AC: 02/26
Item No. 03

The Bombay Salesian Society's

Don Bosco Institute of Technology, Mumbai

(An Autonomous Institute Affiliated to University of Mumbai)

CURRICULUM STRUCTURE FOR SECOND YEAR ENGINEERING

SEMESTER IV

Department of Electronics and Telecommunication Engineering

(As per NEP 2020)

(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 reaffirm our commitment to producing graduates who are not only professionally competent but also dedicated to the greater good of society.

2. Vision and Mission

Vision:

DBIT will be recognized for providing 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 field 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 shape the Course Outcomes (COs) and form the foundation for the 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

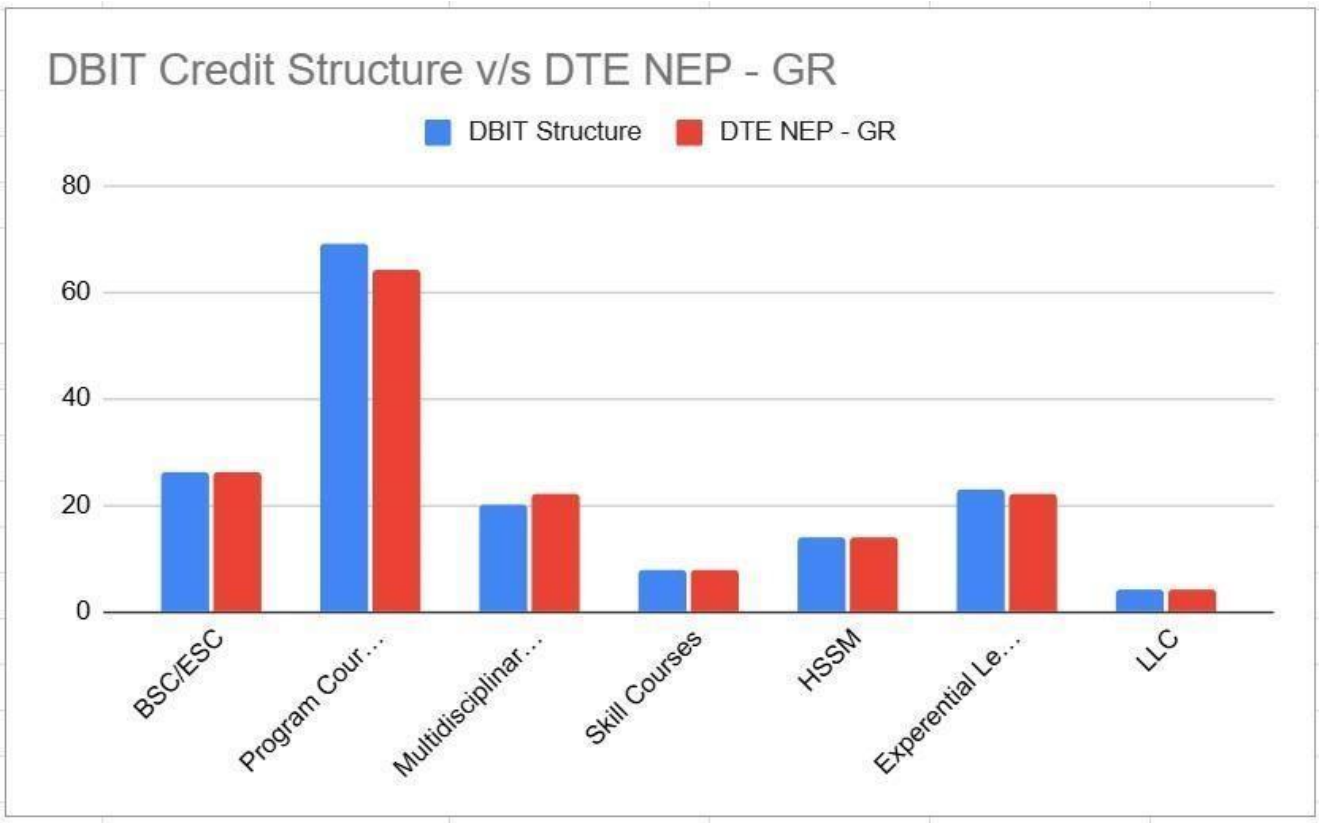
4. Credit Guidelines and Allocation

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 02 weeks
Seminar / Group Discussions	1 Credit = 15 Hours
Community Engagement / Field Project	1 Credit = 30 Hours

