, and querying, with exposure to real-world applications through a case study using Neo4j.

**This course provides learners with an in-depth understanding of advanced database management systems, emphasizing query processing and optimization, secure data access, distributed and emerging database models, data warehousing, ETL processes, and modern big data technologies such as NoSQL and vector databases. It equips students with the skills required to manage, analyze, and retrieve large-scale and complex data in modern data-driven applications.**

		<b>After successful completion, students will be able to ..</b>
<b>Course Outcome</b>	CO1	Identify/Recollect foundational concepts, architectures, and mechanisms used in advanced data management and querying systems (Remembering).
	CO2	Explain how advanced data processing, optimization, distribution, and analytical techniques operate within modern distributed data ecosystems (Understanding).
	CO3	Apply appropriate methods, techniques, tools and commands to efficiently store, process, access and optimize data in a distributed environment (Apply).
	CO4	Analyse data management challenges and system behaviours to identify performance and design trade-offs in distributed database environments (Analyse).

	CO5	Evaluate alternative data management strategies, optimization methods, system architectures, and analytical approaches for their effectiveness and suitability (Evaluate).
	CO6	Design integrated and efficient data management solutions that incorporate advanced querying, distributed processing, and analytical capabilities (Create).

**Syllabus:**

Module No.	Unit No.	Topics	Hrs.
1	<b>Query Processing and Optimization</b>		4
	<b>After completing this module, students will be able to ..</b> 1 Explain the internal stages of query processing and the role of relational operators in query execution. 2 Apply cost estimation techniques to evaluate selection, join, and sorting operations. 3 Analyse and compare alternative query execution plans to identify optimized evaluation strategies.		
	1.1	Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions.	
	1.2	Query Optimization Overview, Goals of Query Optimization, Approaches of Query Optimization, Transformations of Relational Expression, Estimating Statistics of Expression Results Choice of Evaluation Plans.	
<b>Self-Learning Topic : Problems on cost estimation</b>			
2	<b>Data Warehousing, Dimensional Modelling and OLAP</b>		10
	<b>After completing this module, students will be able to ..</b> 1. Explain the role and architecture of data warehouses and Data Lake in enterprise data management and data analytics. 2. Apply dimensional modeling techniques to design star and snowflake schemas. 3. Analyse and apply OLAP operations to support multidimensional data analysis and business intelligence reporting.		

	2.1	Data Warehousing Definition; Is data warehouse still relevant in the age of big data, Database vs. Data Warehouse, OLAP vs. OLTP, Features of a Data Warehouse; Data Warehouse Architecture (layered), Data Marts; Limitations and challenges.	
	2.2	Design Strategies, Data and Dimensional Model; The Star and Snowflake Schema; Fact and Dimension Tables; Factless Fact Table; Primary, Surrogate & Foreign Keys. Analytical queries, OLAP Operations (3D Cube)- Roll-up, Drill-down, Slice, Dice, Pivot, OLAP automation and challenges, Tools used in BI.	
	2.3	Introduction - Data Lake and Data Lake House, Architecture, Data Data Lake vs Data Warehouse.	
<b>Self-Learning Topic:</b> Azure Databricks and BI Tools			
	<b>ETL Process</b>		
	<b>After completing this module, students will be able to ..</b> 1. Explain ETL architectures and data extraction strategies used in enterprise systems. 2. Apply data transformation, cleansing, and loading techniques for effective data integration. 3. Analyze ETL challenges related to data quality, logging, auditing, and reconciliation.		
3	3.1	Typical ETL pipeline architecture, Challenges in ETL stages and full automation; Data Extraction; Identification of Data Sources; Immediate Data Extraction, Deferred Data Extraction - Timestamp-based and log-based extraction	7
	3.2	Data Transformation: Data quality and pre-processing, Data consistency and integrity, Commonly used data transformations.	
	3.3	Data Loading: Data loading in ETL; full and incremental loading; loading process for data warehouse, Operational controls - error handling, logging, auditing and data reconciliation.	
<b>Self-learning Topics:</b> Study ETL tools - Cloud ETL (AWS Glue)			
	<b>Distributed Databases</b>		

	<p><b>After completing this module, students will be able to ..</b></p> <ol style="list-style-type: none"> <li>1. Explain the architecture, types, and design challenges of distributed database systems.</li> <li>2. Apply data fragmentation, allocation, and replication strategies in distributed environments.</li> <li>3. Analyze scalability and availability requirements to select appropriate distributed database design approaches.</li> </ol>	
	<p><b>4.1</b> Introduction, Distributed Database Architecture, Advantages and disadvantages, Design Issues. Distributed Data Processing and challenges.</p>	
	<p><b>4.2</b> Data Fragmentation, Replication and Allocation Techniques for Distributed Databases, Security challenges, DB Replication, Performance, Scalability and Availability.</p>	
	<p><b>4.3</b> Distributed Transaction Management – Definition, properties, types, architecture. Distributed Query Processing - Characterization of Query Processors, Layers/ phases of query processing. Query decomposition, localization, Parallel query execution and cost considerations in distributed query processing.</p>	
<p><b>Self-Learning Topic:</b> Case study - Network Cost Estimation</p>		
<p><b>5</b></p>	<p><b>NoSQL Data Model and MongoDB</b></p>	<p><b>11</b></p>
	<p><b>After completing this module, students will be able to ..</b></p> <ol style="list-style-type: none"> <li>1. Recollect fundamental concepts of NoSQL databases including data and distribution models.</li> <li>2. Explain the differences between SQL and NoSQL databases and trade-offs of key-value, document, and column-family NoSQL data stores.</li> <li>3. Apply MongoDB commands to perform basic db operations, including data creation, querying, updating, sorting, and aggregation.</li> <li>4. Analyze distributed data handling in MongoDB by examining replication and sharding mechanisms and evaluating their impact on consistency, scalability, and fault tolerance.</li> </ol>	
	<p><b>5.1</b> Introduction - NoSQL database concepts, NoSQL data modeling, SQL and NoSQL - Comparison and Benefits. Distribution Models, Transactions handling, Consistency and eventual consistency in distributed data. CAP theorem, ACID vs. BASE.</p>	

	5.2	NoSQL databases: Key-Value data store, Document database and Column Family Data store, Comparison of NoSQL databases w.r.t CAP theorem and ACID properties.	
	5.3	NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell, Basic Data Types, Arrays, Embedded Documents.	
	5.4	Querying MongoDB - find() functions, logical operators, sorting, aggregate functions, and Joining documents, Authentication, Authorization, Indexing and Data migration schema based on schema-less. Distributed environment- Replication and Sharding for horizontal scaling. CRUD operations using Python Distributed environment- Concepts of replication and horizontal scaling.	
	<b>Self-Learning Topic:</b> Study Apache Cassandra and its features.		
6	<b>Trends in advance databases</b>		5
	<b>After completing this module, students will be able to ..</b> 1. Recall fundamental concepts and terminologies related to temporal, spatial, and graph databases. 2. Explain how temporal dimensions are incorporated into relational databases and how new databases support specialized data models, operators, and query mechanisms. 3. Apply new database concepts to formulate queries for time-based, location-based, and relationship-oriented data using appropriate query constructs. 4. Analyze real-world application scenarios to select suitable database models and evaluate their features with reference to one another.		
	6.1	Introduction to Temporal database - Concepts, time representation, time dimension, incorporating time in relational databases. Real world applications.	
	6.2	Introduction to Spatial database - Introduction, data types (coordinates and shapes – points, line and polygon), models, operators and queries. Real world applications.	
	6.3	Introduction to Graph database - Introduction, Features, Data – Nodes and edges, Graph traversal, Basic query – connections and shortest paths, Real world applications.	
	<b>Self-Learning Topic:</b> Case Study Neo4J		
<b>Total</b>			<b>45</b>

### Suggested Experiment Lists:

Expt No.	List of Experiments
1	<p>ETL Process – Automation of ETL stages using Python and SQLite.</p> <p><b>Objective:</b> To understand Extract–Transform–Load (ETL) concepts and automate data integration using Python scripts and SQLite database.</p> <p><b>Outcome:</b> Students will be able to design automated ETL pipelines and perform data extraction, transformation, and loading for structured datasets.</p>
2	<p>Data Warehouse: Star schema design (Fact and dimension tables) to perform basic analytical queries.</p> <p><b>Objective:</b> To learn dimensional modeling and design a star schema suitable for analytical processing.</p> <p><b>Outcome:</b> Students will be able to create fact and dimension tables and execute analytical queries using star schema architecture.</p>
3	<p>Data Warehouse : Snowflake schema design (Fact and dimension tables) to perform basic analytical queries.</p> <p><b>Objective:</b> To understand normalized dimensional modeling using snowflake schema and its advantages.</p> <p><b>Outcome:</b> Students will be able to design normalized warehouse schemas and compare star vs snowflake schema performance and structure.</p> <hr/> <p>Data Warehouse and OLAP Operations – Rollup, drill down, slicing, dicing and Pivot.</p> <p><b>Objective:</b> To explore OLAP operations for multidimensional data analysis and decision support systems.</p> <p><b>Outcome:</b> Students will be able to perform OLAP operations and analyze data across multiple dimensions for business intelligence applications.</p>
4	<p>NoSQL Databases Operations: MongoDB installation and basic operations.</p> <p><b>Objective:</b> To introduce NoSQL databases and perform installation, configuration, and basic MongoDB operations.</p>

	<p><b>Outcome:</b> Students will be able to install MongoDB, create databases/collections, and execute basic document operations.</p>
5	<p>MongoDB: Aggregation pipeline and JOINS.</p> <p><b>Objective:</b> To understand advanced data processing using MongoDB aggregation framework and collection relationships using lookup operations.</p> <p><b>Outcome:</b> Students will be able to design aggregation pipelines and perform analytical queries including joins in MongoDB.</p>
6	<p>MongoDB – Sharding and Replication.</p> <p><b>Objective:</b> To study distributed database concepts including data distribution, fault tolerance, and high availability in MongoDB.</p> <p><b>Outcome:</b> Students will be able to configure replication and sharding mechanisms and explain scalability and reliability features of distributed databases.</p>
7	<p>MongoDB – CRUD operation using Python.</p> <p><b>Objective:</b> To integrate MongoDB with Python applications and perform programmatic database operations.</p> <p><b>Outcome:</b> Students will be able to develop Python programs to implement CRUD operations on MongoDB collections.</p>
8	<p>MongoDB: User creation and authentication.</p> <p><b>Objective:</b> To understand database security concepts including user management, authentication, and access control in MongoDB.</p> <p><b>Outcome:</b> Students will be able to configure authentication mechanisms and manage secure database access using user roles and permissions.</p>
9	<p>MongoDB: Authentication and Authorization</p> <p><b>Objective:</b> To understand database security concepts including user management, authentication, and access control in MongoDB.</p> <p><b>Outcome:</b> Students will be able to configure authentication mechanisms and manage secure database access using user roles and permissions.</p>
10	<p>MongoDB: Database Indexing</p> <p><b>Objective:</b> To understand and implement indexing in MongoDB to improve query performance and data retrieval efficiency.</p>

	<b>Outcome:</b> Students will be able to create indexes and analyze query execution to optimize database performance.
11	<p>MongoDB: Data Migration</p> <p><b>Objective:</b> To understand and perform data migration from a schema-based (relational) database to a schema-less (MongoDB) database.</p> <p><b>Outcome:</b> Students will be able to transform structured data into document format and migrate it into MongoDB for flexible data storage.</p>

### Assessment Methodology:

<b>CA-20</b>	<p>Certification: NPTEL (20 Marks) (Approved by instructor) OR) Any two Pedagogies (10 marks each)</p> <ul style="list-style-type: none"> <li>* MCQ /Class Test</li> <li>* Case study/Assignment</li> <li>* GATE based Assignment</li> <li>* Certification: UdeMy/Coursera (Approved by instructor)</li> <li>* Open Book Test</li> <li>* Working model / simulation of a course-based concept.</li> </ul>
<b>MSE</b>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>* Q1 A or B - 10 marks</li> <li>* Q2 A or B - 10 marks</li> <li>* Q3 A or B - 10 marks</li> <li>* For each question, A and B should be based on the same CO.</li> <li>* MSE should be based on 50% syllabus.</li> <li>* Time: 90 minutes (1 hour 30 minutes)</li> <li>* Total Marks: 30</li> </ul>
<b>ESE</b>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>* Q1 A or B - 10 marks</li> <li>* Q2 A or B - 10 marks</li> <li>* Q3 A or B - 10 marks</li> <li>* Q4 A or B - 10 marks</li> <li>* Q5 A or B - 10 marks</li> <li>* For each question, A and B should be based on the same CO.</li> <li>* ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE.</li> <li>* Time: 120 minutes (2 hours)</li> <li>* Total Marks: 50</li> </ul>

<b>TW-25</b>	Active Participation = 5 marks Tutorial Submission = 20 marks
<b>Oral Exam-25</b>	Oral exam

**Textbooks:**

1. Theraja Reema, “Data Warehousing”, Oxford University Press.
2. Fundamentals of Data Engineering: Plan and Build Robust Data Systems By Joe Re (Author), Matt Housley, O’Rielly, 2022.
3. MongoDB – The Definitive Guide 2e, by Kristina Chodorow, O’Rielly, 2013.
4. NoSQL for Mere Mortals by Dan Sullivan, Edition 1st, Publisher - Addison-Wesley Professional

**References:**

1. PaulrajPonniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India.
2. Ralph Kimball, Margy Ross, “The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling”, 3rd Edition. Wiley India.
3. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling By Ralph Kimball, Edition 3rd, Wily, 2013

**Online Platforms:**

1. <https://nptel.ac.in/courses/106106095>
2. <https://www.coursera.org/professional-certificates/ibm-data-manager-IBM/Edx> - <https://www.edx.org/certificates/professional-certificate/ibm-sql-nosql-and-relational-database-fundamentals>

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25DBIT4PCC03	Operating System	-	2	-	-	2	-	2	
		Examination Scheme							
			CA	MSE	ESE	TW	OR	PR	Total
		<b>Theory</b>	50	0	0	-	-	-	50
		<b>Lab</b>	-	-	-	25	-	25	50
		<b>Total</b>	<b>100</b>						

<b>Pre-Requisite Courses:</b>	25FE1VESC02 - Problem Solving using C programming
	25FE2PCC04 - Data structure and algorithm

**Course and Module Overview:**

The Operating Systems & Virtualization course provides a comprehensive understanding of how modern operating systems function as the core interface between computer hardware and software. The course introduces fundamental OS concepts such as process management, CPU scheduling, concurrency, memory management, storage systems, and I/O mechanisms, along with contemporary topics like virtualization, containers, and cloud-native operating systems. Through a balance of theory and hands-on exposure, students learn how operating systems manage resources efficiently, ensure security and isolation, and support scalability in modern computing environments. The course prepares learners for careers and research in systems programming, cloud infrastructure, virtualization technologies, cybersecurity, and distributed systems, while also strengthening problem-solving and analytical skills essential for advanced computing domains.

**Module 1: OS Overview & Virtualization Concepts**

This module introduces the foundational concepts of operating systems, including their goals, functions, architectures, and types. It explains the role of the OS as an abstraction layer and introduces virtualization concepts, focusing on CPU and memory virtualization through mechanisms such as time-sharing and context switching

**Module 2: Processes and Process Management**

This module focuses on the process abstraction used by operating systems. It covers process creation, execution, termination, and lifecycle management using standard process APIs. The interaction between processes, system calls, context switching, and CPU scheduling is also explored

**Module 3: Concurrency & Synchronization**

This module introduces concurrency and multithreading in operating systems. It explains common concurrency problems such as race conditions and deadlocks, and presents synchronization mechanisms including locks, mutexes, condition variables, and semaphores. Thread scheduling techniques are also discussed

**Module 4: CPU Scheduling & Memory Management**

This module covers two critical OS components: CPU scheduling and memory management. It explains scheduling algorithms and how operating systems manage memory through virtualization techniques such as paging, segmentation, address translation, and memory replacement policies.

**Module 5: Storage, I/O Systems & File Systems**

This module focuses on persistent storage and file systems. It covers storage technologies like disks and SSDs, RAID configurations, file system interfaces, internal implementations, crash consistency mechanisms, buffer caching, and I/O virtualization

**Module 6: Security, Performance & Future Trends**

This module introduces system-level security and virtualization technologies. It covers virtual machines, hardware virtualization, hypervisors, container-based OS-level virtualization, isolation techniques, and emerging trends such as cloud-native operating systems and unikernels..

**The Operating Systems & Virtualization course offers a comprehensive understanding of core OS principles and modern virtualization technologies essential for efficient resource management and secure computing. It prepares students for advanced careers in systems programming, cloud computing, cybersecurity, and distributed systems.**

<b>Course Outcomes</b>	<b>After successful completion of the course, the students will be able to</b>	
	CO1	Describe OS concepts including virtualization, concurrency, and persistence.
	CO2	Explain processes, threads, CPU scheduling, and abstraction mechanisms.
	CO3	Apply concurrency and memory management concepts for OS-level problem-solving.
	CO4	Analyze scheduling, synchronization, and memory performance issues.
	CO5	Evaluate storage systems, file-system designs, and I/O mechanisms
	CO6	Design and implement small-scale virtualized or containerized environments.

**Syllabus:**

Module No.	Unit No.	Topics	Hrs.
		<b>OS Overview &amp; Virtualization Concepts</b>	

	<p><b>After completing this module, students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Explain the goals, functions, and architectures of operating systems</li> <li>2. Describe different types of operating systems and their use cases</li> <li>3. Understand the concept of virtualization and OS-provided abstractions</li> <li>4. Explain CPU virtualization techniques such as time-sharing and context switching</li> </ol>		
	1.1 Introduction to OS, goals, and functions		
	1.2 OS Architectures and Types		
	1.3 The concept of virtualization (CPU & memory)		
	1.4 Abstractions provided by OS		
	1.5 CPU Virtualization Basics: Time-sharing, context switching		
	<p><b>Self-Learning Topic :</b> Types of Operating Systems (Real-world Case Studies), Evolution of Operating Systems from Batch Processing to Cloud-Native Architectures</p>		
2	<p><b>Processes and Process Managements</b></p>		
	<p><b>After completing this module, students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Define and explain the process abstraction in operating systems</li> <li>2. Use and explain process-related system calls such as fork, exec, and wait</li> <li>3. Describe process lifecycle states and state transitions</li> <li>4. Explain the role of system calls and context switching</li> <li>5. Analyze how CPU scheduling interacts with the process model</li> </ol>		
	2.1	Process abstraction	5
	2.2	Process API (fork, exec, wait)	
	2.3	Process lifecycle and state transitions	
	2.4	System calls and context switching	
	2.5	Scheduling interactions with process model	
<p><b>Self-Learning Topics:</b> Signals and interrupts in Linux (SIGKILL, SIGINT, SIGSTOP), Case study: How modern browsers manage processes (Chrome/Firefox).</p>			

3	<b>Concurrency &amp; Synchronization</b>		5
	<b>After completing this module, students will be able to:</b>		
	1. Explain the need for concurrency and multithreading		
	2. Identify race conditions and common concurrency bugs		
	3. Apply synchronization mechanisms such as locks, mutexes, and semaphores		
	4. Analyze deadlock scenarios and prevention/detection techniques		
	5. Explain thread scheduling strategies used by operating systems		
	3.1	Threads and the need for concurrency	
3.2	Race conditions and concurrency bugs		
3.3	Locks, Mutexes, Condition Variables		
3.4	Semaphores		
3.5	Deadlocks: prevention, detection		
3.6	Thread scheduling		
<b>Self-Learning Topics: Cgroups &amp; Namespaces in Linux.</b>			
4	<b>CPU Scheduling &amp; Memory Management</b>		5
	<b>After completing this module, students will be able to:</b>		
	1. Compare CPU scheduling algorithms such as FIFO, SJF, MLFQ, and CFS		
	2. Explain the concept of memory virtualization		
	3. Describe address translation using segmentation and paging		
	4. Analyze page faults, TLBs, and swap space mechanisms		
5. Evaluate different memory replacement policies			
4.1	Scheduling algorithms: FIFO, SJF, MLFQ, CFS		
4.2	Memory virtualization		
4.3	Address translation, segmentation		
4.4	Paging, multi-level paging		

	4.5	TLBs, page faults, swap space	
	4.6	Memory replacement policies	
	<b>Self-Learning Topics:</b> Page replacement simulations.		
5	<b>Storage, I/O Systems &amp; File Systems</b>		5
	<b>After completing this module, students will be able to:</b>		
	<ol style="list-style-type: none"> <li>1. Explain challenges in persistent storage systems</li> <li>2. Describe disk, SSD, and RAID architectures</li> <li>3. Understand file system interfaces and internal data structures</li> <li>4. Explain directory structures, inodes, and allocation methods</li> <li>5. Analyze journaling, crash consistency, and buffer cache mechanisms</li> <li>6. Explain I/O virtualization concepts</li> </ol>		
	5.1	Persistent storage challenges	
	5.2	Disks, SSDs, RAID	
	5.3	File system interface	
	5.4	File system implementation	
	5.5	Directories, inodes, allocation	
	5.6	Journaling and crash consistency	
	5.7	Buffer cache	
5.8	I/O virtualization		
	<b>Self-Learning Topics:</b> RAID levels and performance comparisons.		
6	<b>Virtualization, Security, Performance &amp; Future Trends</b>		5
	<b>After completing this module, students will be able to:</b>		
<ol style="list-style-type: none"> <li>1. Explain virtual machine concepts and hardware virtualization basics</li> <li>2. Differentiate between Type 1 and Type 2 hypervisors</li> <li>3. Describe OS-level virtualization using containers</li> <li>4. Explain security mechanisms such as isolation and sandboxing</li> <li>5. Analyze emerging trends including cloud-native OS and unikernels</li> </ol>			

	6.1	Virtual machine concepts	
	6.2	Hardware virtualization basics	
	6.3	Virtual Machine Monitor (VMM) / Hypervisor, VMM/HV: Type 1 & Type 2	
	6.4	OS-level virtualization (containers overview)	
	6.5	Virtual Resource Management	
	6.6	Security: isolation, sandboxing	
	<b>Self-Learning Topics:</b> Virtual machine escape attacks (case studies like VENOM), Serverless architectures and how they differ from VMs/containers, Secure boot and trusted platform modules (TPM).		
<b>TOTAL</b>			30