DBIT Overall Curriculum Credit Structure:

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 (MDM)	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						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
Total Credits (Major)		21	21	21	21	20	21	20	19	164	160 - 176



5. Degree Options and Exit Pathways

Students are offered flexible learning pathways through the following options:

Undergraduate Degree Options:

- B.E. - 164 credits
- B.E. Minor/Honors - 182 credits
- B.E. Honors with Research - 182 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).

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
VSEC	Vocational and Skill Enhancement Course

UG Second Year EXTC 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**
25ET4PCC01	PCC	Discrete Time Signal Processing	3	-	1	3	-	1	4
25ET4PCC02	PCC	Electromagnetics and Antennas	3	2	-	3	1	-	4
25ET4PCC03	PCC	Digital VLSI Design	3	2	-	3	1	-	4
25ET4PCC04	PCC	Microcontrollers and Applications	-	2*+2	-	-	2	-	2
25XX4MDMYY	MDM	Multidisciplinary Minor @	2	2	-	2	1	-	3
25ET4CEP01	CEP	Community Engagement Project	-	2	-	-	1	-	1
25IL4EEM01	EEM	Entrepreneurship Essentials	2	-	-	2	-	-	2
25IL4LLCXX	LLC	Liberal Learning Course	-	2$	-	-	1	-	1
		Total	**13**	**14**	**1**	**13**	**7**	**1**	**21**

* Two hours of practical class to be conducted as demo/practical/discussion.

@ Students must select one Multidisciplinary Minor (MDM) course provided by a different engineering department than their own, from the range offered by the Institute.

$ Two hours of activity to be conducted for full class relative to respective LLC.

Examination and Assessment Structure

Examination Marking Scheme: Semester IV									
Course Code	**Course Vertical**	**Course Name**	**Examination Marks**						
			CA	**MSE**	**ESE**	**TW**	**OR**	**PR**	**Total**
25ET4PCC01	PCC	Discrete Time Signal Processing	20	30	50	25	-	-	125
25ET4PCC02	PCC	Electromagnetics and Antennas	20	30	50	25	25	-	150
25ET4PCC03	PCC	Digital VLSI Design	20	30	50	25	-	25	150
25ET4PCC04	PCC	Microcontrollers and Applications	50	-	-	25	-	25	100
25XX4MDMYY	MDM	Multidisciplinary Minor @	20	30	50	25	-	-	125
25ET4CEP01	CEP	Community Engagement Project	-	-	-	25	25	-	50
25IL4EEM01	EEM	Entrepreneurship Essentials	50	-	-	-	-	-	50
25IL4LLCXX	LLC	Liberal Learning Course	50	-	-	-	-	-	50
		Total Marks	**230**	**120**	**200**	**150**	**50**	**50**	**800**

UG Second Year EXTC Program

Assessment Methodology

Type of Courses	Assessment Tools	Marks Distribution
Theory	**CA-20**	Certification: NPTEL (20 Marks) (Approved by Instructor) **OR** Any two Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Tutorial • MOOCs Certification (Approved by Instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Theory (PCC – Lab)	**CA-50**	Any of the following Pedagogies Summing up to Maximum 50 marks: • MCQ /Class Test (10 marks) • Case study/Assignment (10 marks) • GATE based Tutorial (10 marks) • MOOCs Certification (Approved by Instructor) (10 marks) • Open Book Test (10 marks) • Working model / simulation of a course-based concept (30 Marks)
Theory (VEC)	**CA-50**	• Active Participation = 5 marks • MCQ /Class Test= 10 marks • Assessment of the activity carried out by student = 25 marks • Assignment = 10 marks
Engineering Skills Workshop	**CA-50**	• 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.
Liberal Learning Courses (LLC)	**CA-50**	• Active Participation = 5 marks • Assessment of the Activity carried out by student = 25 marks • Cultural Event Participation = 10 marks • Technical Event Participation = 10 marks
Theory	**MSE**	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