### Suggested List of Experiments:

Expt. No.	List of Experiments
1	<p>Process Creation and System Calls:</p> <p><b>Objective:</b>To understand and implement process creation, program execution, and synchronization in C using fork(), exec(), and wait() while observing process IDs and states.</p> <p><b>Outcome:</b>Students will be able to write C programs that create and manage processes, execute new programs, synchronize parent-child execution, and analyze process behavior using PIDs and states.</p>
2	<p>Exploring the Process Abstraction via /proc</p> <p><b>Objective:</b>To explore the Linux /proc file system for understanding process abstraction by examining attributes such as memory usage, scheduling details, open file descriptors, and runtime statistics.</p> <p><b>Outcome:</b>Students will be able to analyze and interpret process-related information from the /proc file system to understand process behavior, resource utilization, and execution characteristics in a Linux environment.</p>

3	<p>CPU Scheduling Simulation</p> <p><b>Objective:</b>To implement and simulate CPU scheduling algorithms such as First Come First Serve (FIFO), Shortest Job First (SJF), Round Robin Scheduling, and Multilevel Feedback Queue, and evaluate their performance based on turnaround time, waiting time, and response time.</p> <p><b>Outcome:</b>Students will be able to compare and analyze the efficiency of different CPU scheduling algorithms by calculating key performance metrics and understanding their impact on system performance for various workloads.</p>
4	<p>Context Switching and Time-Sharing Analysis</p> <p><b>Objective:</b>To measure and analyze context switch rates using tools like vmstat, pidstat, and perf, and study how the operating system schedules processes under CPU load.</p> <p><b>Outcome:</b>Students will be able to monitor system performance, interpret context switching behavior, and analyze how the operating system schedules processes under varying CPU load conditions</p>
5	<p>Thread Creation and Concurrency Basics</p> <p><b>Objective:</b>To implement multithreading in C using POSIX Threads to create and manage multiple threads, demonstrating concurrent execution and observing race conditions and interleaving behavior.</p> <p><b>Outcome:</b>Students will be able to develop multithreaded programs, analyze concurrent execution, and identify issues like race conditions and interleaving in thread-based systems.</p>
6	<p>Synchronization using Locks and Semaphores</p> <p><b>Objective:</b> To implement mutual exclusion in multithreaded programs using pthread mutex and semaphore to address the critical section problem.</p> <p><b>Outcome:</b>Students will be able to apply synchronization techniques using mutexes and semaphores to ensure safe concurrent execution and effectively solve the critical section problem in multithreaded systems.</p>
7	<p>Solving Concurrency Bugs:</p>

	<p><b>Objective:</b>To design programs that intentionally demonstrate concurrency issues such as race condition, deadlock, and order violations, and apply synchronization mechanisms to eliminate these bugs.</p> <p><b>Outcome:</b>Students will be able to identify, analyze, and resolve concurrency problems by applying appropriate synchronization techniques to ensure correct and efficient multithreaded execution.</p>
8	<p>Memory Virtualization and Address Translation</p> <p><b>Objective:</b>To simulate virtual-to-physical address translation using paging by implementing a page table and demonstrating how logical addresses are mapped to physical addresses.</p> <p><b>Outcome:</b>Students will be able to implement and analyze address translation mechanisms, understand page table operations, and explain how logical addresses are converted into physical addresses in memory management.</p>
9	<p>Page Replacement Algorithm Simulation</p> <p><b>Objective:</b>To implement and simulate page replacement algorithms such as First In First Out (FIFO), Least Recently Used (LRU), Optimal Page Replacement, and Clock Page Replacement, and evaluate their performance using hit and miss ratios.</p> <p><b>Outcome:</b>Students will be able to analyze and compare different page replacement strategies by computing hit/miss ratios and understanding their impact on memory management efficiency.</p>
10	<p>File System Exploration and I/O Behavior</p> <p><b>Objective:</b>To implement file I/O operations using Linux system calls such as open(), read(), write(), and lseek(), and evaluate performance differences between buffered and unbuffered operations.</p> <p><b>Outcome:</b>Students will be able to perform low-level file handling using system calls and analyze the impact of buffering on I/O performance and efficiency.</p>
11	<p>Simple File System Simulation</p> <p><b>Objective:</b>To design and implement a file system simulator that models core components such as inode, file system block, free list, and directory structure, and perform operations like</p>

	<p>file creation, deletion, and traversal.</p> <p><b>Outcome:</b>Students will be able to simulate and analyze file system behavior by implementing core structures and performing basic file operations, gaining an understanding of how storage is organized and managed internally.</p>
12	<p>Virtualization: Working with VMs or Containers</p> <p><b>Objective:</b>To install and configure virtualization environments using VirtualBox, Kernel-based Virtual Machine, or container platforms like Docker, and evaluate their performance, resource allocation, and isolation mechanisms.</p> <p><b>Outcome:</b>Students will be able to set up and compare virtual machines and containers, analyzing differences in performance, resource utilization, and isolation in modern computing environments.</p>

**Assessment Methodology:**

<b>CA-50</b>	<p>Active Participation = 5 marks  MCQ /Class Test= 25 marks  Mini Project = 25 marks  Mini Project Active participation 5 marks  Instructor Assessment of the Activity carried out by student = 25 marks  Assignment = 10 marks</p>
<b>TW-25</b>	<p>Active Participation = 5 marks  Tutorial Submission = 20 marks</p>
<b>PR-25</b>	<p>Practical examination will be based on the experiments performed by the students during laboratory sessions.</p>

**Text Books:**

1. Remzi H. Arpaci-Dusseau & Andrea C. Arpaci-Dusseau, Operating Systems: Three Easy Pieces (OSTEP), 2018.
2. Operating System Concepts – Abraham Silberschatz, Peter Baer Galvin & Greg Gagne  
Publisher: Wiley
3. Modern Operating Systems – Andrew S. Tanenbaum & Herbert Bos  
Publisher: Pearson
4. Operating Systems: Internals and Design Principles – William Stallings
5. Linux Administration: A Beginner’s Guide – Wale Soyinka  
Publisher: McGraw-Hill

**Reference Books:**

1. The Linux Programming Interface – Michael Kerrisk, Publisher: No Starch Press
2. Professional Linux Kernel Architecture – Wolfgang Mauerer

3. Virtualization Essentials – Matthew Portnoy Publisher: Wiley
4. Kubernetes in Action – Marko Luksa Publisher: Manning
5. Cloud Computing: A Hands-On Approach – Arshdeep Bahga & Vijay Madisetti, Publisher: Universities Press

**Useful Links:**

1. <https://pages.cs.wisc.edu/~remzi/OSTEP/>
2. NPTEL Courses - Operating Systems – IIT Madras, Instructor: Prof. Varadharajan
3. Operating System Fundamentals – IIT Kharagpur, Instructor: Prof. S. Dasgupta
4. Linux Programming and System Administration – IIT Kharagpur
5. MIT Open Course Ware (MIT OCW) - Operating System Engineering

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25IT4CEP01	Community Engagement Project - 2	-	2*	-	-	1	-	1	
		Examination Scheme							
			CA	MSE	ESE	TW	OR	PR	Total
		<b>Theory</b>	-	-	-	-	-	-	-
		<b>Lab/Tut</b>	-	-	-	25	25	-	50
		<b>Total</b>	50						

<b>Pre-Requisite Courses:</b>	25BSH2CEP02-Python Programming
	25IT3CEP03 -Java Programming

### Course General Overview

This course is designed to engage students with real-world community needs and sustainability challenges while developing engineering, analytical, and interpersonal competencies. It introduces learners to local and global issues aligned with the Sustainable Development Goals (SDGs), enabling them to explore socio-economic, environmental, and technological dimensions of community problems. Through field visits, surveys, and stakeholder interactions, students learn to identify genuine needs and convert them into well-defined engineering and social problem statements.

The course emphasizes the application of engineering fundamentals, appropriate technologies, and collaborative teamwork to design practical solutions. Students develop critical skills in data collection, analysis, project planning, and ethical decision-making.

With a strong focus on sustainability, innovation, and self-directed learning, the course encourages students to evaluate the societal and environmental impact of their solutions. By the end of the course, learners will be capable of designing feasible, scalable, and community-centric prototypes or interventions that demonstrate measurable positive outcomes. This holistic experience prepares students for socially responsible engineering practice and lifelong learning.

<b>Course Outcomes</b>	<b>After successful completion of the course, the students will be able to</b>	
	CO1	Identify community needs and societal challenges and relate them to relevant Sustainable Development Goals.
	CO2	Understand the social, environmental, ethical, and technical aspects of identified community problems using appropriate documentation techniques.
	CO3	Apply engineering knowledge, tools, and project management techniques to develop solutions for real-world community problems in a team environment.

	CO4	Analyze collected field data, resource availability, risks, and constraints to refine problem statements and solution approaches.
	CO5	Evaluate the effectiveness, sustainability, societal impact, and environmental implications of proposed or implemented solutions using standard engineering norms.
	CO6	Design and develop innovative, feasible, and community-centric solutions or prototypes that address identified needs and demonstrate measurable impact.

### **Guidelines for Community Engagement Mini Project**

#### 1. Group Formation:

Students shall form a community engagement project group consisting of a minimum of three (3) and a maximum of four (4) students. The group structure is intended to promote teamwork, leadership, inclusiveness, and collaborative learning, in alignment with SDG-4 (Quality Education) and SDG-17 (Partnerships for the Goals).

#### 2. Community Survey and Need Identification :

Each group shall conduct a systematic community survey through field visits, interactions with stakeholders, or secondary data analysis to identify societal, environmental, or technological needs. Identified needs shall be mapped to relevant Sustainable Development Goals (SDGs) and converted into a clearly defined problem statement in consultation with the faculty supervisor / Head of Department / internal faculty committee.

#### 3. Problem Definition and Sustainability Context:

The problem statement shall explicitly address sustainability, social relevance, feasibility, and ethical considerations, ensuring alignment with the course objectives and selected SDGs.

#### 4. Project Planning and Management:

Students shall prepare and submit a detailed implementation plan using Gantt / PERT / CPM charts, clearly indicating weekly activities, milestones, responsibilities, and deliverables.

This activity aims to develop project management competencies and structured problem-solving skills.

#### 5. Maintenance of Project Log Book:

Each group shall maintain a project log book documenting weekly progress, community interactions, learning outcomes, challenges faced, and corrective actions.

The faculty supervisor shall periodically review, verify, and provide written feedback in the log book to ensure continuous improvement.

6. Faculty Mentorship and Self-Learning :

The faculty supervisor shall act as a mentor and facilitator, providing guidance and feedback at appropriate stages. However, emphasis shall be on self-learning, independent thinking, research orientation, and innovation, in line with lifelong learning outcomes and SDG-4.

7. Solution Development and Selection :

Students shall analyze the problem comprehensively, propose multiple alternative solutions, and evaluate them based on sustainability, feasibility, cost, societal impact, and SDG relevance. The most appropriate solution shall be selected in consultation with the faculty supervisor.

8. Design, Development, and Demonstration :

The selected solution shall be designed and developed into a working model, prototype, or validated solution using appropriate tools, technologies, and components relevant to the students' domain. The solution shall be demonstrated with emphasis on community applicability and SDG contribution.

9. Validation and Documentation :

The proposed solution shall be validated using proper justification, such as field feedback, performance analysis, simulations, or comparative studies.

A comprehensive project report shall be prepared and submitted in the standard format , highlighting SDG alignment, societal impact, and sustainability aspects.

10. Assessment Process:

- Progress Monitoring :• At least two formal reviews per semester:

Review 1: Problem finalization & proposed solution.

Review 2: Implementation, testing, and validation.

**Assessment Methodology:**

<b>Types of Assessment</b>	<b>Assessment Tools</b>
<b>TW-25</b>	Active Participation = 5 marks Project Presentation 1 & 2 = 10 Project Submission = 10 marks
<b>OR-25</b>	Oral Exams will be conducted at the end of the semester, Marks will be awarded based on the rubrics set for the mini project quality criterias. Project Quality(10Marks) ,Fully Functional Model (5Marks) , Standard engineering Practices(5Marks), Team Members Contribution (5 Marks)

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25IL4EEM01	Entrepreneurship Essentials	2	-	-	2	-	-	2	
		<b>Examination Scheme</b>							
			CA	MSE	ESE	TW	OR	PR	Total
		<b>Theory</b>	50	-	-	-	-	-	<b>50</b>
		<b>Lab/Tut</b>	-	-	-	-	-	-	-
		<b>Total</b>	<b>50</b>						

<b>Pre-Requisite Courses:</b>	Basic knowledge of management functions, leadership, and organizational behavior.
	Ability to interpret simple financial data, manage budgets, and understand basic accounting principles & Proficiency in using digital tools line Excel.
	Communication, presentation, and interpersonal skills & critical thinking, creativity, problem-solving skills, and an interest in innovation and real-world business scenarios.

### Course and Module Overview:

The course aims to develop an understanding of entrepreneurship and its role in economic development. It focuses on entrepreneurial behavior, theories, types of entrepreneurs, business idea generation, project planning, venture development, and the impact of external environments including government policies and global challenges. The course also encourages self-learning through case studies and real-world entrepreneurial practices in India.

#### Module 1: Foundations of Entrepreneurship Development

This module introduces the fundamentals of entrepreneurship and its significance in economic growth. It covers the concept and need for entrepreneurship development, definitions of entrepreneurship and entrepreneurs, and key characteristics required for entrepreneurial success. Case studies of entrepreneurs from small towns in India provide practical insights into grassroots entrepreneurship.

#### Module 2: Theories of Entrepreneurship & External Influences

This module explores major entrepreneurship theories proposed by Schumpeter, McClelland, Leibenstein, Knight, and Hagen. It examines how sociocultural, political, economic, and personal factors influence entrepreneurial development. The role of entrepreneurial culture in fostering innovation and enterprise creation is emphasized.

#### Module 3: Types & Classification of Entrepreneurs

This module focuses on different types of entrepreneurs, including intrapreneurs, women entrepreneurs, and social entrepreneurs. It discusses challenges faced by women entrepreneurs and

the role of Self-Help Groups (SHGs). The module also highlights social entrepreneurship in India and the importance of NGOs in social responsibility and development..

**Module 4: Entrepreneur Project Development & Business Idea**

This module emphasizes innovation, creativity, and idea generation. Students learn about identifying business opportunities through environmental scanning and change. The entrepreneurship development cycle and SWOT analysis help learners understand how to convert ideas into viable entrepreneurial ventures.

**Module 5: Business Plan**

This module covers the structure and objectives of a business plan. It includes market analysis, feasibility analysis, and planning for marketing, finance, organization, and management. Case studies on mergers, acquisitions, and takeovers of start-ups provide exposure to strategic business growth and expansion.

**Module 6: Venture Development**

This module explains the steps involved in starting a venture, institutional support systems, venture funding, and sources of finance. It discusses legal requirements, marketing channels, and challenges in venture setup. The module also analyzes the impact of COVID-19 on MSMEs in India and government relief measures under the Atma Nirbhar Bharat Abhiyan.

<b>Course Outcomes</b>	<b>After successful completion of the course, the students will be able to.</b>	
	CO1	Recall fundamental concepts of entrepreneurship, identify types and characteristics of entrepreneurs, and list major entrepreneurship theories and government support initiatives in India.
	CO2	Explain the role of entrepreneurship in economic and social development and describe the influence of theories, innovation, creativity, and external environmental factors on entrepreneurial growth.
	CO3	Apply idea generation techniques, SWOT and feasibility analysis, and knowledge of finance, institutional support, and legal requirements to plan entrepreneurial ventures.
	CO4	Analyze market conditions, customer needs, challenges faced by women entrepreneurs, MSMEs and social entrepreneurs, and the impact of policies and external factors on ventures.
	CO5	Evaluate business plans, government support schemes, and entrepreneurial case studies to assess venture viability and development outcomes.
	CO6	Design innovative business ideas, develop comprehensive business plans, and create sustainable entrepreneurial solutions to address socio-economic and environmental challenges.

**Syllabus:**

<b>Module No.</b>	<b>Unit No.</b>	<b>Topics</b>	<b>Hrs</b>
<b>1</b>	<b>Foundations of Entrepreneurship Development</b>		<b>6</b>
	After completing this module, students will be able to: <ol style="list-style-type: none"> <li>1. Explain the concept and need for entrepreneurship development.</li> <li>2. Identify the characteristics and qualities of successful entrepreneurs.</li> <li>3. Describe the importance of entrepreneurship in economic growth.</li> </ol>		
	1.1	Concept and need of entrepreneurship development.	
	1.2	Definition of entrepreneur, entrepreneurship importance and significance of growth of entrepreneurial activities.	
	1.3	Characteristics and qualities of an entrepreneur.	
<b>Self-Learning Topics:</b> Case studies of entrepreneurs from small towns in India.			
<b>2</b>	<b>Theories of Entrepreneurship &amp; External Influences on Entrepreneurship Development</b>		<b>6</b>
	After completing this module, students will be able to: <ol style="list-style-type: none"> <li>1. Explain major theories of entrepreneurship proposed by Schumpeter, McClelland, Leibenstein, Knight, and Hagen.</li> <li>2. Examine the influence of sociocultural, political, economic, and personal factors on entrepreneurship development.</li> <li>3. Assess the role of entrepreneurial culture in promoting entrepreneurial activities.</li> </ol>		
	2.1	Theories by: Schumpeter, McClelland, Leibenstein, Knight & Hagen.	
	2.2	External influences: Sociocultural, Political, Economic, Personal.	
	2.3	Role of entrepreneurial culture in entrepreneurship development.	
<b>Self-Learning Topics:</b> Factors affecting entrepreneurship development.			
<b>3</b>	<b>Types &amp; Classification of Entrepreneurs</b>		<b>6</b>
	After completing this module, students will be able to:		

	<ol style="list-style-type: none"> <li>1. Distinguish between different types of entrepreneurs including intrapreneurs, women entrepreneurs, and social entrepreneurs.</li> <li>2. Analyze the challenges faced by women entrepreneurs and the role of Self-Help Groups (SHGs).</li> <li>3. Explain the importance of social entrepreneurship and the role of NGOs in social responsibility.</li> </ol>	
	3.1	Intrapreneur: Types & classification, concept & development of intrapreneurship.
	3.2	Women Entrepreneur: concept, development and problems faced by women entrepreneurs, development of women entrepreneurs with reference to the Self Help Group (SHG).
	3.3	Social Entrepreneurship: concept, development of social entrepreneurship in India. Importance and Social responsibility of NGOs.
	<b>Self-Learning Topics:</b> Entrepreneurial Development Program (EDP): concept & factors influencing EDP.	
4	<b>Entrepreneur Project Development &amp; Business Idea</b>	
	After completing this module, students will be able to: <ol style="list-style-type: none"> <li>1. Differentiate between innovation, invention, and creativity in the context of entrepreneurship.</li> <li>2. Apply idea generation techniques and environmental scanning to identify business opportunities.</li> <li>3. Explain the entrepreneurship development cycle and use SWOT analysis for project evaluation.</li> </ol>	
	4.1	Innovation, Invention, Creativity, Business idea, opportunities through change.
	4.2	Idea generation: Sources, development of product or idea, environmental scanning.
	4.3	Creating entrepreneurial ventures: Entrepreneurship development cycle.
	<b>Self-Learning Topics:</b> SWOT analysis.	
5	<b>Business Plan</b>	
	After completing this module, students will be able to: <ol style="list-style-type: none"> <li>1. Identify the elements and objectives of a business plan.</li> <li>2. Analyze market and feasibility aspects of entrepreneurial ventures.</li> <li>3. Evaluate marketing, financial, organizational, and ownership structures of business plans.</li> </ol>	
		6
		6

	5.1	Elements of business plan, objectives of business plan.	
	5.2	Market analysis and feasibility analysis.	
	5.3	Marketing, Finance, Organization & Management, Ownership.	
<b>Self-Learning Topics:</b> Case study on takeover, mergers and acquisitions of start-ups in India & global.			
6	<b>Venture Development</b>		6
	After completing this module, students will be able to:		
	<ol style="list-style-type: none"> <li>1. Explain the steps involved in starting a venture and sources of finance.</li> <li>2. Identify legal requirements and marketing channels for establishing a new business unit.</li> <li>3. Analyze the impact of COVID-19 and government policy responses on MSMEs in India.</li> </ol>		
	6.1	Steps involved in starting a venture, institutional support to an entrepreneur, venture funding, requirements of capital (Fixed and working), sources of finance, problem of venture set-up and prospects.	
	6.2	Legal requirements for establishment of a new unit, Marketing: methods and channel.	
6.3	Impact of COVID-19 on micro, small and medium enterprises in India, pandemic shock of COVID-19 and policy response.		
<b>Self-Learning Topics:</b> Self Learning topics: Government financing support programme for businesses Covid 19, relief measures to small businesses in India (Atma Nirbhar Bharat Abhiyan).			
<b>TOTAL</b>			36

### Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (50 Marks)	<ul style="list-style-type: none"> <li>● Certification NPTEL: 20 Marks (Approved by instructor)</li> </ul> <p style="text-align: center;"><b><i>And / Or</i></b></p> <p style="text-align: center;"><b>Any 05 Pedagogies (10 marks each)</b></p> <ul style="list-style-type: none"> <li>● Assignment</li> <li>● Case Study Analysis (individual / group)</li> <li>● Certification: Udemy / Coursera (Approved by instructor)</li> <li>● Class Test</li> </ul>

	<ul style="list-style-type: none"> <li>● Discussion &amp; Reflective Learning</li> <li>● Idea Generation &amp; Opportunity Identification</li> <li>● MCQ Test</li> <li>● Open Book Test</li> <li>● Project Report: Venture Development Plan</li> <li>● Simulation of a course based concept.</li> </ul>
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### **Text Books:**

1. Business Planning and Entrepreneurial Management by Michael Vaz & Meeta Seta, Publication: Manan Prakashan (2023 June, 7th edition), ISBN: 978-93-5750-083-8.
2. Business Planning and Entrepreneurial Management by Dr. Rinkesh Chheda & Ms. Falguni Mathews, Publication: Himalaya Publishing House (2019), ISBN: 978-93-5367-613-1.
3. Business Planning and Entrepreneurial Management by Veena Prasad & Deepali Kamle, Publication: Himalaya Publishing House (2018), ISBN: 978-93-5202-078-2.

### **Reference Books:**

1. Corporate Entrepreneurship and Innovation by Paul Burns, Publication: Bloomsbury Academic (2025 June, 5th edition), ISBN (Paperback): 9781350384071, ISBN (eBook EPUB/MOBI): 9781350384095, ISBN (eBook PDF): 9781350384101.
2. Dynamics of Entrepreneurial Development & Management by Dr. Desai Vasant, Publication: Himalaya Publishing House (2019, 6th edition), ISBN: 978-93-5750-083-8.
3. Online Book, Institute of Distance & Open Learning (IDOL) University of Mumbai, <https://old.mu.ac.in/wp-content/uploads/2014/04/Management-PAPER-V-ENTREPRENEURSHIP-Management-final-book.pdf>
4. Entrepreneurship in the New Millennium by Donald F. Kuratko & Richard M. Hodgetts, Publication: Cengage learning South-Western Cengage Learning India (2008 Jan), ISBN: 978-8131505618 (typical Indian edition).
5. Business Planning: A Guide to Business Start-Up by Butler David, Publication: Taylor & Francis Ltd / Butterworth-Heinemann (2000). ISBN-13: 978-0-7506-4706-9

### **Useful Links:**

1. <https://www.ahlawatassociates.com/blog/legal-requirements-for-starting-a-business-in-india>
2. <https://smallbusiness.chron.com/business-plans-fail-projects-fail-10901.html>
3. <https://rcic.in/acquisitions/mergers-acquisitions-case-studies-india/>
4. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1049>

## Preface

The evolving landscape of higher education emphasizes the need for students to acquire knowledge that extends beyond the boundaries of a single discipline. In alignment with the broader vision of the National Education Policy (NEP) 2020, engineering education increasingly encourages students to explore learning opportunities that integrate concepts from multiple domains. The Multi-Disciplinary Minor (MDM) Courses offered at Don Bosco Institute of Technology (DBIT), Mumbai, reflect this academic approach by providing structured pathways for students to develop competence in areas outside their primary field of study.

Multi-Disciplinary Minor courses enable students to broaden their academic exposure while pursuing their core engineering program. Through these courses, learners are encouraged to engage with complementary areas of knowledge that enhance their analytical ability, problem-solving skills, and intellectual curiosity. Such interdisciplinary learning supports the development of well-rounded professionals who are capable of understanding complex real-world challenges from multiple perspectives.

The MDM framework allows students to pursue a focused set of courses in a chosen domain, thereby enabling deeper engagement with emerging technologies, interdisciplinary applications, and contemporary areas of study. This approach encourages learners to build additional competencies that complement their primary discipline and strengthen their academic and professional profile.

These courses emphasize conceptual understanding, application-oriented learning, and collaborative exploration of ideas. Students are encouraged to participate in discussions, case studies, project-based learning, and practical activities that promote critical thinking and innovation. Such learning experiences help develop adaptability, creativity, and interdisciplinary awareness—skills that are increasingly essential in modern professional environments.

Multi-Disciplinary Minor courses also play an important role in fostering intellectual flexibility among students. By interacting with concepts from diverse academic fields, learners develop the ability to connect ideas, integrate knowledge, and apply learning in varied contexts. This exposure strengthens their readiness to work in multidisciplinary teams and address complex societal and technological challenges.

The following pages present the syllabi and structure of the Multi-Disciplinary Minor courses offered as part of the academic curriculum at DBIT. The document outlines the objectives, learning outcomes, and academic components associated with these courses. It serves as a reference for students and faculty members to understand the scope and academic expectations of the MDM framework.

The contents of this document may be reviewed and updated periodically by the Academic Council and other academic bodies of the institute in accordance with evolving academic practices and institutional priorities.

Through the Multi-Disciplinary Minor courses, DBIT aims to nurture engineers who possess not only strong disciplinary knowledge but also the interdisciplinary perspective required to contribute effectively to innovation, research, and societal development.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25CE4MDM01	Web Development	2	2-	-	2	1	-	3
		<b>Examination Scheme</b>						
		Theory	CA	MSE	ESE	Total		
			20	30	50	100		
		Lab	TW	OR	PR	Total		
			25	-	-	25		
		<b>Total</b>	<b>125</b>					

<b>Pre-requisite Courses:</b>	25FE1VSEC02 - Problem Solving using C programming.
<p><b>Course and Module Overview:</b> This course provides a structured and comprehensive introduction to web development, covering both client-side and server-side technologies along with database integration. The course begins with fundamental concepts of web communication, including clients, servers, HTTP protocols, and the structure of web applications. It then progresses to front-end development using HTML, CSS, and JavaScript, enabling students to design and develop interactive and responsive web pages.</p> <p>Further, the course introduces modern full-stack development using the <b>MERN stack (MongoDB, Express.js, React.js, Node.js)</b>. Students learn how different components of a web application interact, including user interface design, server-side scripting, API development, and database operations. The course emphasizes practical implementation, data flow analysis, and performance considerations, culminating in the development of a simple full-stack web application.</p> <p><b>Module 1</b> Introduces fundamentals of web development including HTTP, clients, servers, HTML, and CSS. Helps students understand webpage structure and styling.</p> <p><b>Module 2</b> Covers JavaScript, DOM, and event handling for adding interactivity. Enables dynamic content manipulation and basic form validation.</p> <p><b>Module 3</b> Introduces MERN stack components and basics of Node.js and Express. Helps in understanding backend development and simple API creation.</p> <p><b>Module 4</b> Focuses on React.js including components, props, state, and hooks. Enables development of reusable and interactive user interfaces.</p> <p><b>Module 5</b> Covers MongoDB operations and Express.js backend development. Helps in building APIs and connecting applications with databases.</p>	

**Module 6** Integrates React, Node, Express, and MongoDB into a full-stack application. Provides hands-on experience in building and connecting complete web systems.

**Overall, the course equips students with fundamental and practical skills in full-stack web development, enabling them to design, develop, and deploy basic web applications. It builds a strong foundation for advanced topics such as cloud computing, microservices, and scalable web architectures, and prepares students for internships and careers in software and web development.**

**Course Outcomes:** On successful completion, of course, learner/student will be able to:

CO1	Identify basic concepts of web technologies, front-end tools, server-side components, databases, and the MERN stack.
CO2	Explain how web pages, scripts, servers, APIs, and databases work together in a complete web application.
CO3	Use HTML, CSS, JavaScript, React, Node.js, Express, and MongoDB to build functional parts of a web application.
CO4	Analyze data flow between frontend, backend, and database, and break down how different MERN components interact.
CO5	Evaluate web application performance, select suitable web technologies, and validate user input, API responses, and database operations.
CO6	Design and develop a simple full-stack MERN application integrating user interface, server logic, and database operations.

Module No.	Unit No.	Topics	Hrs.
1	<b>Introduction to Web Development</b>		<b>06</b>
	<b>After completing this module, students will be able to:</b> <ol style="list-style-type: none"> <li>1. Describe basic web concepts including clients, servers, and communication protocols</li> <li>2. Explain HTTP request-response cycle and working of web applications</li> <li>3. Understand HTML structure and semantic elements for webpage design</li> <li>4. Apply CSS for styling web pages using different selectors and properties</li> <li>5. Analyze how web pages are structured and rendered in browsers</li> </ol>		
	1.1	Web Essentials: Clients, Servers and Communication, The Internet, Basic Internet protocols, World wide web, HTTP Request Message, HTTP Response Message, Web Clients, Web Servers	

	1.2	HTML: fundamental syntax and semantics, Tables, Lists, Image, HTML5 control elements, Semantic elements, Drag and Drop.	
	1.3	CSS3: Inline, embedded and external style sheets – Rule cascading, Syntax, Inclusion, Color, Background, Fonts, Tables, lists, CSS3 selectors.	
<b>Self Study Topics:</b> HTML5 Audio Video controls			
2	<b>Front End Development</b>		04
		<p><b>After completing this module, students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Describe basic concepts of JavaScript including variables, operators, and functions</li> <li>2. Apply conditional statements and functions to solve simple problems</li> <li>3. Explain the Document Object Model (DOM) and its role in web development</li> <li>4. Implement form validation using regular expressions</li> <li>5. Analyze and handle events to create interactive web pages</li> </ol>	
	2.1	<b>Java Script:</b> Introduction to JavaScript: Variables, Operators, Conditional Statements, Functions.	
	2.2	Document Object Model- Introduction to the DOM, Defining the DOM,, Dom Tree, Simple form validation-Regular Expressions—patterns, flags, matching, validation applications.	
	2.3	Event Handling- Events, Fetch & Callbacks: Event Flow, Event Handlers/Listeners, The Event Object, Types of Events.	
<b>Self Learning Topics:</b> Date Object - Getting and setting date & time values			
3	<b>Introduction to MERN Stack</b>		05
		<p><b>After completing this module, students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Describe the components of the MERN stack and their roles</li> <li>2. Install and set up Node.js and MongoDB environments</li> <li>3. Explain the concept of npm and package management</li> <li>4. Develop basic server-side programs using Node.js</li> <li>5. Create simple APIs using Express and understand JSON data</li> </ol>	

		format	
	3.1	What is MERN-MongoDB, Express, React, Node, Installing Node.js & MongoDB	
	3.2	Understanding npm and packages, Basics of Node.js: running a simple JS program, Creating a very simple API using Express (GET request)	
<b>Self Learning Topic:</b> Understanding JSON Data Format			
4	<b>Web Programming using React JS</b>		05
		<b>After completing this module, students will be able to:</b> <ol style="list-style-type: none"> <li>1. Describe the fundamentals of React and its component-based architecture</li> <li>2. Develop UI components using React elements and components</li> <li>3. Explain and use state and props for dynamic data handling</li> <li>4. Implement event handling and hooks in React applications</li> <li>5. Display and manage lists of data in user interfaces</li> </ol>	
	4.1	<b>React Framework:</b> Introduction to React JS, Components and Elements of React.	
	4.2	React State and Props, Handling events in React Events, Hooks Displaying list of items in UI.	
<b>Self Learning Topic:</b> Passing props between components			
5	<b>MongoDB-Database Operations and Express.js</b>		05
		<b>After completing this module, students will be able to:</b> <ol style="list-style-type: none"> <li>1. Describe NoSQL databases and their advantages over traditional databases</li> <li>2. Perform CRUD operations using MongoDB</li> <li>3. Connect MongoDB with Node.js applications</li> <li>4. Develop backend services using Express framework and routing</li> <li>5. Explain middleware and handle HTTP request–response objects</li> </ol>	
	5.1	Introduction to NoSQL databases, CRUD operations in MongoDB Connecting MongoDB with Node.js.	

	5.2	Introduction to Express framework, Creating routes (GET, POST, PUT, DELETE), Middleware concept, Working with request & response objects	
<b>Self Learning Topics:</b> Difference Between SQL and NoSQL Databases			
6	<b>MERN Integration</b>		05
	<b>After completing this module, students will be able to:</b> <ol style="list-style-type: none"> <li>1. Explain the integration of frontend, backend, and database in MERN stack</li> <li>2. Connect React applications with Express backend APIs</li> <li>3. Perform basic CRUD operations using MongoDB</li> <li>4. Fetch and display API data in React applications</li> <li>5. Develop a simple full-stack MERN application</li> </ol>		
	6.1	Connecting React frontend with Express backend, CRUD app using MERN, Simple MongoDB data read/write, Basic Create & Read operations, Fetching and displaying API data in React	
	<b>Self Learning Topic:</b> Testing APIs in Postman		
			<b>Total 30</b>

### Suggested Experiments List:

Exp. No.	List of Experiments
1	Design a static web page using headings, paragraphs, lists, tables, images, and semantic elements. <b>Objective:</b> To identify and apply basic concepts of web technologies and use HTML elements to design a structured static web page. <b>Outcome:</b> Students will be able to create structured web pages using HTML and demonstrate understanding of fundamental web concepts and front-end components.
2	Create a web form using HTML5 input types and form elements. <b>Objective:</b> To understand how web pages collect user input and use HTML5 form elements to design interactive forms. <b>Outcome:</b> Students will be able to design forms that capture user data effectively and explain how form data is used in web applications.

3	<p>Apply inline, internal, and external CSS for colors, fonts, layout, and basic responsiveness.</p> <p><b>Objective:</b> To identify front-end styling techniques and apply CSS to improve layout, design, and responsiveness of web pages .</p> <p><b>Outcome:</b> Students will be able to style web pages using different CSS methods and evaluate suitable styling approaches for better UI design.</p>
4	<p>Implement JavaScript programs using variables, operators, conditions, and functions.</p> <p><b>Objective:</b> To understand scripting in web applications and implement JavaScript programs using basic programming constructs.</p> <p><b>Outcome:</b> Students will be able to develop scripts that add dynamic behavior to web pages and explain how scripts interact with web content.</p>
5	<p>Implement mouse and keyboard events such as click, hover, and keypress on a web page.</p> <p><b>Objective</b> To analyze user interaction with web pages and implement event handling using JavaScript.</p> <p><b>Outcome:</b> Students will be able to create interactive web applications by handling events and analyzing how user actions affect application behavior.</p>
6	<p>Validate user inputs using DOM manipulation and regular expressions.</p> <p><b>Objective:</b> To evaluate input validation techniques and implement validation using DOM manipulation and regular expressions.</p> <p><b>Outcome:</b> Students will be able to validate user inputs effectively and ensure data correctness in web applications.</p>
7	<p>Develop a basic server and implement GET and POST APIs using <a href="#">Express.js</a>.</p> <p><b>Objective:</b> To understand server-side components and APIs and develop a basic server using Express.js.</p> <p><b>Outcome:</b> Students will be able to build server-side applications and explain how APIs handle client-server communication.</p>
8	<p>Perform Create and Read operations in MongoDB and connect the database with <a href="#">Node.js</a>.</p> <p><b>Objective:</b> To identify database concepts and perform Create and Read operations while connecting MongoDB with Node.js.</p> <p><b>Outcome:</b> Students will be able to interact with databases, manage data, and analyze data flow between server and database.</p>
9	<p>Create a React application using components, props, state, and hooks to render data.</p> <p><b>Objective:</b> To understand front-end frameworks and develop dynamic user interfaces using React components, props, state, and hooks .</p>

	<b>Outcome:</b> Students will be able to build modular UI components and analyze how data flows within a React application.
10	Develop a simple full-stack MERN application integrating React frontend, Express backend, and MongoDB database. <b>Objective:</b> To design and integrate frontend, backend, and database components of a MERN stack application and analyze interaction between them. <b>Outcome:</b> Students will be able to develop a complete full-stack web application and evaluate the performance and integration of different MERN components.

### Assessment Methodology:

<b>CA-20</b>	Certification: NPTEL (20 Marks) (Approved by instructor) OR Any two Pedagogies (10 marks each) * MCQ /Class Test * Case study/Assignment * GATE based Assignment * Certification: Udemy/Coursera (Approved by instructor) * Open Book Test * Working model / simulation of a course-based concept.
<b>MSE</b>	Question Paper Pattern is as follows: All Questions are compulsory. * Q1 A or B - 10 marks * Q2 A or B - 10 marks * Q3 A or B - 10 marks * For each question, A and B should be based on the same CO. * MSE should be based on 50% syllabus. * Time: 90 minutes (1 hour 30 minutes) * Total Marks: 30
<b>ESE</b>	Question Paper Pattern is as follows: All Questions are compulsory. * Q1 A or B - 10 marks * Q2 A or B - 10 marks * Q3 A or B - 10 marks * Q4 A or B - 10 marks * Q5 A or B - 10 marks * For each question, A and B should be based on the same CO. * ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. * Time: 120 minutes (2 hours) * Total Marks: 50
<b>TW-25</b>	Active Participation = 5 marks Tutorial Submission = 20 marks

## Textbooks

1. **J. Duckett**, *HTML and CSS: Design and Build Websites*, 1st Edition, John Wiley & Sons, 2011.
2. **J. Duckett**, *JavaScript and JQuery: Interactive Front-End Web Development*, 1st Edition, John Wiley & Sons, 2014.
3. **M. Haverbeke**, *Eloquent JavaScript: A Modern Introduction to Programming*, 3rd Edition, No Starch Press, 2018.
4. **A. Banks and E. Porcello**, *Learning React: Modern Patterns for Developing React Apps*, 2nd Edition, O'Reilly Media, 2020.

## References

1. **E. Brown**, *Learning JavaScript*, 3rd Edition, O'Reilly Media, 2016.
2. **M. Casciaro and L. Mammino**, *Node.js Design Patterns*, 3rd Edition, Packt Publishing, 2020.
3. **K. Chodorow**, *MongoDB: The Definitive Guide*, 3rd Edition, O'Reilly Media, 2019.

## Useful Links

1. **Web Development Tutorials (HTML, CSS, JavaScript, React, Node, MongoDB):**  
<https://www.w3schools.com/>
2. **MongoDB Tutorial (Beginner to Advanced):**  
<https://www.w3schools.com/mongodb/>
3. **Express.js & Node.js Web Development Guide:**  
[https://developer.mozilla.org/en-US/docs/Learn\\_web\\_development/Extensions/Server-side/Express\\_Nodejs/Introduction](https://developer.mozilla.org/en-US/docs/Learn_web_development/Extensions/Server-side/Express_Nodejs/Introduction)
4. **JavaScript Programming with React, Node & MongoDB (Coursera Specialization):**  
<https://www.coursera.org/specializations/javascript-programming-with-react-node-mongodb>

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25ET4MDM01	Embedded System	2	2	-	2	1	-	3	
		<b>Examination Scheme</b>							
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	-	-	25
		<b>Total</b>	<b>125</b>						

<b>Pre-Requisite Courses:</b>	25FE1VSEC01: C Programming
	25FE1ESC02: Basic Electrical and Digital Electronics

**Course and Module Overview:**

This course provides a strong foundation in sensors, microcontrollers, and embedded systems with an application-oriented approach aligned to Industrial IoT. It enables students to understand physical parameters, sensing techniques, and the role of sensors in embedded applications. The course covers microprocessor and microcontroller fundamentals, 8051 architecture and programming, sensor and actuator interfacing, and Embedded C programming. Students also learn signal conditioning, peripheral interfacing, and communication protocols, helping them design and implement complete embedded solutions for real-world and industrial IoT applications.

**Module 1** introduces the basic concepts, architecture, and applications of microprocessors and microcontrollers in embedded systems. It builds foundational understanding of embedded platforms and their role in processing real-world signals.

**Module 2** module provides detailed knowledge of the 8051 microcontrollers, including its architecture, instruction set, and on-chip peripherals. It enables students to understand microcontroller programming and its application in embedded system design.

**Module 3** covers the principles, characteristics, and selection of sensors and actuators used in embedded and Industrial IoT applications. It helps students understand sensing techniques and choose appropriate components for real-world systems.

**Module 4** focuses on interfacing sensors and actuators with microcontrollers for monitoring, control, and automation. It develops skills in integrating hardware components to build simple embedded applications.

**Module 5** introduces embedded system concepts and Embedded C programming. It enables students to develop structured programs and implement logic for real-time embedded applications.

**Module 6** covers signal conditioning, ADC/DAC interfacing, and communication protocols

required for embedded systems. It enables students to design and integrate complete hardware-software solutions for data acquisition and control.

**Overall, this course develops strong fundamentals in microcontrollers, sensors, and embedded system design. It enables students to integrate hardware and software for building real-world automation and IoT-based applications. The course prepares learners to design efficient, reliable, and intelligent embedded systems used in modern engineering solutions.**

<b>Course Outcomes</b>	<b>After successful completion of the course, the students will be able to</b>	
	CO1	Describe the functional block diagram of microprocessors and microcontrollers along with different types of memories. (Remembering)
	CO2	Explain the differences between general-purpose computing systems and embedded systems, including types of sensors and transducers. (Understanding)
	CO3	Select suitable sensors based on design requirement and sensor specifications and then program the microcontroller's I/O and timers using its instruction set. (Applying)
	CO4	Analyze working principles and parameters of various sensors and actuators to choose suitable components. (Analyzing)
	CO5	Evaluate and justify appropriate signal conditioning techniques for sensor-based applications. (Evaluating)
	CO6	Design and develop a complete embedded application integrating sensors and actuators for a real-world problem. (Creating)

**Syllabus:**

Module No.	Unit No.	Topics	Hrs
		<b>Fundamentals of Microprocessor and Microcontroller</b>	
		After completing this module, students will be able to: 1. Describe the architecture and key features of microprocessor and embedded systems, ALU, registers, address bus, and data bus operations.	