Theory	**ESE**	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
Course - Laboratory	**TW- 25**	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory Performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.
Community Engagement Project (CEP)	**TW-25**	• Active Participation = 05 marks • Project Report = 10 marks Progress Presentations (min 02) & Demonstration = 10 marks
Tutorial	**TW-25**	• Active Participation = 5 marks Tutorial Submission = 20 marks Tutorials should cover the entire syllabus.
Laboratory	**OR-25**	Oral examination will be based on the entire syllabus.
Laboratory	**PR-25**	Practical examination will be based on the experiments performed by the students during laboratory sessions.

Weightage of COs across all Assessments:

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

Note: Total weightage of all COs should be 100%.

1. **Course Vertical 1- Program Core Course (PCC): Total Credits: 14**

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	T	P	L	T	P	Total
		3	1	-	3	1	-	**4**
		Examination Scheme						
25ET4PCC01	**Discrete Time Signal Processing**	**Theory**	**CA 1**	**CA 2**	**MSE**	**ESE**	**Total**	
			10	10	30	50	**100**	
		Tutorial		**TW**	**OR**	**PR**		
				25	-	-	**25**	

Pre-Requisite Courses:	25ET3PCC01: Mathematics for Signal Processing

Course and Module Overview:

This course provides a structured and in-depth introduction to Digital Time Signal Processing (DTSP), covering the complete spectrum from discrete-time signal representation to advanced filter design and real-world applications. The course begins with the fundamentals of discrete- time signals and systems, emphasizing the transformation of signals from time domain to frequency domain using the Discrete Fourier Transform (DFT) and its efficient implementation through Fast Fourier Transform (FFT). It then advances to the design and analysis of digital filters, realization structures, and the impact of finite word length effects on system performance.

The course also explores practical applications of DTSP in modern engineering domains, including biomedical signal analysis, speech processing, image processing, and wireless communication systems. It is especially relevant for Electronics and Telecommunication (EXTC) students, as modern communication systems—such as 5G/6G wireless networks, IoT devices, biomedical instruments, audio processing systems, and embedded communication hardware—rely heavily on digital signal processing techniques for efficient, reliable, and real-time operation.

Module 1 Establishes the transform-domain foundation by introducing discrete-time signal processing concepts, including Discrete Fourier Transform (DFT) including its properties, Inverse Discrete Fourier Transform (IDFT), and Fast Fourier Transform (FFT) algorithms. It covers aliasing, signal sampling, and efficient computation techniques such as overlap-add and overlap-save methods. This knowledge enables EXTC students to analyze signals in the frequency domain, which is essential for communication system design, spectral analysis, and efficient signal processing implementations.

Module 2 Focuses on IIR digital filter design, including classical analog filter approximations such as Butterworth and Chebyshev filters, and their transformation into digital filters using impulse invariance and bilinear transformation methods. It also examines the role of poles and zeros in shaping frequency response. These concepts are critical for designing filters used in communication receivers, noise reduction, and channel equalization.

Module 3 Introduces FIR digital filters, highlighting their characteristics, phase properties, and design techniques using windowing and frequency sampling methods. It also includes comparison with IIR

filters to understand design trade-offs. This module equips students with the ability to design stable and linear-phase filters widely used in audio processing, data transmission, and biomedical applications.

Module 4 Covers digital filter realization structures, including cascade, parallel, lattice, and frequency sampling structures for FIR and IIR systems. These structures are essential for efficient hardware and software implementation of digital filters, enabling optimized performance in real-time signal processing systems.

Module 5 Addresses finite word length effects, including quantization, rounding, truncation errors, and noise modeling in digital systems. It provides insight into how numerical limitations affect filter performance and system stability, which is crucial for implementing DSP algorithms on embedded systems and digital hardware platforms.

Module 6 Integrates DTSP concepts with real-world applications, including ECG and EEG signal analysis, echo cancellation, speech and audio processing, computer vision, and image processing. It also explores applications in 5G/6G wireless communication systems and healthcare technologies, demonstrating how DTSP forms the backbone of modern intelligent and communication systems.

Course Outcomes	**After successful completion of the course, the students will be able to**	
	CO1	Describe the fundamental concepts and mathematical formulations of DFT, FFT, filter design methods, and finite word length effects in digital systems. (Remembering)
	CO2	Explain the theoretical principles behind discrete-time Fourier transformations, digital filter responses, and the effects of quantization and filter structures. (Understanding)
	CO3	Apply appropriate algorithms and mathematical tools to compute DFT/FFT and to design basic IIR and FIR filters using standard techniques. (Applying)
	CO4	Analyze the performance and characteristics of digital filters and systems in terms of frequency response, pole-zero configuration, quantization effects, and real-time DSP performance. (Analyzing)
	CO5	Evaluate different types of digital filters, implementation methods, and transform techniques, and choose the most suitable approach for a specific digital signal processing application. (Evaluating)
	CO6	Design and implement efficient digital filters and signal processing systems for real-world applications using DFT/FFT techniques and filter design methods (Creating)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Discrete Fourier Transform & Fast Fourier Transform**	10
		After completing this module, students will be able to: • Describe the fundamentals of digital signal processing systems and sampling concepts. • Explain aliasing, signal conversion from analog to discrete-time, and DSP system elements • Apply DFT and IDFT properties for frequency-domain analysis of discrete- time signals • Compute circular convolution using DFT and IDFT techniques. • Analyze and implement FFT algorithms (DIT and DIF) for efficient spectral computation. • Apply overlap-add and overlap-save methods for processing long data sequences.	
	1.1	Digital Signal Processing System, Difference between Digital and Analog Signal Processing, Converting an Analog Signal to a Discrete Time signal, Concept of Aliasing, Basic Elements of a DSP System, Advantage and Disadvantage of digital and analog signal processing, Definition and Properties of DFT, IDFT, Circular convolution of sequences using DFT and IDFT.	
	1.2	Filtering of Long Data Sequences: Overlap-Save and Overlap-Add methods	
	1.3	Fast Fourier Transform (FFT): Radix-2 Decimation-in-Time and Decimation-in-Frequency algorithms, Inverse FFT, Composite Radix FFT (N = 2×3, N = 3×2)	
		Self-Learning Topics: Use of DFT in communication systems for spectrum analysis and interference identification.	
2		**IIR Digital Filters**	10
		After completing this module, students will be able to: • Explain the characteristics of IIR filters and different filter types (LPF, HPF, BPF, BSF). • Analyze analog filter approximations such as Butterworth and Chebyshev module-wisefilters. • Apply transformation techniques (impulse invariance and bilinear transformation) to design digital filters. • Design IIR digital filters from analog prototypes with numerical methods. • Evaluate the effect of poles and zeros on frequency response of IIR systems.	
	2.1	Types of IIR Filters (Low Pass, High Pass, Band Pass, Band Stop), Analog filter approximations: Butterworth, Chebyshev I.	

	2.2	Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters (Butterworth and Chebyshev-I) from Analog filters with numerical examples	
	2.3	Effect of Poles and Zeros on the Frequency Response of IIR filters.	
	Self-Learning Topics: Position of Poles and Zeros of Low Pass, High Pass, Band Pass, Band Stop, All Pass filters, Design of Notch filter and Resonator.		
3	**FIR Digital Filters**		**10**
	After completing this module, students will be able to: • Describe the characteristics and phase properties of FIR filters • Differentiate between minimum phase, maximum phase, mixed phase, and linear phase FIR filters. • Design FIR filters using window techniques (Rectangular, Hamming, Hanning, Blackman). • Apply frequency sampling techniques for FIR filter design. • Compare FIR and IIR filters in terms of stability, complexity, performance.		
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase (Type 1 to Type 4) FIR Filters.	
	3.2	Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, and Blackman), Design of FIR filters using Frequency Sampling technique, Comparison of IIR and FIR filters.	
	Self-Learning Topics: Practical Applications of IIR and FIR Digital Filters		
4	**Digital Filter Structures**		**06**
	After completing this module, students will be able to: • Explain various realization structures for FIR systems (cascade, frequency sampling, lattice). • Analyze realization structures for IIR systems (cascade, parallel, lattice ladder). • Implement digital filters using suitable structures for efficient computation. • Evaluate computational complexity of different filter structures.		
	4.1	Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure.	
	4.2	Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure.	
	Self-Learning Topics: Computational complexities for N^{th} order FIR filter		
5	**Finite Word Length Effects in Digital Filters**		**04**
	After completing this module, students will be able to: • Explain rounding, truncation, and quantization errors in digital systems. • Analyze the effect of finite word length on filter performance and output noise • Evaluate product quantization and noise models in IIR filter structures. • Assess the impact of numerical limitations on stability and accuracy of digital filters.		