<b>1</b>	2. Understand the architecture, pin configuration, and working of Arduino boards.	<b>04</b>
	3. Compare Arduino and Raspberry Pi based on functionality and applications	
	1.1 Microprocessor and Microcontroller - Features, functional block diagram, address bus and data bus, ALU and Registers	
	1.2 Arduino: Architecture, pin functions, and applications	
1.3 Raspberry Pi: Architecture, pin functions, and applications		
<b>Self-Learning Topics:</b> : Types of Memories RAM, ROM and memory mapping		
<b>2</b>	<b>8051 Microcontroller</b>	<b>07</b>
	After completing this module, students will be able to:	
	1. Explain the organization and functions of internal RAM, ROM, and Special Function Registers (SFRs)	
	2. Understand different addressing modes and their usage in programming	
	3. Explain the working of I/O ports, timers, and counters	
	2.1 Block diagram, features, Pin diagram, SFRs	
2.2 Internal RAM and ROM		
2.3 Addressing modes types, Instruction Set and Programming		
2.4 Ports, Timers, Counters, Interrupts		
<b>Self-Learning Topics:</b> Optical sensor and Sound sensor		
<b>3</b>	<b>Types of Sensors and actuator</b>	<b>06</b>
	After completing this module, students will be able to:	
	1. Differentiate between sensors and transducers and explain their working principles	
	2. Classify various types of sensors, working based on their applications.	
3. Explain key sensor parameters such as range, sensitivity, accuracy, linearity, resolution, and calibration		
4. Describe the operation of other sensors like IR, motion, pressure, level, and humidity sensors.		
3.1 Sensors vs transducers: working principles, Types of Sensors,		
3.2 Parameters/Specifications: range, sensitivity, accuracy, linearity,		

		resolution, calibration	
	3.3	Temperature sensors: RTD, thermocouple, thermistor Proximity sensors: inductive (LVDT), capacitive, photoelectric, ultrasonic Chemical sensors: gas, smoke, conductivity, pH Other sensors: IR, motion, pressure, level, humidity Actuators: motors, relays, drivers for interfacing Display devices: LCD, LED, OLED	
	<b>Self-Learning Topics:</b> Optical, sound, laser, combustible gas sensors		
4	<b>Interfacing of Sensors and Actuators</b>		04
	After completing this module, students will be able to: <ul style="list-style-type: none"> <li>1. Understand the criteria for selecting appropriate sensors for specific applications</li> <li>2. Explain interfacing techniques of sensors with microcontrollers and microprocessors.</li> <li>3. Interface actuators such as motors and relays with embedded systems.</li> <li>4. Analyze real-world applications in embedded systems and industrial automation.</li> </ul>		
	4.1	Sensor selection and interfacing with microcontrollers/ microprocessors, and control in embedded systems.	
	4.2	Interfacing motors, relays, and display devices, Applications in embedded systems and industrial automation	
	<b>Self-Learning Topics:</b> Simple embedded system projects		
5	<b>Introduction to Embedded Systems and Embedded C</b>		05
	After completing this module, students will be able to: <ul style="list-style-type: none"> <li>1. Differentiate between Embedded C and standard C programming</li> <li>2. Apply knowledge of data types, variables, and storage classes in Embedded C</li> <li>3. Perform bitwise operations and understand their significance in embedded programming</li> <li>4. Use arrays, strings, and structures effectively in Embedded C programs</li> </ul>		
	5.1	Definition, block diagram, characteristics and applications, and quality attributes of Embedded Systems	
	5.2	Embedded C Vs C, Data types, Variables, Storage Classes	

	5.3	Bit operations, Arrays, Strings and Structures	
	<b>Self-Learning Topics:</b> Serial communication basics, clock frequency, timers/counters.		
6	<b>Peripheral Interfacing</b>		04
	After completing this module, students will be able to		
	<ol style="list-style-type: none"> <li>1. Explain interfacing and usage of analog and digital peripherals in embedded systems.</li> <li>2. Describe communication protocols such as UART, I2C, and SPI</li> <li>3. Differentiate between various serial communication interfaces based on speed and applications.</li> <li>4. Design and develop a complete embedded application integrating sensors</li> </ol>		
	6.1	Basic Peripherals: GPIO, Analog-to-Digital Converters (ADC), Digital-to-Analog Converters (DAC)	
	6.2	Advanced Peripherals: Pulse-width modulation (PWM), Universal Asynchronous Receiver/Transmitter (UART), Inter-Integrated Circuit (I2C) and Serial Peripheral Interface (SPI)	
	<b>Self-Learning Topics:</b> Comparative study of sensors like temperature, pressure, proximity sensors for real-world data acquisition.		
<b>Total</b>			<b>30</b>

### Suggested List of Experiments (Minimum 8)

Exptt No.	List of experiments
1	<p><b>Program to perform 8-Bit Arithmetic operations using 8051.</b></p> <p><b>Objective:</b>Students will be able to understand various arithmetic instructions of 8051 microcontrollers.</p> <p><b>Outcome:</b>Students will be able to Perform arithmetic operations to observe status of parity, carry and overflow flags</p>
2	<p><b>Program to study various addressing Modes of 8051.</b></p> <p><b>Objective:</b>Students will be able to understand various addressing modes of 8051 microcontrollers.</p> <p><b>Outcome:</b>Students will be able to access data stored in various ways and use in the programming and differentiate among the various addressing modes</p>
3	<p><b>Program to perform block transfer of 10 data bytes in internal memory.</b></p> <p><b>Objective:</b>Students will be able to understand various data transfer instructions of 8051. Microcontroller.</p>

	<p><b>Outcome:</b>Students will be able to perform block transfer within internal memory of 8051 using indirect addressing mode of 8051 microcontroller.</p>
4	<p><b>Program to perform an exchange of a block of 10 bytes from internal memory.</b></p> <p><b>Objective:</b>Students will be able to understand various data transfer instructions of 8051. microcontroller.</p> <p><b>Outcome:</b>Students will be able to perform block exchange within internal memory of 8051 using indirect addressing mode of 8051 microcontroller.</p>
5	<p><b>Program to perform inverted block transfer and subsequently verify if it's a Palindrome or not.</b></p> <p><b>Objective:</b>Students will be able to understand various data transfer instructions of 8051. microcontroller.</p> <p><b>Outcome:</b>Students will be able to perform inverted block transfer and subsequently verify if it's a Palindrome or not using compare or subtraction.</p>
6	<p><b>Program to arrange set of 10 number stored in internal memory in ascending order and finding the highest value number</b></p> <p><b>Objective:</b>Students will be able to understand sorting algorithms (such as Bubble Sort or Selection Sort) to arrange a dataset in ascending order</p> <p><b>Outcome:</b>Students will be able to apply comparison logic to identify the maximum value within a set of numbers and utilize nested loops to iterate through and process multiple data elements stored in memory</p>
7	<p><b>Program to Interface LEDs at Port 1 of 8051 Microcontroller.</b></p> <p><b>Objective:</b>Students will be able to understand Assembly instructions to toggle individual LEDs.</p> <p><b>Outcome:</b>Students will be able to generate delay by means of the Rx registers and blink the LEDs connected to Port 1</p>
8	<p><b>Program for performing Serial Communication using UART.</b></p> <p><b>Objective:</b>Students will be able to understand the concept of serial data transmission of the string " via UART.</p> <p><b>Outcome:</b>Students will be able to configure serial registers and timer-based baud rates to perform serial data transmission.</p>
9	<p><b>To study and obtain the performance characteristics of a Thermistor.</b></p> <p><b>Objective:</b>Students will be able to understand the temperature-dependent resistance properties of NTC/PTC thermistors and their calibration.</p> <p><b>Outcome:</b>Students will be able to plot the resistance-temperature curve and determine the sensitivity of the thermistor</p>
10	<p><b>To measure an unknown resistance using a Wheatstone (Meter) Bridge.</b></p>

	<p><b>Objective:</b>Students will be able to apply the null-deflection principle to accurately measure electrical resistance.</p> <p><b>Outcome:</b>Students will be able to balance the bridge circuit and calculate unknown resistance values with high precision.</p>
11	<p><b>To study and test the operation of a 4-bit Flash type Analog-to-Digital Converter (ADC).</b></p> <p><b>Objective:</b> Students will be able to understand high-speed data conversion using parallel comparators and priority encoders.</p> <p><b>Outcome:</b> Students will be able to demonstrate how analog voltages are converted into discrete 4-bit digital signals.</p>
12	<p><b>To design and test a Digital-to-Analog Converter (DAC) using an R–2R ladder network.</b></p> <p><b>Objective:</b>Students will be able to understand the weighted resistor principle and binary ladder networks for signal conversion.</p> <p><b>Outcome:</b> Students will be able to construct an R-2R network and verify the output voltage levels against theoretical digital inputs.</p>
13	<p><b>To interface sensors using the DBIT-EXTC Embedded Systems Trainer Kit.</b></p> <p><b>Objective:</b>Students will be able to familiarise themselves with the hardware architecture and peripheral headers of the specific trainer kit.</p> <p><b>Outcome:</b>Students will be able to establish successful hardware-software communication between the kit and external sensor modules.</p>
14	<p><b>To interface a Temperature or Proximity Sensor with a Microcontroller and display data on LCD/OLED.</b></p> <p><b>Objective:</b>Students will be able to implement sensor data acquisition and real-time visual feedback using display protocols (I2C/Parallel).</p> <p><b>Outcome:</b>Students will be able to write firmware to process sensor signals and format them for user-readable display outputs.</p>
15	<p><b>To develop a simple Embedded System–based application for Industrial or IoT use.</b></p> <p><b>Objective:</b>Students will be able to integrate multiple hardware components to solve a practical, real-world monitoring or control problem.</p> <p><b>Outcome:</b>Students will be able to design a functional prototype that demonstrates data collection and automated decision-making.</p>

**Assessment Methodology:**

<b>Type of Assessment</b>	<b>Assessment Tools</b>
<p><b>Continuous Assessment (CA)</b>  <b>(20 Marks)</b></p>	<p>Certification: NPTEL (20 Marks) (Approved by instructor) <b>OR</b> Any 02 Pedagogies (10 marks each)</p> <ul style="list-style-type: none"> <li>● MCQ /Class Test</li> <li>● Case study/Assignment</li> <li>● GATE based Assignment</li> <li>● Certification Udemy/Coursera (Approved by instructor)</li> <li>● Open Book Test</li> <li>● Working model / Simulation of a course-based concept.</li> </ul>
<p><b>Mid Semester Examination (MSE)</b>  <b>(30 Marks)</b></p>	<p>Question Paper Pattern is as follows:</p> <p>All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● MSE should be based on 50% syllabus.</li> <li>● Time: 90 minutes (1 hour 30 minutes)</li> <li>● Total Marks: 30</li> </ul>
<p><b>End Semester Examination (ESE)</b>  <b>(50 Marks)</b></p>	<p>Question Paper Pattern is as follows:</p> <p>All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● Q4 A or B - 10 marks</li> <li>● Q5 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE.</li> <li>● Time: 120 minutes (02 hours)</li> <li>● Total Marks: 50</li> </ul>

<b>Term Work</b>  <b>(25 Marks)</b>	<ul style="list-style-type: none"> <li>● Active Participation (Lab) = 05 marks</li> <li>● Laboratory Report = 10 marks</li> <li>● Laboratory performance = 10 marks</li> </ul> <p>Based on the performance and satisfactory completion of assigned laboratory work.</p>
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#### **Text Books:**

1. D.V.S. Murthy, “Transducers and Instrumentation,” PHI Learning, 2nd Edition, 2013.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C, Muhammad Ali Mazidi, Pearson Education, 2nd Edition (or newer)
3. Sensors and Signal Conditioning, Ramon Pallas Areny, John G. Webster, 2nd edition, John Wiley and Sons, 2000.
4. Vijay K. Garg, “Wireless Communication and Networking”, Morgan -Kaufmann Series in Networking, Elsevier, 2010.

#### **Reference Books:**

1. Microcontrollers: Architecture, Implementation and Programming Technology, Kenneth Hintz and Daniel Tabak, McGraw Hill Education.
2. 8051 Microcontroller Architecture, Programming and Application, Kenneth J. Ayala and Dhananjay Gadre, Cengage Learning India.
3. A.K. Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation”, Dhanpatri & Co., 19th Edition, 2011.
4. Nathan Ida, “Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction”, Second Edition, IET Control, Robotics and Sensors Series 127, 2020.
5. Jacob Fraden Handbook of Modern Sensors Physics, Designs, and Applications Fourth Edition, Springer, 2010.

#### **Useful Links:**

1. <https://www.ni.com/en-in/innovations/white-papers/06/sensor-fundamentals.html>
2. <https://www.youtube.com/watch?v=WwQSfk6SSSo>
3. <https://www.youtube.com/watch?v=MGC2LWeNKSI>
4. <https://www.youtube.com/watch?v=vjhp0zTXEsc>

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25ILIT4MDM01	Data Structure and Algorithm	2	1	-	2	1	-	3	
		Examination Scheme							
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	-	-	25

<b>Pre-Requisite Courses:</b>	25FE1VESC02 - Problem Solving using C programming
<p><b>Course and Module Overview:</b>  The course Data Structure and Algorithm is designed to provide students with a strong foundation in organizing, managing, and processing data structure efficiently using appropriate data structures and algorithms. The course introduces fundamental concepts such as Abstract Data Types (ADTs), algorithm design principles, and complexity analysis, enabling students to evaluate algorithmic efficiency using asymptotic notations. Emphasis is placed on both linear and non-linear data structures, along with their practical implementations using arrays and linked representations. Students gain hands-on experience in applying stacks, queues, trees, graphs, searching, sorting, and hashing techniques to solve real-world computational problems.</p> <p><b>Module 1: Introduction to Data Structures and Algorithms</b>  This module introduces the basic concepts and classifications of data structures, highlighting the need for structured data organization in programming. Students explore primitive and non-primitive data structures, linear and non-linear structures, and Abstract Data Types (ADTs). The module also covers algorithm fundamentals, including properties, design techniques, and performance evaluation. A strong focus is placed on asymptotic notations (Big O, Omega, Theta) to analyze time and space complexity, enabling students to compare algorithm efficiency.</p> <p><b>Module 2: Linear Data Structure – LISTS</b>  This module focuses on Lists as an Abstract Data Type, covering both array-based and linked list implementations. Students learn about different types of linked lists, including singly, doubly, and circular linked lists. All fundamental operations such as insertion, deletion,</p>	

traversal, merging, updating, and copying are studied along with their performance analysis. Practical applications like Polynomial arithmetic helps students understand real-life use cases of linked lists.

**Module 3: Linear Data Structure – STACKS & QUEUES**

This module introduces Stacks and Queues as ADTs, emphasizing their operations and implementations using arrays and linked lists. Students explore stack applications such as reversing data and expression conversion. Queue concepts include linear queues, circular queues, priority queues, and their implementations. The module also highlights expression evaluation techniques and double-ended queues, strengthening students’ understanding of sequential data processing

**Module 4: Non-Linear Data Structure – TREES**

This module introduces Stacks and Queues as ADTs, emphasizing their operations and implementations using arrays and linked lists. Students explore stack applications such as reversing data and expression conversion. Queue concepts include linear queues, circular queues, priority queues, and their implementations. The module also highlights expression evaluation techniques and double-ended queues, strengthening students’ understanding of sequential data processing

**Module 5: Non-Linear Data Structure – GRAPHS**

This module introduces graphs as a data structure for modeling networks and relationships. Students learn graph terminologies and representation methods using adjacency matrices and adjacency lists. Graph traversal techniques such as Breadth First Search and Depth First Search are studied along with applications like topological sorting. Real-world applications of graphs in networking are emphasized.

**Module 6: Searching, Sorting & Hashing**

This module focuses on efficient data retrieval and organization techniques. Students study linear and binary search algorithms, followed by basic sorting techniques such as selection sort, insertion sort, and bubble sort. The module also introduces hashing concepts, including hash functions, collision handling, and resolution techniques like chaining and open addressing. Advanced sorting techniques such as merge sort are included as self-learning topics.

<b>After successful completion of the course, the students will be able to</b>	
CO1	Identify fundamental concepts of data structures, algorithms, Abstract Data Types (ADTs), and asymptotic notations.
CO2	Explain the functioning, implementation, and applications of linear and non-linear data structures, including arrays, linked lists, stacks, queues, trees, and graphs.

<b>Course Outcomes</b>	CO3	Select appropriate data structures and ADT operations (insertion, deletion, traversal, etc.) to solve computational and real-world problems efficiently.
	CO4	Analyze the time and space complexity of array-based and linked-list-based implementations, and evaluate algorithm performance using asymptotic techniques.
	CO5	Evaluate the searching, sorting, hashing, and expression processing techniques (infix, postfix, evaluation) using suitable data structures.
	CO6	Design and develop solutions for real-life problems using data structures .

**Syllabus:**

<b>Module No.</b>	<b>Unit No.</b>	<b>Topics</b>	<b>Hrs.</b>
<b>1</b>	<b>Introduction to Data Structures and Algorithms</b>		<b>05</b>
	After completing this module, students will be able to: <ol style="list-style-type: none"> <li>1. Explain the need for data structures and classify them into primitive and non-primitive types.</li> <li>2. Distinguish between linear and non-linear data structures and their use cases.</li> <li>3. Define Abstract Data Types (ADTs) and relate them to practical implementations.</li> <li>4. Describe fundamental algorithm properties and common design techniques.</li> <li>5. Analyze time and space complexity using asymptotic notations (Big-O, <math>\Omega</math>, <math>\Theta</math>).</li> <li>6. Compare algorithms based on efficiency and performance metrics.</li> </ol>		
	1.1	Data Structures concepts: Definition, classification, and need for data structures. Types of data structures: primitive, non-primitive, linear, and non-linear, Abstract Data Types (ADT)	
	1.2	Concept of algorithms: properties, design techniques, and performance analysis. Asymptotic notation: Big O, Omega, Theta with examples	
	<b>Self-Learning Topics:</b> Self-Learning: Comparative growth analysis of functions		

<b>2</b>	<b>Linear Data Structure – LISTS</b>		<b>04</b>
	After completing this module, students will be able to:		
	<ol style="list-style-type: none"> <li>1. Describe Lists as an Abstract Data Type and explain their characteristics.</li> <li>2. Implement array-based and linked list representations.</li> <li>3. Differentiate between singly, doubly, and circular linked lists.</li> <li>4. Perform fundamental operations such as insertion, deletion, traversal, merging, updating, and copying.</li> </ol>		
	<ol style="list-style-type: none"> <li>5. Analyze the performance of list operations in different implementations.</li> <li>6. Apply linked lists to solve problems such as polynomial arithmetic.</li> </ol>		
	2.1	List as an ADT, Array-based implementation, Linked List implementation.	
2.2	Types of Linked List- Singly linked lists, doubly linked lists and circular linked lists.		
2.3	All operations (Insertion, Deletion, Merge, Traversal, update, copying etc.) with singly linked lists, doubly linked lists and their analysis.		
<b>Self-Learning Topics:</b> Reversing a singly linked list, Applications of linked lists Polynomial arithmetic			
<b>3</b>	<b>Linear Data Structure – STACKS &amp; QUEUES</b>		<b>06</b>
	After completing this module, students will be able to:		
	<ol style="list-style-type: none"> <li>1. Explain Stacks and Queues as Abstract Data Types.</li> <li>2. Implement stacks and queues using arrays and linked lists.</li> <li>3. Apply stack operations to problems such as data reversal and expression conversion.</li> <li>4. Describe different queue types including linear, circular, priority, and double-ended queues.</li> <li>5. Implement expression evaluation techniques using stacks.</li> <li>6. Analyze the efficiency of stack and queue operations in sequential data processing.</li> </ol>		
	3.1	Introduction to Stack, Stack as ADT, ADT Operations on Stack, Array and Linked List representation of Stack, Applications – Reversing data, Conversion of Infix to prefix and postfix expression.	
3.2	Introduction to Queue, Queue as an ADT, operations on Queue, Implementation of Linear Queue, Circular and Priority Queue using arrays and Linked List.		
<b>Self-Learning Topics:</b> Evaluation of postfix and prefix expressions, Double Ended Queue			

<b>Non-Linear Data Structure – TREES</b>		<b>05</b>
After completing this module, students will be able to: <ul style="list-style-type: none"> <li>1. Define trees and explain basic tree terminologies.</li> <li>2. Differentiate between various tree structures and representations.</li> <li>3. Perform tree traversal techniques such as preorder, inorder, and postorder.</li> <li>4. Implement binary trees and binary search trees.</li> <li>5. Analyze the time complexity of tree operations.</li> <li>6. Apply tree-based structures to solve hierarchical data problems.</li> </ul>		
<b>4</b>	4.1 Tree Terminologies, Tree as an ADT, Binary Tree - Operations, Tree Traversals, Binary Search Tree (BST) - Operations	
<b>Self-Learning Topics:</b> AVL Tree, Applications		
<b>Non-Linear Data Structure – GRAPHS</b>		<b>03</b>
After completing this module, students will be able to: <ul style="list-style-type: none"> <li>1. Explain graph concepts, terminologies, and applications.</li> <li>2. Represent graphs using adjacency matrices and adjacency lists.</li> <li>3. Implement graph traversal techniques such as Breadth First Search (BFS) and Depth First Search (DFS).</li> <li>4. Apply graph algorithms to problems such as topological sorting.</li> <li>5. Analyze the computational complexity of graph traversal algorithms.</li> <li>6. Relate graph concepts to real-world applications such as networking and routing.</li> </ul>		
<b>5</b>	5.1 Graph Terminologies, Graph representation: adjacency matrix and list	
	5.2 Graph traversal: BFS, DFS with applications, Applications of Graphs -Topological sorting.	
<b>Self-Learning Topics:</b> Graph applications in networking		
<b>Searching, Sorting &amp; Hashing</b>		<b>07</b>
After completing this module, students will be able to: <ul style="list-style-type: none"> <li>1. Implement linear and binary search algorithms.</li> <li>2. Compare searching techniques based on time complexity and applicability.</li> <li>3. Implement basic sorting algorithms such as selection, insertion, and bubble sort.</li> <li>4. Explain hashing concepts, hash functions, and collision resolution techniques.</li> <li>5. Apply hashing methods such as chaining and open addressing.</li> <li>6. Explore advanced sorting techniques like merge sort as a self-learning component.</li> </ul>		
<b>6</b>	6.1 Searching: Linear Search and Binary Search: Concepts and Implementation	

	6.2	Sorting: Selection Sort, Insertion Sort, Bubble Sort	
	6.3	Hashing: Hash Functions, Overflow handling, Collision & Collision Resolution Techniques, Linear hashing, Hashing with chaining, Separate Chaining, Open Addressing.	
<b>Self-Learning Topics:</b> Merge Sort.			
<b>TOTAL</b>			<b>30</b>

### Suggested List of Experiments:

Expt. No.	Title of the Experiment (Perform any 10 of the following)
1	<p>Implementation of Insertion and deletion in a specific position in an Array using Function.</p> <p><b>Objective:</b>To understand and implement insertion and deletion operations at specific positions in an array using functions.</p> <p><b>Outcome:</b>Students will be able to perform and analyze array operations and understand their time complexity.</p>
2	<p>Implementation of recursive programs using functions.</p> <p><b>Objective:</b>To understand recursion and implement basic recursive algorithms using functions.</p> <p><b>Outcome:</b>Students will be able to design recursive solutions and compare them with iterative approaches.</p>
3	<p>Array Implementation of Stack</p> <p><b>Objective:</b>To implement stack operations (push, pop, peek) using arrays.</p> <p><b>Outcome:</b>Students will be able to use stack ADT and understand the LIFO principle in problem solving.</p>
4	<p>Array Implementation of Linear and Circular Queue.</p> <p><b>Objective:</b>To implement creation and operations (insertion, deletion, traversal) on singly linked lists.</p> <p><b>Outcome:</b>Students will be able to differentiate between linear and circular queues and apply FIFO principle efficiently.</p>
5	Implementation of Singly Linked List

	<p><b>Objective:</b>To implement creation and operations (insertion, deletion, traversal) on singly linked lists.</p> <p><b>Outcome:</b>Students will be able to dynamically manage data using linked list structures.</p>
6	<p>Implementation of Doubly Linked List</p> <p><b>Objective:</b>To implement doubly linked lists and perform bidirectional traversal and operations.</p> <p><b>Outcome:</b>Students will be able to efficiently perform operations using forward and backward links.</p>
7	<p>Implementation of Stack using Linked List</p> <p><b>Objective:</b>To implement stack ADT using linked list representation.</p> <p><b>Outcome:</b>Students will be able to overcome array limitations and implement dynamic stack operations.</p>
8	<p>Implementation of Binary Search Tree and Traversals</p> <p><b>Objective:</b> To implement Binary Search Tree (BST) and perform traversal techniques (inorder, preorder, postorder).</p> <p><b>Outcome:</b> Students will be able to organize hierarchical data and apply traversal methods.</p>
9	<p>Reversing a List using Stack</p> <p><b>Objective:</b> To use stack for reversing elements of a list.</p> <p><b>Outcome:</b> Students will be able to apply stack concepts in solving practical problems.</p>
10	<p>Infix to Postfix Conversion using Stack</p> <p><b>Objective:</b> To convert infix expressions to postfix using stack ADT.</p> <p><b>Outcome:</b> Students will be able to understand operator precedence and expression handling.</p>
11	<p>Evaluation of Postfix Expression using Stack</p> <p><b>Objective:</b> To evaluate postfix expressions using stack operations.</p> <p><b>Outcome:</b> Students will be able to implement expression evaluation algorithms.</p>
12	<p>Implementation of Deque using Linked List</p> <p><b>Objective:</b> To implement a double-ended queue (deque) using linked lists.</p> <p><b>Outcome:</b>Students will be able to perform insertion and deletion at both ends efficiently.</p>

**Text Books:**

1. Reema Thareja, “Data Structures using C”, 3rd Edition, Oxford, 2023.
2. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, “Fundamentals of Data Structures in C”, 2nd Edition, W. H. Freeman and Company, 2008.
3. “Introduction to Algorithms” – Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein (CLRS), 4th Edition (2022).