	5.1	Rounding and truncation errors, Quantization error, Output noise power from a digital system	
	5.2	Product quantization, Noise model for direct form and cascaded IIR structure (first order)	
	Self-Learning Topics: Coefficient quantization error and zero input limit cycle		
6	**Applications of Discrete Time Signal Processing**		**05**
	After completing this module, students will be able to: • Explain the application of DTSP in biomedical signal analysis such as ECG and EEG. • Analyze DTSP techniques used in speech and audio processing systems. • Apply signal processing concepts in image processing and computer vision. • Evaluate the role of DTSP in modern communication systems such as 5G/6G. • Interpret real-world signal processing problem in healthcare and embedded system.		
	6.1	Application of DTSP for ECG, EEG signals analysis and echo cancellation	
	6.2	Application of DTSP in Speech and Audio AI systems, Computer Vision, and Image Processing,	
	6.3	5G/6G Wireless Communication, Health Care and Biomedical Signal Processing,	
	Self-Learning Topics Application of DTSP for Music and Audio Technology.		
		TOTAL	**45**

Suggested List of Tutorial Topics:

Tutorial No.	Topics
1	Discrete-Time Signals **Objective:** To understand and generate basic discrete-time signals such as unit impulse, step, ramp, exponential, and saw-tooth signals. **Outcome:** Students will be able to create and analyze different discrete-time signals and understand their characteristics in time domain.
2	Sinusoidal Signals and Frequency Response **Objective:** To generate sinusoidal signals and study their frequency response in terms of magnitude and phase. **Outcome:** Students will be able to interpret how sinusoidal signals behave in frequency domain and analyze system response.

3	Linear and Circular Convolution **Objective:** To implement linear and circular convolution and understand their differences for discrete-time signals. **Outcome:** Students will be able to perform convolution operations and distinguish between linear and circular convolution results.
4	Auto-correlation and Cross-correlation **Objective:** To compute auto-correlation and cross-correlation functions for discrete-time sequences. **Outcome:** Students will be able to analyze similarity, periodicity, and time delay between signals using correlation techniques.
5	Discrete Fourier Transform and Power Spectrum **Objective:** To compute the N-point DFT of a sequence and analyze its power density spectrum. **Outcome:** Students will be able to transform signals into frequency domain and interpret their spectral properties.
6	FFT (DIT-FFT) and Frequency Response **Objective:** To implement the Decimation-In-Time FFT algorithm and evaluate signal frequency response efficiently. **Outcome:** Students will be able to apply FFT for faster computation of DFT and analyze frequency characteristics of signals.
7	Inverse FFT and Signal Reconstruction **Objective:** To reconstruct time-domain signals using the inverse FFT and understand its relationship with DFT. **Outcome:** Students will be able to accurately recover original signals from frequency-domain representations using IFFT
8	IIR Butterworth Filter Design **Objective:** To design low-pass and high-pass Butterworth IIR filters and study the effect of filter order. **Outcome:** Students will be able to design smooth-response filters and analyze how order affects sharpness and performance.
9	IIR Chebyshev Filter Design **Objective:** To design Chebyshev IIR filters and compare their characteristics with Butterworth filters. **Outcome:** Students will be able to implement Chebyshev filters, analyse their equiripple passband behaviour, and draw meaningful comparisons with Butterworth filter performance in terms of selectivity and ripple.