**Reference Books:**

1. “Data Structures and Algorithms Made Easy” – Narasimha Karumanchi, Latest (2022) – CareerMonk Publications.
2. “Data Structures and Algorithm Analysis in C++” – Mark Allen Weiss, 4th Edition.
3. Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, “Data Structures Using C”, Pearson Publication, 2nd edition, 2015.

**Useful Links:**

1. Use visualization tools like Visualgo or Pythontutor.
2. <https://nptel.ac.in/courses/106/102/106102064/>
3. Data Structure using C Programming - Course (swayam2.ac.in)

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25ET4MDM02	Sensor Technology	2	2	-	2	1	-	3	
		Examination Scheme							
			CA	MSE	ESE	TW	OR	PR	Total
		<b>Theory</b>	20	30	50	-	-	-	<b>100</b>
		<b>Lab/Tut</b>	-	-	-	25	-	-	<b>25</b>
		<b>Total</b>	<b>125</b>						

<b>Pre-Requisite Courses:</b>	25FE1BSC02 Applied Physics
	25FE1ESC02 Basic Electrical and Digital Electronics
<b>Course and Module Overview:</b>	
<p>This course introduces the fundamentals of sensor technology used in modern engineering applications, focusing on sensing principles, transduction mechanisms, and performance characteristics. It covers measurement of physical, chemical, and environmental parameters along with signal conditioning and data acquisition techniques. Students are also exposed to modern technologies such as MEMS, nano-sensors, and wireless sensing systems. Through theory and laboratory practice, the course builds strong foundational knowledge and supports the design, implementation, and testing of sensor-based systems for industrial, IoT, and automation applications.</p> <p><b>Module 1</b> establishes the basic concepts of sensors and transducers, including performance parameters, characteristics, and selection criteria. It develops fundamental understanding and analytical ability required for evaluating sensor performance and selecting appropriate sensors for practical applications.</p> <p><b>Module 2</b> explains the operating principles, characteristics, and calibration of commonly used thermal and proximity sensors. It helps students understand sensor behavior and apply suitable sensors for measurement and control in real-world systems.</p> <p><b>Module 3</b> introduces chemical, environmental, motion, and pressure sensors along with their working principles. It enhances understanding of diverse sensing techniques and supports the selection and application of sensors in safety, environmental monitoring, and smart systems.</p> <p><b>Module 4</b> covers modern sensing technologies such as MEMS and nano-sensors along with their applications. It provides exposure to advanced, compact, and low-power sensor technologies used in healthcare, consumer electronics, and industrial systems.</p> <p><b>Module 5</b> focuses on wireless communication techniques used in sensor networks. It enables understanding of remote sensing, data transmission, and integration of sensors in IoT-based and intelligent systems.</p>	

**Module 6** introduces data acquisition systems, signal conditioning, and ADC/DAC concepts. It enables students to acquire, process, and interface sensor signals, and supports the design and implementation of complete sensor-based systems through practical applications.

**Overall, this course builds a strong foundation in sensor principles, modern sensing technologies, and data acquisition systems. It enables students to analyze, select, and integrate sensors into real-world applications. The course prepares learners to design and implement sensor-based solutions for industrial, IoT, and automation systems.**

<b>Course Outcomes</b>	<b>After successful completion of the course, the students will be able to</b>	
	CO1	Define and classify sensors and transducers based on physical quantity, transduction principle, and application. (Remembering)
	CO2	Explain the operating principles and characteristics of different sensors using theoretical concepts and laboratory observations. (Understanding)
	CO3	Implement and use appropriate sensors, interfacing techniques, and data acquisition methods in laboratory experiments and practical systems. (Applying)
	CO4	Analyze and compare sensor and wireless sensing system performance based on accuracy, sensitivity, power consumption, and communication range. (Analyzing)
	CO5	Evaluate and justify the selection of sensors and signal conditioning circuits for specific engineering applications using experimental results. (Evaluating)
	CO6	Design, integrate, and test a sensor-based system incorporating sensing, signal conditioning, data acquisition, and communication modules. (Creating)

**Syllabus:**

Module No.	Unit No.	Topics	Hrs
<b>1</b>		<b>Introduction to Sensors</b>	<b>05</b>
		<b>After completing this module, students will be able to:</b>	

	<ol style="list-style-type: none"> <li>1. Understand the concepts of sensors and transducers, their roles in engineering systems, and their classification based on physical quantities and materials.</li> <li>2. Explain key sensor performance parameters such as accuracy, precision, sensitivity, range, linearity, hysteresis, repeatability, and resolution.</li> <li>3. Analyze advanced parameters including stability, noise, dynamic characteristics, response time, recovery time, and drift.</li> <li>4. Perform basic numerical calculations related to sensitivity, range, and offset.</li> <li>5. Select appropriate sensors based on criteria like environmental conditions, reliability, calibration requirements, and cost.</li> </ol>	
1.1	Overview and Classification of Sensors: Sensor and Transducer, Role of sensors in engineering systems, Classification of sensors based on Physical quantity to be sensed, Classification based on materials, Multidisciplinary aspect of sensors, Evolution of Technologies	
1.2	Sensor Performance Parameters and Selection Criteria I: Accuracy, Precision, Calibration, Sensitivity, Threshold, Range, Linearity, Hysteresis, Selectivity, Repeatability, Reproducibility, Resolution.	
1.3	Sensor Performance Parameters and Selection Criteria II: Stability, Noise, Excitation, Dynamic Characteristics, -3db point, Safe Limit, Response time, Recovery Time, Drift. Numerical based on Sensitivity, Range and Offset. Criteria for sensor selection: environmental conditions, reliability, Calibration requirements, and Cost.	
<b>Self -Learning Topics:</b> Block diagram of sensor, Digital Sensors-Principle and its advantage over Analog Sensor.		
<b>2</b>	<b>Temperature and Proximity</b>	<b>05</b>
	<b>After completing this module, students will be able to:</b> <ol style="list-style-type: none"> <li>1. Understand the working principles of temperature sensors such as RTD, thermocouple, and thermistors.</li> <li>2. Interpret graphs like temperature vs time, voltage vs time, and resistance vs temperature.</li> <li>3. Explain the operation of proximity sensors such as LVDT and capacitive sensors.</li> <li>4. Describe the working of photoelectric and ultrasonic sensors for non-contact detection.</li> </ol>	

	5. Compare different types of sensors based on their characteristics and applications.	
	2.1 Temperature Sensors: Resistance Temperature Detector sensor, Graphs of Temp vs Time, Voltage vs Time, and Resistance vs Temperature.	
	2.2 Thermocouple and Thermistors sensors	
	2.3 Proximity Sensors: Linear Variable Differential Transducer (LVDT) and Capacitive type sensors	
	2.4 Proximity Sensors: Photoelectric and Ultrasonic sensors	
	<b>Self-Learning Topics:</b> Optical sensor and Sound sensor	
	<b>Chemical and Other types</b>	
	<b>After completing this module, students will be able to:</b>	
	<ol style="list-style-type: none"> <li>1. Understand the working principles of chemical sensors such as gas, smoke, conductivity, and pH sensors.</li> <li>2. Explain the operation and applications of sensors like infrared (IR), motion, and pressure sensors.</li> <li>3. Describe the working of level, moisture, and humidity sensors.</li> <li>4. Identify different types of sensors and their uses in various real-world applications.</li> <li>5. Compare different sensors based on their characteristics and functionality.</li> </ol>	<b>05</b>
<b>3</b>	3.1 Chemical Sensors: Gas sensor and Smoke sensor.	
	3.2 Conductivity sensor and pH sensor.	
	3.3 Other Sensors: Infrared (IR) sensor, Motion sensor, and Pressure sensor	
	3.4 Level sensor, Moisture sensor, and Humidity sensor.	
	<b>Self-Learning Topics:</b> Image sensor and GPS sensor	
	<b>MEMS and Nano Sensors</b>	
	<b>After completing this module, students will be able to:</b>	
<b>4</b>	<ol style="list-style-type: none"> <li>1. Understand the basics of MEMS technology, its working principles, advantages, and applications.</li> <li>2. Explain the use of MEMS-based sensors such as accelerometers, pressure sensors, and gyroscopes in engineering systems.</li> </ol>	<b>05</b>

	<p>3. Understand the concept and working principles of nano sensors and their unique properties.</p> <p>4. Describe applications of MEMS and nano sensors in healthcare, environmental monitoring, and industry.</p> <p>5. Explain why nano sensors are highly sensitive and fast in response</p>	
	4.1	MEMS Sensors: Introduction to MEMS technology, basic operating concepts, advantages, and applications of MEMS.
	4.2	Accelerometers, pressure sensors, and gyroscopes in engineering systems.
	4.3	Nano Sensors: Introduction to nano-sensor concepts, basic working ideas, and application areas.
	4.4	Applications in healthcare, environment monitoring, and industry, why nano sensors are sensitive and fast.
	<b>Self-Learning Topics:</b> Chemical sensors, Combustible Gas sensors	
5	<b>Wireless Sensing Technologies</b>	
	<b>After completing this module, students will be able to:</b>	
	<p>1. Understand the basics of MEMS technology, its working principles, advantages, and applications.</p> <p>2. Explain the use of MEMS-based sensors such as accelerometers, pressure sensors, and gyroscopes in engineering systems.</p> <p>3. Understand the concept and working principles of nano sensors and their unique properties.</p> <p>4. Describe applications of MEMS and nano sensors in healthcare, environmental monitoring, and industry.</p> <p>5. Explain why nano sensors are highly sensitive and fast in response.</p>	
	5.1	Introduction to wireless sensing concepts and the role of wireless communication in sensor-based systems.
	5.2	Overview of Bluetooth technology including basic concepts of piconet and scatternet, link types, and network establishment (device connection).
	5.3	Short-range wireless technologies for sensor applications including Ultra-Wide Band (UWB) with emphasis on basic architecture, operating principles, and typical applications.
	5.4	Radio Frequency Identification (RFID) with emphasis on basic architecture, operating principles, and typical applications.
	<b>Self-Learning Topics:</b> ZigBee - components, architecture, network topologies; Near Field Communication (NFC) – overview and applications.	
		<b>05</b>

<b>6</b>	<b>Data Acquisition and Signal Processing</b>		<b>05</b>
	<b>After completing this module, students will be able to:</b>		
	<ol style="list-style-type: none"> <li>1. Understand the concept of data acquisition, including analog and digital data, sampling, and system architecture.</li> <li>2. Explain the use of data loggers and the effect of noise and interference on sensor data quality.</li> <li>3. Understand signal conditioning techniques and the role of circuits like Wheatstone Bridge, Flash ADC, and R–2R DAC.</li> <li>4. Describe how sensor data is processed and converted for practical use in measurement systems.</li> <li>5. Identify applications of temperature, pressure, and displacement sensors in industrial, automotive, and environmental systems.</li> </ol>		
	<b>6.1</b>	Concept of data acquisition in sensor-based systems. Overview of analog and digital data, sampling concept, and block-level architecture of a data acquisition system used in practical applications.	
	<b>6.2</b>	Introduction to data loggers and data recording systems. Basic understanding of noise and interference in measurement systems and their impact on sensor data quality.	
	<b>6.3</b>	Signal conditioning in sensor-based measurement systems. Wheatstone Bridge, Flash ADC, and R–2R DAC explained using functional block diagrams and their role in sensor data acquisition systems.	
<b>6.4</b>	Applications of temperature, pressure, and displacement sensors in industrial, automotive, and environmental monitoring systems.		
<b>Self-Learning Topics:</b> Study of sensor data acquisition using microcontroller-based platforms (conceptual level).			

**Suggested List of Experiments:**

Expt. No.	Title of the Experiment
1	<p><b>Sensor Characterization and Datasheet Interpretation.</b></p> <p><b>Objective:</b>The objective of this practical is to study the characteristics of sensors and learn how to interpret sensor datasheets. It focuses on understanding key parameters like sensitivity, range, and accuracy.</p> <p><b>Outcome:</b>After this practical, students will be able to read and understand</p>

	<p>sensor datasheets, identify important parameters, and select suitable sensors for different applications.</p>
2	<p><b>Measurement of Displacement Using an LVDT.</b></p> <p><b>Objective:</b>The objective of this practical is to study the working principle of an LVDT (Linear Variable Differential Transformer) and to measure displacement using it. It also aims to understand the relationship between displacement and output voltage.</p> <p><b>Outcome:</b>After completing this practical, students will be able to measure displacement using an LVDT, understand its linear characteristics, and interpret the output signal for different positions accurately.</p>
3	<p><b>Measurement and comparison of temperature using RTD and Thermocouple.</b></p> <p><b>Objective:</b>The objective of this practical is to measure temperature using an RTD and a thermocouple and to study their working principles. It also aims to compare their performance in terms of accuracy, sensitivity, and response.</p> <p><b>Outcome:</b>After completing this practical, students will be able to measure temperature using both RTD and thermocouple, understand their differences, and compare their performance for various applications.</p>
4	<p><b>Measurement of Solution Acidity and Alkalinity Using a pH Sensor and Arduino.</b></p> <p><b>Objective:</b>The objective of this practical is to measure the acidity and alkalinity of a solution using a pH sensor interfaced with an Arduino. It also aims to understand the working of the pH sensor and the use of Arduino for data acquisition and display.</p> <p><b>Outcome:</b> After completing this practical, students will be able to measure pH values using a pH sensor and Arduino, interpret the results to determine acidity or alkalinity, and gain basic knowledge of sensor interfacing and data monitoring.</p>
5	<p><b>Non-Contact Distance Measurement Using an Ultrasonic Sensor and Arduino.</b></p> <p><b>Objective:</b>The objective of this practical is to measure distance without physical contact using an ultrasonic sensor interfaced with an Arduino. It also</p>

	<p>aims to understand the working principle of ultrasonic waves and their use in distance measurement.</p> <p><b>Outcome:</b>After completing this practical, students will be able to measure distance using an ultrasonic sensor and Arduino, interpret the sensor output, and understand the basics of non-contact measurement and sensor interfacing.</p>
6	<p><b>Touch and Proximity Detection Using a Capacitive Sensor and Arduino.</b></p> <p><b>Objective:</b> The objective of this practical is to study touch and proximity detection using a capacitive sensor interfaced with an Arduino. It aims to understand the working principle of capacitive sensing and how changes in capacitance are used to detect touch or nearby objects.</p> <p><b>Outcome:</b>After completing this practical, students will be able to detect touch and proximity using a capacitive sensor and Arduino, interpret changes in capacitance, and understand the basics of sensor interfacing and its applications.</p>
7	<p><b>Measurement of Applied Pressure Using a Pressure Sensor and Arduino.</b></p> <p><b>Objective:</b> The objective of this practical is to measure applied pressure using a pressure sensor interfaced with an Arduino. It also aims to understand the working principle of the pressure sensor and how pressure variations are converted into electrical signals.</p> <p><b>Outcome:</b>After completing this practical, students will be able to measure pressure using a pressure sensor and Arduino, interpret the sensor output, and understand the basics of pressure measurement and sensor interfacing.</p>
8	<p><b>Measurement of Angular Velocity and Orientation Using a Gyroscope and Arduino.</b></p> <p><b>Objective</b> The objective of this practical is to measure angular velocity and orientation using a gyroscope interfaced with an Arduino. It also aims to understand the working principle of the gyroscope and how rotational motion is detected.</p> <p><b>Outcome</b> After completing this practical, students will be able to measure angular velocity and orientation using a gyroscope and Arduino, interpret the sensor data, and understand the basics of motion sensing and sensor interfacing.</p>

9	<p><b>Wireless Sensor Data Transmission Using Zigbee Modules and Arduino.</b></p> <p><b>Objective:</b>The objective of this practical is to study wireless data transmission using Zigbee modules interfaced with Arduino. It aims to understand the basic concept of wireless communication and how sensor data can be transmitted without physical connections.</p> <p><b>Outcome:</b>After completing this practical, students will be able to transmit sensor data wirelessly using Zigbee and Arduino, understand the fundamentals of wireless communication, and apply it in simple sensor network applications.</p>
10	<p><b>Wireless Serial Communication Using Bluetooth and Arduino.</b></p> <p><b>Objective:</b>The objective of this practical is to study wireless serial communication using Bluetooth interfaced with Arduino. It aims to understand how data is transmitted and received wirelessly between devices using Bluetooth technology.</p> <p><b>Outcome:</b>After completing this practical, students will be able to establish Bluetooth communication with Arduino, transmit and receive data wirelessly, and understand the basics of wireless serial communication for sensor applications.</p>
11	<p><b>Measurement and Storage of Environmental Temperature Using an Arduino-Based Data Logger.</b></p> <p><b>Objective:</b>The objective of this practical is to measure and store environmental temperature using an Arduino-based data logger. It aims to understand temperature sensing, data acquisition, and how data can be recorded over time.</p> <p><b>Outcome:</b>After completing this practical, students will be able to measure environmental temperature, store the data using an Arduino data logger, and understand the basics of data logging and monitoring for real-time applications.</p>
12	<p><b>Design and Testing of a 4-Bit Flash ADC Using Comparators.</b></p> <p><b>Objective:</b> The objective of this practical is to design and test a 4-bit flash ADC using comparators. It aims to understand the working principle of flash analog-to-digital conversion and how analog signals are converted into digital form.</p> <p><b>Outcome:</b>After completing this practical, students will be able to design a basic</p>

	flash ADC, understand the role of comparators in conversion, and interpret digital output corresponding to analog input signals.
13	<p><b>Digital-to-Analog Conversion Using a 4-Bit R–2R Ladder DAC.</b></p> <p><b>Objective:</b>Please give objective and outcome in brief para for the following sensor practical</p> <p><b>Outcome:</b>After completing this practical, students will be able to convert digital signals into analog form using an R–2R ladder DAC, understand its working principle, and analyze the relationship between digital input and analog output voltage.</p>
14	<p><b>Measurement of Unknown Resistance Using Wheatstone Bridge.</b></p> <p><b>Objective:</b>The objective of this practical is to measure an unknown resistance using a Wheatstone bridge. It aims to understand the working principle of the bridge circuit and the condition for balance.</p> <p><b>Outcome:</b>After completing this practical, students will be able to determine unknown resistance accurately using a Wheatstone bridge, understand the balance condition, and analyze its application in measurement systems.</p>
15	<p><b>Sensor-Based Mini Project: Integration of Sensor, Data Acquisition, and Communication.</b></p> <p><b>Objective:</b>The objective of this practical is to design and implement a sensor-based mini project by integrating a sensor, data acquisition system, and communication module. It aims to understand how different components work together to collect, process, and transmit data.</p> <p><b>Outcome:</b>After completing this practical, students will be able to develop a basic sensor-based system, integrate sensing, data acquisition, and communication, and apply their knowledge to real-time monitoring and control applications.</p>

**Assessment Methodology:**

Type of Assessment	Assessment Tools
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<p><b>Continuous Assessment (CA)</b>  <b>(20 Marks)</b></p>	<p>Certification: NPTEL (20 Marks) (Approved by instructor) <b>OR</b> Any 02 Pedagogies (10 marks each)</p> <ul style="list-style-type: none"> <li>● MCQ /Class Test</li> <li>● Case study/Assignment</li> <li>● GATE based Assignment</li> <li>● Certification Udemy/Coursera (Approved by instructor)</li> <li>● Open Book Test</li> <li>● Working model / Simulation of a course-based concept.</li> </ul>
<p><b>Mid Semester Examination (MSE)</b> <b>(30 Marks)</b></p>	<p>Question Paper Pattern is as follows:</p> <p>All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● MSE should be based on 50% syllabus.</li> <li>● Time: 90 minutes (1 hour 30 minutes)</li> <li>● Total Marks: 30</li> </ul>
<p><b>End Semester Examination (ESE)</b> <b>(50 Marks)</b></p>	<p>Question Paper Pattern is as follows:</p> <p>All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● Q4 A or B - 10 marks</li> <li>● Q5 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE.</li> <li>● Time: 120 minutes (02 hours)</li> <li>● Total Marks: 50</li> </ul>
<p><b>Term Work</b> <b>(25 Marks)</b></p>	<ul style="list-style-type: none"> <li>● Active Participation (Lab) = 05 marks</li> <li>● Laboratory Report / Journal = 10 marks</li> <li>● Laboratory Performance = 10 marks</li> </ul> <p>Based on the performance and satisfactory completion of assigned laboratory work.</p>

**Text Books:**

1. D.V.S. Murthy, “Transducers and Instrumentation”, PHI Learning, 2nd Edition, 2013.
2. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
3. Antti V. Raisanen, Arto Lehto, “Radio Engineering for Wireless Communication and Sensor Applications”, Artech House mobile communications series, USA, 2003.
4. Sensors and Signal Conditioning, Ramon Pallas Areny, John G. Webster, 2nd edition, John Wiley and Sons, 2000.
5. Vijay K. Garg, “Wireless Communication and Networking”, Morgan -Kaufmann Series in Networking, Elsevier, 2010.

**Reference Books:**

1. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Kirt Williams, Artech House, 2004.
2. Micro Electro Mechanical System Design, James J. Allen, Taylor and Francis, 2005
3. Nathan Ida, “Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction”, Second Edition, IET Control, Robotics and Sensors Series 127, 2020.

**Useful Links:**

1. <https://www.ni.com/en-in/innovations/white-papers/06/sensor-fundamentals.html>
2. <https://www.youtube.com/watch?v=WwQSfk6SSSo>
3. <https://www.youtube.com/watch?v=MGC2LWeNKSI>
4. <https://www.youtube.com/watch?v=vjhp0zTXEsc>

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25ME4MDM01	Logistics and Supply Chain Management	3	2	-	3	1	-	4	
		<b>Examination Scheme</b>							
			CA	MSE	ESE	TW	OR	PR	Total
		<b>Theory</b>	20	30	50	-	-	-	<b>100</b>
		<b>Lab/Tut</b>	-	-	-	25	-	-	<b>25</b>
		<b>Total</b>	<b>125</b>						

<b>Pre-Requisite Course:</b>	Engineering Mathematics
<p><b>Course Overview:</b> The LSCM course focuses on the strategic importance of logistics and supply chain integration in achieving a competitive advantage. The curriculum emphasizes performance measurement, inventory optimization, and the design of resilient supply chain networks. Students will engage in practical learning through experiments such as the "Beer Game" simulation to understand the Bullwhip Effect and software-based modeling for network optimization. A significant portion of the course is dedicated to modern trends, including <b>Industry 4.0/5.0</b>, digitization (IoT, Blockchain, AI), and sustainability practices like green logistics.</p> <p><b>Module 1:</b> This foundational module distinguishes between logistics and SCM while exploring the Value Chain Process. It covers supply chain stages, strategic fit, and critical "Make vs. Buy" decisions in outsourcing.</p> <p><b>Module 2:</b> Focuses on the financial and operational drivers that influence performance. You will learn to use the SCOR Model for benchmarking and explore the challenges of managing global supply chain networks and risks.</p> <p><b>Module 3:</b> This module introduces quantitative techniques to manage stock levels. Key topics include ABC and VED analysis for classification, Economic Order Quantity (EOQ) for cost minimization, and strategies for warehouse layout and automation.</p> <p><b>Module 4:</b> Explores the technological transformation of the industry. It covers the role of AI and Data Analytics, as well as the implementation of IoT, Blockchain, and management systems like WMS (Warehouse Management System).</p> <p><b>Module 5:</b> Detailed study of transportation modes, route optimization, and distribution challenges. It also examines the shift toward 3PL and 4PL providers and the growing importance of Green Logistics for environmental sustainability.</p> <p><b>Module 6:</b> The final module focuses on mathematical modeling to design efficient networks. Topics include facility location, capacity planning, and solving complex problems like the Travelling Salesman Problem to ensure supply chain resilience.</p>	

<b>Course Outcomes</b>	After successful completion of this course the students will be able to	
	CO1	Define Logistics and Supply Chain Management concepts and their role in today's business environment. (Remembering)
	CO2	Explain the drivers of supply chain performance and risks in supply chain management. (Understanding)
	CO3	Apply various techniques of inventory management and rank the items using inventory management techniques. (Applying)
	CO4	Analyze various strategies and techniques to minimize overall logistics cost. (Analyzing)
	CO5	Evaluate the role of digitization in supply chain management leading to sustainability. (Evaluating)
	CO6	Develop various mathematical models/tools to design the supply chain network. (Creating)

**Syllabus:**

Module No.	Unit No.	Topics	Hours
<b>1</b>	<b>Introduction to Logistics and SCM</b>		<b>04</b>
	After completing this module, students will be able to. 1. Distinguish between Logistics and Supply Chain Management (SCM) and explain their strategic importance in achieving a competitive advantage. 2. Analyze the Value Chain Process to identify activities that add value for the end customer.		
	<b>1.1</b>	Objectives of a Supply Chain Management, Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Key issues in SCM, logistics & SCM	
	<b>1.2</b>	Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of Stream lined SCM.	
	<b>1.3</b>	Supplier Selection, Supplier quality audits, Contract management, Non-Disclosure Agreement (NDA), Make & Buy Decision while in-out sourcing.	
<b>Self-Learning Topics:</b> Global Logistics & Trade, Sustainable & Circular Supply Chains, Risk Management & Resilience.			
	<b>Supply Chain Performance</b>		

2

04

	<p>After completing this module, students will be able to.</p> <ol style="list-style-type: none"> <li>1. Identify and analyze the key financial and operational drivers of supply chain performance, such as facilities, inventory, and transportation.</li> <li>2. Map supply chain processes using the SCOR (Supply Chain Operations.</li> </ol>		
	<p><b>2.1</b> Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influence designing Global Supply Chain Network.</p>		
	<p><b>2.2</b> Supplier performance measurement – (Delivery &amp; Quality performance, schedule adherence, Goods receipt compliance etc), Supplier Capacity Analysis, Supplier Score card.</p>		
	<p><b>Self-Learning Topics:</b> Supply Chain Risk Management (Risks involved in supply chain which includes – Supplier Financial Risk, Performance Risk, Compliance Risk, Country specific Risk, Cyber Security.</p>		
3	<p><b>Inventory and Warehouse management</b></p>		
	<p>After completing this module, students will be able to.</p> <ol style="list-style-type: none"> <li>1. Apply inventory classification techniques like ABC and VED analysis to prioritize management efforts and optimize resource allocation.</li> <li>2. Solve deterministic inventory problems using Economic order Quantity (EOQ) and Reorder point (ROP) models to minimise total holding and ordering costs.</li> </ol>		06
	<b>3.1</b>	Inventory classification and control models (EOQ, JIT, VMI).	
	<b>3.2</b>	Warehouse layout, material handling and automation. Demand forecasting techniques for optimization.	
	<p><b>Self-Learning Topics:</b> Replenishment systems (Q and P system)</p>		
<p><b>Supply chain analytics and digitalization</b></p>			
4	<p>After completing this module, students will be able to.</p> <ol style="list-style-type: none"> <li>1. Describe the role of Industry 4.0/5.0 technologies, such as IoT, Blockchain, and AI, in transforming digital supply chains.</li> </ol>		06
	<b>4.1</b>	Role of data analytics and AI in SCM	
	<b>4.2</b>	Digital supply chain transformation (IOT, Block chain, Industry 4.0 &5.0), TMS (Transport Management System), WMS (Warehouse Management System).	
	<p><b>Self-Learning Topics:</b> Application of Bar coding, Significance of SAP/RFID.</p>		

5	<b>Logistics Management and outsourcing</b>		07
	After completing this module, students will be able to. 1. Compare different transportation modes based on cost, speed, and suitability for various product types. 2. Assess the benefits and risks of outsourcing to 3PL and 4PL providers for logistics activities.		
	5.1	Evolution, Objectives, Components and Functions of Logistics Management, modes of transportation and route optimization.	
	5.2	Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management.	
	5.3	Reverse logistics, 3PL, 4PL, Green logistics and sustainability in supply chain management	
<b>Self-Learning Topics:</b> Beyond 4PL: The Rise of 5PL and Lead Logistics Providers (LLPs), Intermodalism and Synchronomodality, Cold Chain & Specialized Logistics			
6	<b>Supply Chain Network Design</b>		03
	After completing this module, students will be able to. 1. Formulate and solve mathematical models (like Linear Programming or the Transshipment model) to optimize distribution networks. 2. Determine optimal facility locations and capacity levels considering demand uncertainty and logistics costs.		
	6.1	Factors influencing distribution network design, Supply chain resilience, Design options for distribution network,	
	6.2	Introduction to mathematical modelling, considerations in modelling SCM systems, Overview of the models, Travelling salesman problem.	
<b>Self-Learning Topics:</b> Supply chain- Lead Time, Takt Time, Minimum Order Quantity (MOQ), Manufacturing Critical Path Time (MCT)			
<b>Total</b>			<b>30</b>

### Suggested Experiment List:

Expt. No.	Topic/ Module
1	<b>Inventory Management: ABC and VED Analysis</b> <b>Objective:</b> To apply inventory classification techniques to prioritize items based on their value and criticality. <b>Outcomes:</b> Students will be able to

	<ol style="list-style-type: none"> <li>1. Categorize items into A, B, and C classes based on annual usage value.</li> <li>2. Perform VED (Vital, Essential, Desirable) analysis based on functional criticality.</li> </ol>
2	<p><b>Deterministic Inventory Modeling (EOQ &amp; ROL)</b></p> <p><b>Objective:</b> To calculate optimal order quantities and timing to minimize total inventory costs.</p> <p><b>Outcomes:</b> Students will be able to</p> <ol style="list-style-type: none"> <li>1. Calculate the Economic Order Quantity (EOQ) for a manufacturing firm case study</li> <li>2. Determine the Reorder Level (ROL) by considering lead time and buffer stock.</li> </ol>
3	<p><b>Supply Chain Network Design &amp; Optimization</b></p> <p><b>Objective:</b> To apply mathematical models for designing an efficient distribution network.</p> <p><b>Outcomes:</b> Students will be able to</p> <ol style="list-style-type: none"> <li>1. Apply Transportation or Transshipment Problem models to a scenario.</li> <li>2. Use software (such as Excel Solver) to minimize shipping costs from factories to distribution centers while meeting demand and capacity constraints.</li> </ol>
4	<p><b>Bullwhip Effect Simulation (The Beer Game)</b></p> <p><b>Objective:</b> To understand demand fluctuations, information distortion, and the "Bullwhip Effect" within a multi-stage supply chain.</p> <p><b>Outcomes:</b> Students will be able to</p> <ol style="list-style-type: none"> <li>1. Track inventory and backorders through a four-stage role-playing simulation (Retailer, Wholesaler, Distributor, and Manufacturer).</li> <li>2. Identify causes of demand amplification and suggest reduction strategies like streamlined SCM or improved information sharing.</li> </ol>
5	<p><b>Supply Chain Performance Benchmarking (SCOR Model)</b></p> <p><b>Objective:</b> To measure and analyze supply chain performance using standardized metrics.</p> <p><b>Outcomes:</b> Students will be able to</p> <ol style="list-style-type: none"> <li>1. Analyze a case study using the SCOR framework across dimensions like Reliability, Responsiveness, and Agility.</li> <li>2. Develop a Supplier Scorecard to evaluate vendors based on delivery, quality, and compliance.</li> </ol>
6	<p><b>Digitization and Sustainability Assessment</b></p> <p><b>Objective:</b> To evaluate the role of Information Technology and Green SCM in modern logistics.</p> <p><b>Outcomes:</b> Students will be able to</p>

	<ol style="list-style-type: none"> <li>1. Analyze the application of RFID, Barcoding, or WMS in a warehouse environment.</li> <li>2. Calculate a Sustainability Index or CO2 emission impact for specific logistics routes.</li> </ol>
7	<p><b>The Bullwhip Effect: Information Distortion at P&amp;G or "SmartTech"</b>  <b>Objective:</b> To understand demand fluctuations, information distortion, and the "Bullwhip Effect" in a multi-stage supply chain.  <b>Outcomes:</b> Students will be able to</p> <ol style="list-style-type: none"> <li>1. Identify the causes of demand amplification throughout the supply chain.</li> <li>2. Suggest reduction strategies, such as streamlined Supply Chain Management (SCM) or improved information sharing.</li> </ol>
8	<p><b>Outsourcing Strategy: 3PL vs. 4PL Transition for Unilever or PUMA</b>  <b>Objective:</b> To assess the benefits and risks of outsourcing to Third-Party Logistics (3PL) and Fourth-Party Logistics (4PL) providers for logistics activities.  <b>Outcomes:</b> Students will be able to</p> <ol style="list-style-type: none"> <li>1. Analyze various strategies and techniques to minimize overall logistics costs.</li> <li>2. Evaluate the evolution of logistics management from 3PL to 4PL and beyond (such as 5PL or Lead Logistics Providers).</li> </ol>
9	<p><b>Supply Chain Risk Management: The Ericsson/Philips Semiconductor Fire</b>  <b>Objective:</b> To identify and analyze the key financial and operational risks involved in a supply chain, including supplier performance and compliance risks.  <b>Outcomes:</b> Students will be able to</p> <ol style="list-style-type: none"> <li>1. Explain the impact of supply chain risks on overall performance and resilience.</li> <li>2. Identify specific risk categories such as supplier financial risk, performance risk, and country- specific risk.</li> </ol>

**Assessment Criteria:**

Assessment Tool	Marks Distribution
<p><b>Continuous Assessment (CA)</b>  <b>20 marks</b></p>	<p>Certification: NPTEL (20 Marks) (Approved by instructor)  <b>OR</b>  Any two Pedagogies (10 marks each)</p> <ul style="list-style-type: none"> <li>● MCQ /Class Test</li> <li>● Case study/Assignment</li> <li>● GATE based Tutorial</li> <li>● MOOCs Certification (Approved by Instructor)</li> </ul>

	<ul style="list-style-type: none"> <li>● Open Book Test</li> <li>● Working model / simulation of a course-based concept.</li> </ul>
<p><b>Mid Semester Examination (MSE) (30 Marks)</b></p>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● MSE should be based on 50% syllabus.</li> <li>● Time: 90 minutes (1 hour 30 minutes)</li> <li>● Total Marks: 30</li> </ul>
<p><b>End Semester Examination (ESE) (50 Marks)</b></p>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● Q4 A or B - 10 marks</li> <li>● Q5 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE.</li> <li>● Time: 120 minutes (2 hours)</li> <li>● Total Marks: 50</li> </ul>
<p><b>Term Work (25 Marks)</b></p>	<ul style="list-style-type: none"> <li>● Active Participation (Lab) = 5 marks</li> <li>● Laboratory Report = 10 marks</li> <li>● Laboratory performance = 10 marks</li> </ul> <p>Based on the performance and satisfactory completion of assigned laboratory work</p>

**Text Books:**

1. Martin Christopher - "Logistics and Supply Chain Management", 4th Edition 2010, Pitman Publishing.
2. David Simchi- Levi, Philip Kaminsky, Edith Simchi- Levi - Designing and managing the supply chain (McGraw hill)
3. Sunil Chopra, Peter Meindl – Supply chain management: Strategy, Planning and Operation (Pearson)

**Reference Books:**

1. Jeremy F. Shapiro - Modeling the supply chain (Cengage)
2. Sridhar Tayur, Ram Ganeshan, Michael Magazine - Quantitative Models for supply chain

- management (Springer)
3. Donald Waters - Logistics: An Introduction to supply chain management (Palgrave Macmillan)
  4. Nada R. Sanders – Bigdata driven supply chain management (Pearson)
  5. Bowersox, Closs, Cooper – Supply chain logistics management (McGraw-Hill)

**Useful Links:**

1. [https://onlinecourses.nptel.ac.in/noc22\\_mg74/preview](https://onlinecourses.nptel.ac.in/noc22_mg74/preview)
2. [https://onlinecourses.swayam2.ac.in/cec22\\_mg22/preview](https://onlinecourses.swayam2.ac.in/cec22_mg22/preview)

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned				
		L	P	T	L	P	T	Total	
25ME4MDM02	Prototyping with CAD Modeling	2	2	-	2	1	-	3	
		Examination Scheme							
			CA	MSE	ESE	TW	OR	PR	Total
		<b>Theory</b>	20	30	50	-	-	-	<b>100</b>
		<b>Lab/Tut</b>	-	-	-	25	-	-	<b>25</b>
		<b>Total</b>	<b>125</b>						

<b>Pre-Requisite Courses:</b>	1. Engineering Mechanics
	2. Engineering Graphics

**Course Overview:**

This course introduces Computer/IT/EXTC students to practical 3D modeling and 3D printing for rapid hardware prototyping. Students learn free CAD tools to create 3D Models for e.g. custom enclosures, sensor mounts, and IoT device parts etc. Export STL files for FDM/SLA printing. Students gain hands-on skills in the full digital-to-physical workflow, emphasizing design verification and simple prototype projects.

**Module 1** introduces foundational CAD concepts including parametric modeling, file formats (STEP/IGES/BRep), and CSG/BRep representation methods for creating 3D geometry.

**Module 2** covers filament deposition and resin-based additive manufacturing processes with comparative analysis of material properties, applications, and process parameters for rapid prototyping.

**Module 3** explores powder bed fusion (SLS), binder jetting, and hybrid metal additive manufacturing techniques for complex multi-material prototypes.

**Module 4** focuses on STL mesh generation, file format standards, mesh quality metrics, validation, and repair workflows for print-ready model preparation.

**Module 5** explains printer firmware commands (G-code/M-code), slicer parameter interpretation, and execution flow for 3D printer hardware control.

**Module 6** combines practical 3D printing, prototype assembly, dimensional assessment, and reverse engineering using 3D scanning for iterative design improvement.

<b>Course Outcomes</b>	After successful completion, the students will be able to	
	<b>CO1</b>	Define CAD file formats, CSG/BRep modeling approaches, and parametric modeling terminology. ( <b>Remembering</b> )
	<b>CO2</b>	Explain G-code and M-code execution workflow in 3D printer firmware and slicer parameter interpretation. ( <b>Understanding</b> )

	<b>CO3</b>	Create 3D models from sketches and generate valid STL files with proper mesh validation ( <b>Applying</b> )
	<b>CO4</b>	Compare and select FDM vs SLA processes based on prototyping requirements, material properties, and applications. ( <b>Analyzing</b> )
	<b>CO5</b>	Assess advanced AM process suitability (SLS/Binder Jetting/Material Jetting) for complex prototype requirements ( <b>Evaluating</b> )
	<b>CO6</b>	Design and integrate complete digital manufacturing workflows by combining CAD modeling, additive manufacturing, and reverse engineering concepts for intelligent prototype optimization ( <b>Creating</b> )

**Syllabus:**

<b>Module No.</b>	<b>Unit No.</b>	<b>Topics</b>	<b>Hrs</b>
<b>1</b>	<b>CAD Fundamentals</b>		<b>05</b>
	After completing this module, students will be able to: 1. Define parametric and geometric modeling techniques in CAD. 2. Explain the role and integration of CAD/CAM in the product life cycle.		
	<b>1.1</b>	<b>Introduction to CAD:</b> CAD/CAM In product life cycle, CAD/CAM integration and file formats.	
	<b>1.2</b>	<b>Geometric Modeling Techniques:</b> Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling (only introduction level), feature-based modeling, Feature recognition, Design by feature	
<b>Self-Learning Topics:</b> Comparison and Applications of Geometric Modeling Techniques			
<b>2</b>	<b>Core AM Processes - FDM &amp; SLA</b>		<b>06</b>
	After completing this module, students will be able to: 1. Define AM and its classification 2. Explain SLA and FDM Processes in AM 3. Apply SLA and FDM Processes as per application		
	<b>2.1</b>	<b>AM Processes Classification: SLA Process Fundamentals</b> History of AM, classification, and materials. SLA Process Overview, Advantages, Disadvantages, Applications	

	<b>2.2</b>	<b>FDM Process Fundamentals:</b> FDM Process Overview, Advantages, Disadvantages, Applications.	
<b>Self-Learning Topics:</b> Comparative Study of SLA and FDM in Terms of Working Principle, Applications, Advantages, and Limitations			
<b>3</b>	<b>Advanced AM Processes</b>		<b>06</b>
	After completing this module, students will be able to: 1. Explain SLS, Binder Jetting, DMLS/SLM Processes in AM 2. Apply SLS, Binder Jetting, DMLS/SLM Processes for prototyping 3. Analyze Process Selection Matrix for complex prototypes		
	<b>3.1</b>	<b>SLS Process Fundamentals</b> SLS Process Overview, Advantages, Disadvantages, Applications	
	<b>3.2</b>	<b>Binder Jetting, DMLS and SLM:</b> Process Overview, Advantages, Disadvantages, Applications. Process Selection Matrix: Material properties, resolution, strength, cost analysis for complex prototypes	
<b>Self-Learning Topics:</b> Comparative Study of SLS, Binder Jetting, DMLS/SLM in Terms of Working Principle, Applications, Advantages, and Limitations			
<b>4</b>	<b>STL File Generation &amp; Terminologies</b>		<b>05</b>
	After completing this module, students will be able to: 1. Apply STL generation techniques for prototyping 2. Analyze STL File for different product requirements 3. Evaluate STL Mesh for efficiency and suitability 4. Validate mesh using Cura Slicer		
	<b>4.1</b>	<b>STL File Format Basics:</b> Triangle mesh representation, ASCII vs Binary formats, file structure. Mesh Terminologies, Facets, vertex normals, triangulation, watertight condition, manifold meshes, and Mesh Quality Metrics	
	<b>4.2</b>	<b>Hands-on Practice:</b> Export STL from CAD (Solidworks), validate mesh using Cura Slicer, repair tools	
<b>Self-Learning Topics:</b> Understanding STL File Generation and Its Role in Rapid Prototyping Workflows			
	<b>G-code &amp; M-code Fundamentals</b>		

	<p>After completing this module, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Analyze Slicer Parameters for process optimization</li> <li>2. Evaluate Process parameters for cost and time effectiveness</li> </ol>		
	<p><b>5.1 G-code and M-code Basics:</b> Movement commands (G0 rapid move, G1 linear interpolation), coordinate systems (XYZ) and essential G-codes &amp; M-codes with extrusion control, M104/M109 (hot end temperature), M140/M190 (bed temperature), M106/M107 (cooling fan)</p>		
	<p><b>5.2 Slicer Parameters in G-code:</b> Layer height, print speed, extrusion width, flow rate, retraction settings, Firmware Interpretation, Marlin, Repetier firmware execution</p>		
	<p><b>Self-Learning Topics:</b> Understanding. G-code file format used by 3D printer to print prototype</p>		
6	<p><b>CAD with Reverse Engineering</b></p>		
	<p>After completing this module, students will be able to:</p> <ol style="list-style-type: none"> <li>3. Analyze reverse engineering workflows for accuracy and efficiency</li> <li>4. Evaluate reverse engineering for cost and time savings</li> <li>5. Design a complete reverse engineering workflow for a product</li> </ol>		
	6.1	<p><b>Reverse Engineering:</b> Reverse Engineering: Noncontact surface scanning, point cloud data processing, and CAD model development</p>	04
	6.2	<p><b>Project Planning:</b> Prototype design, part decomposition, printing strategy, assembly workflow, Hands-on Projects, e.g., Phone stand, sensor housing, drone parts, custom enclosures for IT projects</p>	
	<p><b>Self-Learning Topics:</b> Case study with Step-by-Step Workflow for Developing CAD Models from Non-Contact Scanning</p>		
Total		30	

### Suggested List of Experiments:

Sr. No.	Title of the Experiments
1	<p>2D Sketching &amp; Parametric Constraints</p> <p><b>Objective:</b>To understand basic sketching tools and apply geometric &amp; dimensional constraints for parametric design.</p>

	<p><b>Outcome:</b> Learner will be able to create fully constrained 2D sketches and modify dimensions parametrically.</p>
2	<p>Complex 2D Profiles for Extrusion</p> <p><b>Objective:</b>To develop complex multi-contour sketches and prepare them for manufacturing/export.</p> <p><b>Outcome:</b> Learner will be able to design complex profiles and export them for fabrication (DXF).</p>
3	<p>Basic 3D Features - Extrude &amp; Revolve</p> <p><b>Objective:</b>To introduce basic 3D modeling operations and feature creation.</p> <p><b>Outcome:</b> Learner will be able to generate 3D components using standard features and understand feature tree.</p>
4	<p>Boolean Operations &amp; Pattern Features</p> <p><b>Objective:</b>To apply Boolean operations and pattern features in product design.</p> <p><b>Outcome:</b> Learner will be able to create repetitive features and modify models using Boolean operations.</p>
5	<p>Simple Assembly - Phone Stand Components</p> <p><b>Objective:</b>To understand assembly constraints and simulate basic motion.</p> <p><b>Outcome:</b> Learner will be able to assemble parts, apply mates, and perform motion/interference analysis.</p>
6	<p>Multi-Part IoT Enclosure Assembly</p> <p><b>Objective:</b>To learn multi-part assembly design with tolerance considerations.</p> <p><b>Outcome:</b> Learner will be able to can create assemblies with proper fit and generate BOM.</p>
7	<p>STL Export &amp; Basic Slicing</p> <p><b>Objective:</b>To understand file conversion and basic 3D printing preparation.</p>

	<p><b>Outcome:</b> Learner will be able to export models and configure basic slicing parameters.</p>
8	<p>Advanced Slicer Optimization</p> <p><b>Objective:</b>To optimize printing parameters for quality, strength, and time.</p> <p><b>Outcome:</b> Learner will be able to evaluate and optimize slicer settings for different requirements.</p>
9	<p>First Print - Quality Control</p> <p><b>Objective:</b>To evaluate printed parts for dimensional and surface quality.</p> <p><b>Outcome:</b> Learner will be able to measure, analyze, and improve print quality.</p>
10	<p>Multi-Part Assembly Printing</p> <p><b>Objective:</b>To validate assembly fit through real printed components.</p> <p><b>Outcome:</b> Learner will be able to analyze assembly issues and improve design tolerances.</p>
11	<p>IoT Enclosure Project</p> <p><b>Objective:</b>To integrate mechanical design with electronics components.</p> <p><b>Outcome:</b> Learner will be able to design functional enclosures and validate real-world applications.</p>
12	<p>Reverse Engineering Project</p> <p><b>Objective:</b>To understand reverse engineering and product improvement cycle.</p> <p><b>Outcome:</b> Learner will be able to recreate and improve existing products using CAD tools.</p>

**Assessment Criteria:**

Assessment Tool	Marks Distribution
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<p><b>Continuous Assessment (CA)</b> <b>20 marks</b></p>	<p>Certification: NPTEL (20 Marks) (Approved by instructor) <b>OR</b> Any two Pedagogies (10 marks each)</p> <ul style="list-style-type: none"> <li>● MCQ /Class Test</li> <li>● Case study/Assignment</li> <li>● GATE based Tutorial</li> <li>● MOOCs Certification (Approved by Instructor)</li> <li>● Open Book Test</li> <li>● Working model / simulation of a course-based concept.</li> </ul>
<p><b>Mid Semester Examination (MSE)</b> <b>(30 Marks)</b></p>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● MSE should be based on 50% syllabus.</li> <li>● Time: 90 minutes (1 hour 30 minutes)</li> <li>● Total Marks: 30</li> </ul>
<p><b>End Semester Examination (ESE)</b> <b>(50 Marks)</b></p>	<p>Question Paper Pattern is as follows: All Questions are compulsory.</p> <ul style="list-style-type: none"> <li>● Q1 A or B - 10 marks</li> <li>● Q2 A or B - 10 marks</li> <li>● Q3 A or B - 10 marks</li> <li>● Q4 A or B - 10 marks</li> <li>● Q5 A or B - 10 marks</li> <li>● For each question, A and B should be based on the same CO.</li> <li>● ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE.</li> <li>● Time: 120 minutes (2 hours)</li> <li>● Total Marks: 50</li> </ul>
<p><b>Term Work (25 Marks)</b></p>	<ul style="list-style-type: none"> <li>● Active Participation (Lab) = 5 marks</li> <li>● Laboratory Report = 10 marks</li> <li>● Laboratory performance = 10 marks</li> </ul> <p>Based on the performance and satisfactory completion of assigned laboratory work</p>

**Text Books:**

1. CAD/CAM: Principles and Applications – P.N. Rao, McGraw-Hill Education
2. Computer Graphics for Engineers – Anupam Saxena and Birendra Sahay Pearson Education
3. Rapid Prototyping: Principles and Applications in Manufacturing – Chua Chee Kai, Leong Kah Fai, and Lim Chu-Sing, World Scientific Publishing

**Reference Books:**

1. Mastering CAD/CAM – Ibrahim Zeid, McGraw-Hill Education
2. Automation, Production Systems, and Computer-Integrated Manufacturing – Mikell P. Groover, Pearson Education,
3. Principles of Computer-Aided Design and Manufacturing – Farid Amirouche, Pearson Education
4. Numerical Control and Computer-Aided Manufacturing – T.K. Kundra, P.N. Rao, and N.K. Tewari, McGraw-Hill Education
5. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing – Ian Gibson, David Rosen, and Brent Stucker, Springer

**Useful Links:**

1. <https://nptel.ac.in/courses/112102101>
2. <https://nptel.ac.in/courses/112102102>
3. <https://nptel.ac.in/courses/112104289>
4. <https://nptel.ac.in/courses/112102103>
5. <https://nptel.ac.in/courses/112104265>

## Preface

Don Bosco Institute of Technology (DBIT), Kurla, Mumbai, presents the Liberal Learning Courses (LLC) as part of its academic curriculum under the autonomous framework aligned with the National Education Policy (NEP) 2020. The policy emphasizes holistic and multidisciplinary education that enables students to explore learning beyond the boundaries of their primary discipline. In line with this educational vision, Liberal Learning Courses form an important component of the undergraduate curriculum, providing opportunities for students to engage with diverse areas of knowledge and creativity alongside their engineering studies.

Engineering education today requires more than technical competence alone. It demands creativity, communication skills, adaptability, emotional intelligence, and the ability to appreciate perspectives beyond one's core discipline. Liberal Learning Courses aim to address this broader educational need by encouraging students to engage with creative, cultural, and aesthetic domains that enrich their intellectual and personal development.

The LLC framework provides students with opportunities to explore various forms of artistic expression, cultural practices, and creative activities. Such exposure enables learners to develop imagination, aesthetic sensibility, confidence, and collaborative skills. Participation in these courses encourages students to step beyond conventional classroom learning and discover new interests and abilities that contribute to their overall personality development.

The courses emphasize experiential learning through participative and activity-based approaches. Students learn through hands-on engagement, collaborative practice, creative projects, demonstrations, and peer interaction. These learning experiences foster teamwork, communication, leadership, and self-expression while cultivating respect for diverse cultural traditions and forms of artistic creativity.

In addition to promoting creativity and cultural awareness, Liberal Learning Courses contribute to students' emotional well-being and balance during their academic journey. Engaging in creative pursuits provides an avenue for expression and reflection, helping students develop resilience and maintain a healthy perspective amidst the demands of rigorous technical education.

The following pages present the syllabi and structure of the Liberal Learning Courses offered as part of the academic curriculum at DBIT. This document provides an overview of the course objectives, learning outcomes, and learning activities associated with these courses. It serves as a reference for students and faculty members to understand the scope and implementation of Liberal Learning Courses within the curriculum.

The contents of this document may be reviewed and updated periodically by the Academic Council and other academic bodies of the institute in accordance with evolving educational

guidelines and institutional priorities. Feedback from students and faculty will continue to play an important role in strengthening the effectiveness and relevance of these courses.

Through the Liberal Learning Courses, DBIT aims to contribute to the development of engineers who are not only technically competent but also creative, culturally aware, confident, and socially responsible individuals capable of contributing meaningfully to society.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC01	Rhythm & Motion: A Journey Through Dance	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation	Total Marks		
		30	5	10	5	50		

**Course Objectives:**

1	To introduce students to the basic elements and techniques of Indian & contemporary dance forms.
2	To foster collaborative learning through peer-led instruction and group choreography.
3	To enhance students' body rhythm, coordination, expression, and stage confidence through regular practice and performance.
4	To provide a creative platform for self-expression, teamwork, and appreciation of cultural diversity through dance.

**Course Outcomes:**

CO1	Identify and describe the basic elements and cultural context of selected Indian and contemporary dance forms
CO2	Perform foundational movements and rhythm patterns of at least one dance style with correct posture and coordination.
CO3	Design and choreograph a short group dance performance using acquired skills and creativity.
CO4	Engage in effective peer collaboration, contributing ideas, giving and receiving feedback, and working towards a shared goal.
CO5	Document the learning process, including practice routines, group reflections, and performance insights in a learning log.

CO6	Demonstrate confidence, stage presence, and expressive ability through a final group performance.
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**Syllabus:**

Sr. No.	Name of Module	Detailed Content	Hrs
1	Stagecraft and Self-Awareness	Theatre basics, warm-ups, body/voice awareness	02
2	Acting Essentials and Theatre Forms	Voice projection, improvisation, intro to theatre styles	04
3	Script to Stage: Forming Dramatic Teams	Peer group formation, script selection/creation	02
4	Rehearse, Reflect, Repeat	Blocking, dialogues, emotions, peer feedback	12
5	Character, Costume, and Confidence	Character work, stage elements, rehearsal polishing	06
6	Curtains Up: Performance and Reflection	Final performance + reflective presentations	04

**Suggested Themes/Genres for Performance:**

Students may choose or create scenes around...

- Social issues (e.g., gender, education, environment)
- Adapted mythology or folk tales
- Short comedies or farces
- Emotional/dramatic scenes (1-act plays, monologues)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL2LLC03	Creative Visual Art	–	2	–	–	1	–	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Cultural Festival Participation	Technical Festival Participation	Total Marks		
		30	5	10	5	50		

### Course Objectives:

1	To introduce students to the fundamentals of art and design.
2	To develop observation, visualization, and creative expression skills.
3	To explore traditional, contemporary, and digital art media.
4	To promote cultural understanding through indigenous art and craft techniques.
5	To guide students in building a personal art portfolio reflecting originality and growth.

### Course Outcomes:

CO1	Recall the essential elements and principles of art and design. (Remember)
CO2	Explain various traditional, contemporary, and digital art media and their applications. (Understand)
CO3	Apply drawing, painting, craft, and digital tools to express creative ideas. (Apply)
CO5	Analyze Indian art forms, craft techniques, and commercial design practices. (Analyse)
CO5	Evaluate creative outputs based on originality, technique, and sustainability. (Evaluate)
Co6	Create a comprehensive art portfolio showcasing conceptual development and artistic expression. (Create)

### Syllabus:

<b>Sr. No.</b>	<b>Name of Module</b>	<b>Detailed Content</b>	<b>Hrs.</b>
1	Mural Art – I	Charcoal painting techniques, Chalk art, Mandala art, Basic sketching techniques.	07
2	Art of Resume Writing and LinkedIn Profile Building	Resume writing fundamentals, structuring professional resumes, Creating and optimizing LinkedIn profiles, Personal branding basics.	03
3	Mural Art – II	Clay art – Lipan art techniques, Introduction to mural compositions using clay, Application of texture and traditional motifs.	05
4	Craft & Eco Art	Decorations from waste materials, Recycled art projects, Sustainable art practices, Creative handmade craft exploration.	05
5	Software Tools for Creative Media	Basics of animation, Video editing fundamentals, Introduction to sound integration, Creative media production basics.	05
6	Digital Art & Media	Designing digital posters and flyers using Canva, Digital painting and sketching using IbisPaint, Introduction to digital illustration techniques.	05

**Suggested Activities for Creative Visual Art Course:**

1. Create a charcoal or mandala mural artwork
2. Prepare a professional resume and optimized LinkedIn profile
3. Design a small Lipan-inspired clay mural
4. Create a decorative item using recycled materials
5. Produce a short, edited video with basic animation elements
6. Design a digital poster or illustration using any software tool

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
25IL2LLC04	Yoga for Better Life		2			1		1

	Course Name	Assessment Methods				Total Marks	Total Credits
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation		
	Warli Painting	30	5	10	5	50	1

### Course Objectives:

- To introduce students to the basic principles and philosophy of Yoga.
- To develop awareness about physical fitness, posture, breathing, and relaxation.
- To cultivate habits that promote mental well-being and stress management.
- To encourage disciplined lifestyle practices for holistic development.
- To provide hands-on training in basic asanas, pranayama, and meditation techniques.

### Course Outcomes:

- CO1: Recall the meaning, origin, and basic principles of Yoga. (Remember)
- CO2: Explain the benefits of Yoga practices for physical and mental well-being. (Understand)
- CO3: Perform basic yoga asanas and breathing techniques with correct posture. (Apply)
- CO4: Analyze personal lifestyle habits & identify areas for improvement through yoga practices. (Analyze)
- CO5: Evaluate the impact of regular yoga practice on stress, concentration, and health. (Evaluate)
- CO6: Design a simple daily yoga routine suitable for a healthy student lifestyle. (Create)

### Syllabus

Sr. No.	Name of Module	Detailed Content	Hours
1	Introduction to Yoga and Its Philosophy	Meaning and definition of Yoga, Brief history and origin of Yoga, Contribution of Patanjali, Overview of Ashtanga Yoga (Eight Limbs of Yoga), Importance of Yoga in modern life.	04
2	Basic Yoga Postures (Asanas)	Warm-up exercises and stretching, standing asanas, Sitting asanas, Prone posture, Safety precautions and correct alignment in asanas	10
3	Pranayama and Relaxation Techniques	Importance of breath control, Anulom-Vilom pranayama, Bhramari pranayama, Deep breathing exercises, Shavasana for relaxation	06
4	Meditation and Stress Management	Introduction to meditation, Guided meditation practice, Role of Yoga in reducing stress and anxiety, Techniques for improving focus and emotional balance	04
5	Yoga for Healthy Lifestyle	Importance of daily routine (Dinacharya), Basic awareness of balanced diet and Yoga, Posture correction and screen-time management, Time management and discipline through Yoga	03
6	Guided Practice and Personal Routine Development	Supervised yoga practice sessions, Posture and breathing correction techniques, Group discussion on challenges faced during practice, Preparation of a simple personal daily yoga routine	03

#### Suggested Activities for Yoga for Better Life Course

- Morning Yoga Practice Session (Weekly)
- International Yoga Day Participation
- Group demonstration of selected asanas
- Stress Management Workshop
- Posture Awareness Campaign in Campus
- Meditation Circle Session
- Yoga for Examination Stress Awareness Drive
- Yoga Diary – 21-Day Practice Reflection
- Breathing Awareness Session Before Exams
- Healthy Lifestyle Pledge Activity

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
25IL4LL C01	Rhythm & Motion: A Journey Through Dance		2			1		1

	Course Name	Assessment Methods				Total Marks	Total Credits
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation		
	Rhythm & Motion: A Journey Through Dance	30	5	10	5	50	1

**Course Objectives:**

To introduce students to the basic elements and techniques of Indian & contemporary dance forms.

- To foster collaborative learning through peer-led instruction and group choreography.
- To enhance students' body rhythm, coordination, expression, and stage confidence through regular practice and performance.
- To provide a creative platform for self-expression, teamwork, and appreciation of cultural diversity through dance.

**Course Outcomes:**

- **CO1:** Identify and describe the basic elements and cultural context of selected Indian and contemporary dance forms.
- **CO2:** Perform foundational movements and rhythm patterns of at least one dance style with correct posture and coordination.
- **CO3:** Design and choreograph a short group dance performance using acquired skills and creativity.
- **CO4:** Engage in effective peer collaboration, contributing ideas, giving and receiving feedback, and working towards a shared goal.
- **CO5:** Document the learning process, including practice routines, group reflections, and performance insights in a learning log.
- **CO6:** Demonstrate confidence, stage presence, and expressive ability through a final group performance.

<b>Sr. No.</b>	<b>Name of Module</b>	<b>Detailed Content</b>	<b>Hours</b>
1	Foundations of Dance and Body Awareness	Understanding the role of dance in culture Importance of body posture, balance, and rhythm Warm-up techniques and movement preparation	02
2	Introduction to Indian and Contemporary Dance Forms	Basic steps and hand gestures (mudras) from Indian semi-classical styles Folk and contemporary forms (Garba, Bhangra, Bollywood freestyle, etc.) Practice and demonstration under teacher guidance	02
3	Peer Group Formation and Planning for Choreography	Formation of student groups Selection of dance form(s) for performance Setting group goals and distributing roles (lead, scribe, music, etc.)	02
4	Choreography, Practice & Feedback	Step-by-step choreography building through peer learning Weekly practice and feedback loops Focus on synchronization, formations, and transitions	12

5	Performance Rehearsal and Expression Techniques	Integration of expression (bhava), facial movements, and stage presence Full performance rehearsals Guidance and critiques from teacher-in-charge and peers	08
6	Final Performance and Reflective Practice	Group performances (3–5 minutes per group) Reflective presentations on the learning journey and group collaboration Submission of group logbooks and performance details	04

### **Suggested activities for Rhythm & Motion: A Journey Through Dance**

#### **1. Celebration of Culture**

- Fusion of Indian folk dances from different states
- Depiction of festivals through dance (e.g., Holi, Navratri, Onam)

#### **2. Unity in Diversity**

- Blend of classical and contemporary forms (e.g., Bharatanatyam + Hip-hop)
- Represent different states/languages/cultures in a seamless performance

#### **3. Seasons of Life**

- Portray different stages: childhood, youth, maturity
- Express through changing moods and music tempos

#### **4. Nature and Elements**

- Themes like rain, sun, wind, or forest
- Use movement to express fluidity, calmness, or energy

#### **5. Women Empowerment / Social Change**

- Portray strength, transformation, or voice of change through expressive dance
- Depict social messages: education, freedom, equality

#### **6. Friendship and Togetherness**

- Dance to illustrate bonding, celebration, or emotional connection
- Use duets and group motifs creatively

#### **7. Bollywood through the Decades**

- Mix iconic dance styles and songs from 70s to present
- Highlight evolution of movement and costume

#### **8. Patriotic Spirit / India through Dance**

- Depict freedom movement, unity, or symbols of national pride
- Use flag colours, folk styles, or instrumental music

### 9. Time Travel in Dance

- Present past, present, and future through costumes, styles, and transitions
- Explore how dance evolves across time

### 10. Storytelling Without Words

- Select a theme like a journey, dream, or emotional arc
- Tell a story only through expression, posture, and movement

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
25IL4LLC04	Strings & Strokes: An Introduction to Musical Instruments		2			1		1

	Course Name	Assessment Methods				Total Marks	Total Credits
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation		
	Strings & Strokes: An Introduction to Musical Instruments	30	5	10	5	50	1

### Course Objectives:

- To introduce students to the fundamentals of rhythm, melody, and musical notation.
- To provide hands-on learning in playing selected basic musical instruments.

- To foster collaborative learning through peer practice, ensemble formation, and group performance.
- To develop listening skills, coordination, and appreciation for different music cultures.
- To build self-confidence through stage performance and group expression.

**Course Outcomes:**

*By the end of the course, students will be able to:*

- **CO1:** Identify the basic components, history, and playing techniques of selected musical instruments.
- **CO2:** Demonstrate foundational skills in playing at least one melodic or rhythmic instrument.
- **CO3:** Interpret simple musical patterns and rhythms using basic notation or auditory learning.
- **CO4:** Collaboratively compose or practice a short ensemble performance in a peer-learning group.
- **CO5:** Reflect on their own learning journey and peer group experiences through documentation.
- **CO6:** Participate confidently in a group musical performance.

Sr. No.	Name of Module	Detailed Content	Hours
1	Musical Foundations: Sound, Rhythm & Melody	Introduction to sound, rhythm, pitch; clapping exercises, ear training	02
2	Instrument Basics: Form, Function & Playing Technique	Introduction to Instruments: tabla, djembe, harmonium, keyboard, flute, ukulele, etc. (Instruments will vary based on student's choice)	04
3	Group Formation & Instrument Selection	Peer grouping, instrument choice, practice plan	02
4	Practice, Play & Peer Learning	Guided group practice, simple compositions, internal peer reviews	12
5	Building an Ensemble: Sound & Synchrony	Coordination of parts, ensemble play, polishing performance	06
6	The Final Note: Performance & Reflection	Final group performance, presentation, peer feedback	04

## Suggested Performance Themes

- **“Rhythms of India”** - A medley combining classical (e.g., tabla, harmonium), folk, or regional musical patterns from different parts of India.
- **“Sounds Without Borders”** - A fusion of instruments or rhythms inspired by global cultures—e.g., African djembe + Indian flute + Western ukulele.
- **“Nature’s Symphony”** - Use instruments and sounds to depict elements of nature—rain, breeze, thunder, sunrise, birdsong.
- **“Music & Mood”** - A performance that explores different emotions—joy, calm, sadness, excitement—through changes in melody, rhythm, and tempo.
- **“India in Harmony”** - Celebrate unity in diversity through a piece that includes instruments and musical motifs representing India’s multilingual, multicultural richness.
- **“Cinematic Soundtrack”** - Create a simple instrumental piece based on popular Indian or world cinema themes (e.g., folk version of a Bollywood classic or instrumental theme from a famous film).
- **“Soulful Strings: Music for Peace”** - A meditative or soft instrumental piece designed to calm, soothe, and create emotional connection.
- **“Journey Through Time”** - Showcase evolution in music—from folk to contemporary—by starting with traditional sounds and gradually shifting to modern ones.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC01	Rhythm & Motion: A Journey Through Dance	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation	Total Marks		
		30	5	10	5	50		

### Course Objectives:

1	To introduce students to the basic elements and techniques of Indian & contemporary dance forms.
2	To foster collaborative learning through peer-led instruction and group choreography.
3	To enhance students' body rhythm, coordination, expression, and stage confidence through regular practice and performance.
4	To provide a creative platform for self-expression, teamwork, and appreciation of cultural diversity through dance.

### Course Outcomes:

CO1	Identify and describe the basic elements and cultural context of selected Indian and contemporary dance forms
CO2	Perform foundational movements and rhythm patterns of at least one dance style with correct posture and coordination.
CO3	Design and choreograph a short group dance performance using acquired skills and creativity.
CO4	Engage in effective peer collaboration, contributing ideas, giving and receiving feedback, and working towards a shared goal.
CO5	Document the learning process, including practice routines, group reflections, and performance insights in a learning log.
CO6	Demonstrate confidence, stage presence, and expressive ability through a final group performance.

**Syllabus:**

Sr. No.	Name of Module	Detailed Content	Hrs
1	Foundations of Dance and Body Awareness	Understanding the role of dance in culture Importance of body posture, balance, and rhythm Warm-up techniques and movement preparation	2
2	Introduction to Indian and Contemporary Dance Forms	Basic steps and hand gestures (mudras) from Indian semi-classical styles Folk and contemporary forms (Garba, Bhangra, Bollywood freestyle, etc.) Practice and demonstration under teacher guidance	2
3	Peer Group Formation and Planning for Choreography	Formation of student groups Selection of dance form(s) for performance Setting group goals and distributing roles (lead, scribe, music, etc.)	2
4	Choreography, Practice & Feedback	Step-by-step choreography building through peer learning Weekly practice and feedback loops Focus on synchronization, formations, and transitions	12
5	Performance Rehearsal and Expression Techniques	Integration of expression (bhava), facial movements, and stage presence Full performance rehearsals Guidance and critiques from teacher-in-charge and peers	8
6	Final Performance and Reflective Practice	Group performances (3–5 minutes per group) Reflective presentations on the learning journey and group collaboration Submission of group logbooks and performance details	4

**Suggested Activities:**

## 1. Celebration of Culture

- Fusion of Indian folk dances from different states
- Depiction of festivals through dance (e.g., Holi, Navratri, Onam)

## 2. Unity in Diversity

- Blend of classical and contemporary forms (e.g., Bharatanatyam + Hip-hop)
  - Represent different states, languages, and cultures in a seamless performance
3. Seasons of Life
    - Portray different stages: childhood, youth, and maturity
    - Express through changing moods and music tempos
  4. Nature and Elements
    - Themes like rain, sun, wind, or forest
    - Use movement to express fluidity, calmness, or energy
  5. Women Empowerment / Social Change
    - Portray strength, transformation, or voice of change through expressive dance
    - Depict social messages such as education, freedom, and equality
  6. Friendship and Togetherness
    - Dance to illustrate bonding, celebration, or emotional connection
    - Use duets and group motifs creatively
  7. Bollywood through the Decades
    - Mix iconic dance styles and songs from the 70s to the present
    - Highlight evolution of movement and costume
  8. Patriotic Spirit / India through Dance
    - Depict freedom movement, unity, or symbols of national pride
    - Use flag colours, folk styles, or instrumental music
  9. Time Travel in Dance
    - Present past, present, and future through costumes, styles, and transitions
    - Explore how dance evolves across time
  10. Storytelling Without Words
    - Select a theme like a journey, dream, or emotional arc
    - Tell a story only through expression, posture, and movement

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	T	P	T	Total
25IL4LLC02	Introduction to Dramatics: Exploring Theatre Arts	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation	Total Marks		
		30	5	10	5	50		

### Course Objectives:

1	To introduce students to the fundamental elements of drama and theatre performance.
2	To build confidence, voice modulation, and body language through theatrical expression.
3	To encourage collaborative learning through peer-group script development and dramatization.
4	To provide a platform for creativity, empathy, and reflective thinking through stage performance.

### Course Outcomes:

CO1	Identify key elements of theatre including character, dialogue, movement, and space.
CO2	Demonstrate basic acting techniques such as voice projection, improvisation, and body language.
CO3	Collaboratively develop and rehearse a short play or dramatic piece.
CO4	Reflect on dramatic themes, character motivation, and audience engagement.
CO5	Engage in peer learning by giving and receiving feedback during rehearsals.
CO6	Perform a scripted or devised scene on stage as part of a team.

**Syllabus:**

<b>Sr. No.</b>	<b>Name of Module</b>	<b>Detailed Content</b>	<b>Hrs</b>
1	Stagecraft and Self-Awareness	Theatre basics, warm-ups, body/voice awareness	02
2	Acting Essentials and Theatre Forms	Voice projection, improvisation, intro to theatre styles	04
3	Script to Stage: Forming Dramatic Teams	Peer group formation, script selection/creation	02
4	Rehearse, Reflect, Repeat	Blocking, dialogues, emotions, peer feedback	12
5	Character, Costume, and Confidence	Character work, stage elements, rehearsal polishing	06
6	Curtains Up: Performance and Reflection	Final performance + reflective presentations	04

**Suggested Themes/Genres for Performance:** Students may choose or create scenes around:

- Social issues (e.g., gender, education, environment)
- Adapted mythology or folk tales
- Short comedies or farces
- Emotional/dramatic scenes (1-act plays, monologues)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC03	Swaranjali: Introduction to Vocal Music (Singing)	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation	Total Marks		
		30	5	10	5	50		

#### Course Outcome:

1	To introduce students to the fundamentals of Indian vocal music.
2	To build foundational skills in singing through practice of swaras, alankars, and simple compositions.
3	To encourage collaborative learning, creativity, and confidence through group performances.
4	To develop appreciation for musical expression as a form of self-exploration and emotional well-being.

#### Course Outcomes:

CO1	Identify and explain basic elements of Indian vocal music such as swaras, taal, and raag.
CO2	Demonstrate swara practice, pitch accuracy, and basic vocal exercises.
CO3	Collaboratively learn and rehearse selected compositions in peer groups.
CO5	Reflect on personal growth, voice improvement, and peer collaboration.
CO5	Participate in a group musical presentation with proper rhythm and expression.
CO6	Compose or creatively adapt a short group performance based on learned concepts.

#### Syllabus:

Sr. No.	Name of Module	Detailed Content	Hrs
1	Basics of Indian Vocal Music	Sound, pitch (swar), rhythm (taal), laya, introduction to saptak (scale), shruti, swaras.	02

2	Voice Culture & Alankars	Breathing, pitch practice, alankars (note patterns), vocal warm-ups, intro to raag-based practice.	04
3	Raag & Taal Practice	Simple raags like Bhupali/Yaman, Teen Taal, Dadra; clapping cycles, rhythm coordination.	02
4	Song Practice in Peer Groups	Group division; learning bhajans, folk songs, patriotic songs, or classical compositions.	12
5	Expression, Bhava & Presentation Skills	Understanding meaning, emotion (bhava), and improving stage confidence, posture, and projection.	06
6	Group Performance & Reflection	Final group performance (3–5 min); sharing experiences; submission of logbooks/journals.	04

### **Suggested List of Activities for Swaranjali: Introduction to Vocal Music (Singing):**

#### 1. Raag Rang: Colors of Melody

A performance based on a single or combination of simple raags such as *Bhupali* and *Yaman*, showcasing how mood and emotion can be conveyed through melody.

#### 2. Voices of Unity

Group performance using patriotic or unity-based songs such as *Vande Mataram* and *Desh Mera Rangeela* to represent harmony and national spirit.

#### 3. Bhakti & Bhava

Present devotional or bhajan-based compositions that emphasize expression (*bhava*), simplicity, and spiritual connection.

#### 4. Folk Fusion

Blend two or more regional Indian folk songs (e.g., Rajasthani, Marathi, Bengali) with a shared rhythm or melody line to showcase cultural diversity.

#### 5. Seasons in Song

A musical expression of seasons such as spring, monsoon, and winter through selected compositions or original adaptations, using changes in tempo and pitch to reflect mood.

#### 6. Swar Se Shanti (Peace Through Voice)

Soothing compositions or raag-based presentations focusing on calmness, wellness, and introspection—ideal for a soft and expressive performance.

#### 7. Story Through Song

A mini musical narrative told through 2–3 linked compositions expressing a journey or message, such as struggle to peace or darkness to light.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC04	Strings & Strokes: An Introduction to Musical Instruments	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation	Total Marks		
		30	5	10	5	50		

**Course Objectives:**

1	To introduce students to the fundamentals of rhythm, melody, and musical notation.
2	To provide hands-on learning in playing selected basic musical instruments.
3	To foster collaborative learning through peer practice, ensemble formation, and group performance.
4	To develop listening skills, coordination, and appreciation for different music cultures.
5	To build self-confidence through stage performance and group expression.

**Course Outcomes:**

CO1	Identify the basic components, history, and playing techniques of selected musical instruments.
CO2	Demonstrate foundational skills in playing at least one melodic or rhythmic instrument.
CO3	Interpret simple musical patterns and rhythms using basic notation or auditory learning.
CO4	Collaboratively compose or practice a short ensemble performance in a peer-learning group.
CO5	Reflect on their own learning journey and peer group experiences through documentation.
CO6	Participate confidently in a group musical performance.

**Syllabus:**

Sr. No.	Name of Module	Detailed Content	Hrs
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1	Musical Foundations: Sound, Rhythm & Melody	Introduction to sound, rhythm, pitch; clapping exercises, ear training	02
2	Instrument Basics: Form, Function & Playing Technique	Introduction to Instruments: tabla, djembe, harmonium, keyboard, flute, ukulele, etc. (Instruments will vary based on student's choice)	04
3	Group Formation & Instrument Selection	Peer grouping, instrument choice, practice plan	02
4	Practice, Play & Peer Learning	Guided group practice, simple compositions, internal peer reviews	12
5	Building an Ensemble: Sound & Synchrony	Coordination of parts, ensemble play, polishing performance	06
6	The Final Note: Performance & Reflection	Final group performance, presentation, peer feedback	04

### Suggested Performance Themes

- **“Rhythms of India”** - A medley combining classical (e.g., tabla, harmonium), folk, or regional musical patterns from different parts of India.
- **“Sounds Without Borders”** - A fusion of instruments or rhythms inspired by global cultures—e.g., African djembe + Indian flute + Western ukulele.
- **“Nature’s Symphony”** - Use instruments and sounds to depict elements of nature—rain, breeze, thunder, sunrise, birdsong.
- **“Music & Mood”** - A performance that explores different emotions—joy, calm, sadness, excitement—through changes in melody, rhythm, and tempo.
- **“India in Harmony”** - Celebrate unity in diversity through a piece that includes instruments and musical motifs representing India’s multilingual, multicultural richness.
- **“Cinematic Soundtrack”** - Create a simple instrumental piece based on popular Indian or world cinema themes (e.g., folk version of a Bollywood classic or instrumental theme from a famous film).
- **“Soulful Strings: Music for Peace”** - A meditative or soft instrumental piece designed to calm, soothe, and create emotional connection.
- **“Journey Through Time”** - Showcase evolution in music—from folk to contemporary—by starting with traditional sounds and gradually shifting to modern ones.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	T	P	T	Total
25IL4LLC05	Traditional Rangolis of India	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation	Total Marks		
		30	5	10	5	50		

#### Course Objectives:

1	To introduce students to the traditional art of Kolams and Rangolis from Tamil Nadu and other states of India.
2	To understand the cultural, spiritual, and social significance of Rangolis.
3	To develop skills in creating various types of Rangoli patterns.
4	To appreciate the geometrical symmetry and aesthetic value of Rangoli designs.
5	To encourage creativity and imagination in designing new Rangoli patterns.

#### Course Outcomes :

CO1	Recall different types of Rangolis and the materials used to create them. (Remember)
CO2	Explain the traditions and cultural significance behind Rangolis and Kolams. (Understand)
CO3	Apply basic Rangoli techniques to create structured and larger designs. (Apply)
CO4	Analyse the geometric patterns and symmetries present in various Rangoli forms. (Analyse)
CO5	Evaluate different Rangoli styles based on creativity, symmetry, and theme relevance. (Evaluate)
CO6	Create original Rangoli designs integrating traditional elements with innovative themes. (Create)

#### Syllabus:

Sr. No.	Name of Module	Detailed Content	Hrs

1	Introduction to Kolams	What are Kolams or Rangolis and their traditions, Kolams during festivals and religious functions, Kolams inside the puja room (Hridaya Kamalam, Aishwaryam), Health benefits of early morning Rangoli during Margasheersha.	04
2	Dot-Based Kolams	Basic square Kolams (3 dots to 10 dots), Dot Kolams with straight dots, Dot Kolams with interspread dots, Practice and creation of self-designed dot Kolam pattern.	06
3	Sikku Kolam (Twisted Loops)	Basic Sikku Kolams (3 dots to 7 dots), Sikku Kolams with straight dots, Sikku Kolams with interspread dots, Creation of self-designed Sikku Kolam pattern.	06
4	Kambi Kolam (Line Patterns)	Basic Kambi Kolam with 2–3 layers, Kambi Kolam with 4–6 layers, Kambi Kolam with more than 6 layers, Creation of self-designed Kambi Kolam pattern.	04
5	Flower Rangoli and Thematic Designs	Basic Rangoli patterns with flowers, Rangoli with themes, Rangoli during festivals, Creation of theme-based Rangoli design.	03
6	Kolams and Society	Community Kolams, Kolams during marriages, Kolams during Margasheersha month, Social and cultural relevance of Rangolis.	03

### Suggested Activities for Traditional Rangolis of India Course

- Create Hridaya Kamalam or Aishwaryam Kolam.
- Design a 5-dot to 5-dot Kolam pattern.
- Create a Sikku Kolam using 7 dots.
- Design a Kambi Kolam with 6 layers.
- Create a sustainability-themed Rangoli.
- Design decorative border Kolams for community display.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC06	Foundations of Photography	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Euphoria Participation	Colosseum Participation	Total Marks		
		30	5	10	5	50		

### Course Objective:

1	To introduce students to the evolution and foundational concepts of digital photography.
2	To develop proficiency in camera operations, exposure settings, and essential photographic gear.
3	To enable students to understand and apply exposure principles using the exposure triangle (ISO, aperture, shutter speed).
4	To provide hands-on experience in post-processing using Photoshop and Lightroom.
5	To cultivate technical skills and creative vision in digital image-making.

### Course Outcome:

CO1	Recall the evolution of photography, types of cameras, photographic styles, and basic digital photography concepts. (Remember)
CO2	Explain camera components, lens types, sensors, and exposure settings used in photography. (Understand)
Co3	Apply composition rules and exposure triangle principles to capture well-composed photographs. (Apply)
CO4	Analyze lighting conditions, exposure settings, and subject positioning to make informed shooting decisions. (Analyse)
CO5	Evaluate and refine photographs using Photoshop and Lightroom tools. (Evaluate)
CO6	Create compelling photo compositions and digital stories integrating technical skills and creativity. (Create)

### Syllabus:

<b>Sr. No.</b>	<b>Name of Module</b>	<b>Detailed Content</b>	<b>Hrs</b>
1	Introduction to Digital Photography	History of photography, Photographic styles, Rule of thirds, Basic DSLR settings, Necessary gears, Sensors and mirrors in cameras, Full frame vs crop sensor.	05
2	Working with Your Camera	Commanding the mode dial, Lens structure and types, Prime lenses, cleaning lenses, Introduction to shutter speed, aperture and ISO, White balance, Introduction to light.	05
3	Balancing Light: The Exposure Triangle	Detailed understanding of shutter speed, ISO, and aperture, Practical application of exposure triangle, Managing lighting conditions for better image capture.	05
4	Photoshop – Interface and Post-Production	Opening files in Photoshop, Understanding the Photoshop interface, Basic post-production techniques, Color correction and exposure adjustments.	05
5	Photoshop – Tools and Editing Techniques	Different tools used in Photoshop, Image enhancement techniques, Cropping, retouching, layering basics.	05
6	Lightroom – Editing and Enhancement	Lightroom interface overview, Using filters to enhance photographs, Basic workflow for organizing and refining images.	05

### **Suggested Activities for Photography Course**

- Rule of Thirds Challenge – Take 3 photos applying the rule of thirds; peer review and discuss composition.
- Photography challenge - Take photos in different types of photography explained.
- Sensor Showdown – Comparative presentation or discussion on full-frame vs. crop sensor
- DSLR Demo Day – Hands-on exploration of camera settings
- Clean It Right – video on safe lens cleaning
- Before & After Edits – Edit an image using subtle adjustments (brightness, contrast, hue) and present a before/after comparison.
- Mini Retouch Project – Use crop, clone, healing brush, and selection tools to improve an image.
- Creative Edits – Use various tools to apply a creative twist (like turning a daytime photo into night).
- Filter Fun – Apply 3 different Lightroom filters to one image and explain the effects.
- Mood Edit Challenge – Choose a photo and use Lightroom adjustments to convey a specific emotion (e.g., warmth, mystery)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL2LLC07	Tradition & Craft: Hands-On Indian Art	--	2	--	--	1	--	1
		Assessment Methods						
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks		
		30	5	10	5	50		

#### Course Objectives:

1	To introduce students to diverse Indian traditional and contemporary art forms.
2	To develop hands-on skills in craft techniques such as Tanjore, Lipan, Quilling, Clay Modeling, and DIY décor.
3	To cultivate design thinking, creativity, and aesthetic sensibility among students.
4	To promote sustainable and mindful crafting as a stress-relieving and enriching activity.
5	To encourage integration of traditional craftsmanship with contemporary applications.

#### Course Outcomes:

CO1	Recall the historical and cultural origins of traditional Indian art forms such as Tanjore and Lipan art. (Remember)
CO2	Explain the tools, materials, and techniques used in Tanjore, Lipan, Quilling, and Clay Modeling crafts. (Understand)
CO3	Apply techniques to create basic forms in clay modelling, quilling, mirror work, and Tanjore relief work. (Apply)
CO4	Analyse differences between traditional and contemporary art styles and their contribution to modern décor. (Analyse)
CO5	Evaluate the aesthetic and functional aspects of handmade art pieces for home décor. (Evaluate)
CO6	Create a unique DIY home décor project by integrating multiple art forms learned in the course. (Create)

**Syllabus:**

<b>Sr. No.</b>	<b>Name of Module</b>	<b>Detailed Content</b>	<b>Hrs</b>
1	Introduction to Tanjore art	History and origin (Thanjavur, Tamil Nadu), Traditional themes and subjects, Tools and materials: MDF board/wooden board, chalk powder and gum mixture, gold foil, stones, brushes, Sketching and layout transfer techniques, Gesso (relief) work, Stone and gold foil application, Painting and finishing techniques.	06
2	Lipan Art (Mud & Mirror Work)	Origin and cultural significance of Lipan art (Kutch, Gujarat), Tools and materials: clay/M-seal, mirrors, MDF/canvas base, adhesives, Basic motifs and symmetry patterns, Clay application techniques, Mirror embedding techniques, Painting and finishing methods.	06
3	Quilling Art – Paper Filigree	Introduction to quilling art and its applications, Tools and materials: quilling strips, slotted tool, board, glue, Basic coil techniques: tight coil, loose coil, teardrop, marquise, scrolls, Practice of shapes and patterns, Jewelry or decorative craft creation.	06
4	Creative Clay Modeling	Introduction to clay art and types of clay (natural, air-dry, polymer), Tools and safety practices, Basic clay techniques: rolling, pinching, coiling, slab method, joining techniques (scoring and slip), Creating miniature objects, Painting and surface finishing.	04
5	DIY Home Décor	Basics of home décor and design principles, Traditional vs modern décor elements, Wall art and hangings, Decorative lighting concepts, Tabletop and shelf décor ideas, Sustainable and recycled craft applications.	04
6	Creative Hands: Traditional Meets Contemporary	Integration of traditional crafts with modern aesthetics, Mixed-media approach combining Tanjore-style elements, Lipan patterns, Quilling, and Clay modelling, Design planning and execution of final DIY project, Peer feedback and refinement.	04

**Suggested Activities for Tradition & Craft: Hands-On Indian Art Course:**

- Create a small Tanjore-style relief artwork on MDF board using gesso work and gold foil application.

- Design and execute a decorative Lipan art wall plaque incorporating clay work and mirror embedding.
- Craft a quilled jewellery set (earrings and pendant) using basic quilling shapes and proper finishing techniques.
- Create a clay nameplate or wall hanging using basic techniques like rolling, pinching, and coiling.
- Design a functional decorative item (wall art or tabletop décor) using recycled or sustainable materials.
- Develop a mixed-media DIY décor project integrating at least three techniques learned in the course.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC08	LLC – Sports & Fitness	--	2	--	--	1	--	1
		<b>Assessment Methods</b>						
		<b>Mentor Assessment</b>	<b>Course Attendance</b>	<b>Euphoria Participation</b>	<b>Colosseum Participation</b>		<b>Total Marks</b>	
		30	5	10	5		50	

### Course Objectives:

1	To encourage active participation in indoor and outdoor sports for physical and mental well-being.
2	To develop teamwork, leadership, and sportsmanship through group sports activities.
3	To promote a healthy and stress-free lifestyle through regular physical activity.
4	To create awareness about basic fitness practices and recreational sports.

### Course Outcomes:

CO1	Recall the importance of physical fitness and healthy lifestyle habits. (Remembering)
CO2	Explain basic rules of selected indoor and outdoor games. (Understanding)
CO3	Apply basic fitness exercises and warm-up routines. (Applying)
CO4	Demonstrate teamwork and active participation in sports activities. (Analyzing)
CO5	Evaluate personal fitness through continuous participation. (Evaluating)
CO6	Develop lifelong interest in sports and fitness. (Creating)

### Syllabus:

Sr. No.	Name of Module	Detailed Content	Hrs
1	Foundations of Physical Fitness & Team Formation	Introduction to Sports & Physical Fitness – Importance of sports, fitness components, warm-up and team formation.	05

2	Basic Fitness Conditioning & Injury Prevention	Basic Fitness & Conditioning – Stretching, endurance activities, light strength exercises, safety measures.	04
3	Skill Development in Indoor Sports	Indoor Sports Participation – Practice of badminton, table tennis, chess, carrom and basic rules.	06
4	Skill Development in Outdoor Sports	Outdoor Sports Participation – Practice of cricket, football, volleyball, basketball, kho-kho and kabaddi.	06
5	Team Dynamics, Leadership & Sports Ethics	Teamwork, Leadership & Sports Ethics – Role of captain, discipline, fair play, managing wins and losses.	05
6	Recreational Sports, Wellness & Lifelong Fitness	Recreational Sports & Wellness – Sports for stress management and semester-end sports activity.	05

### **Suggested Activities for the Course:**

- Weekly sports participation
- Team practice matches
- Basic fitness routine before games
- Inter-team matches
- Semester-end sports event