10	FIR Filter Design using Windowing Technique **Objective:** To design FIR filters using rectangular, Hamming, and Kaiser windows and study their effects. **Outcome:** Students will be able to analyze how different windows influence frequency response and side-lobe behavior.
11	FIR Filter Design using Frequency Sampling Technique **Objective:** To design FIR filters using the frequency sampling method and evaluate their performance. **Outcome:** Students will be able to construct filters directly from frequency specifications and analyze their characteristics.
12	Minimum, Maximum, and Mixed Phase Systems **Objective:** To understand and identify minimum phase, maximum phase, and mixed phase systems. **Outcome:** Students will be able to classify systems based on pole-zero locations and analyze their stability and response
13	Symmetric and Anti-symmetric FIR Filters and Zero Locations **Objective:** To verify symmetry properties of FIR filters and determine zero locations. **Outcome:** Students will be able to relate symmetry to linear phase and analyze filter behavior using zero distribution.
14	IIR Filter Realization (Cascade and Parallel Forms) **Objective:** To realize IIR filters using cascade and parallel structures. **Outcome:** Students will be able to implement stable filter structures and understand their practical advantages.s)
15	Lattice Structures and Coefficient Quantization **Objective:** To obtain lattice parameters and study the effects of coefficient quantization. **Outcome:** Students will be able to analyze quantization errors and implement efficient lattice filter structures
16	Advanced DTSP Applications **Objective:** To apply DTSP techniques to real-world applications such as ECG processing, echo cancellation, speech/audio systems, computer vision, and image processing. **Outcome:** Students will be able to connect theoretical DTSP concepts to practical applications in healthcare, multimedia, and AI systems.

Text Books:

1. Proakis J., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education.
3. Emmanuel C. Ifeachor, Barrie W. Jervis, -Digital Signal Processing", A Practical Approach by, Pearson Education
4. Tarun Kumar Rawat, - Digital Signal Processing", Oxford University Press, 2015

Reference Books:

1. Sanjit K. Mitra, Digital Signal Processing - A Computer Based Approach - 4th Edition, McGraw Hill Education (India) Private Limited
2. B. Venkata Ramani and M. Bhaskar, -Digital Signal Processors, Architecture, Programming and Applications, Tata McGraw Hill, 2004.
3. L. R. Rabiner and B. Gold, -Theory and Applications of Digital Signal Processing, Prentice- Hall of India, 2006.5. M. M. Mano and M. D. Ciletti, Digital Design, 4th Ed., Pearson Education.
4. Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach",Wiley 2002
5. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011

Useful Links:

1. Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi
   http://www.nptelvideos.in/2012/12/digital-signal-processing.html
2. Digital Signal Processing By Prof. V. M. Gadre , IIT Bombay
   https://nptel.ac.in/courses/108/101/108101174/
3. Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur
   https://nptel.ac.in/courses/108/105/108105055/

Assessment Methodology:

Assessment Tools	Marks Distribution
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by Instructor) **OR** Any two Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Tutorial • MOOCs Certification (Approved by Instructor) • Open Book Test • Working model / Simulation of a course-based concept.

Mid Semester Examination (MSE) (30 Marks)	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
End Semester Examination (ESE) (50 Marks)	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 (02 hours) • Total Marks: 50
Term Work (25 Marks)	● Active Participation = 5 marks ● Tutorial Submission = 20 marks Tutorials should cover the entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	T	P	L	T	P	Total
		3	-	2	3	-	1	4
		Examination Scheme						
25ET4PCC02	Electromagnetics & Antennas	Theory	CA 1	CA 2	MSE	ESE		Total
			10	10	30	50		100
		Lab		TW	OR	PR		
			-	25	25	-		50

Pre-Requisite Courses:	25FE1BSC02- Applied Physics
	25FE1BSC01 -Fundamentals of Engineering Mathematics -I
	25FE2BSC01- Fundamentals of Engineering Mathematics-II

Course and Module Overview:

This course progresses from static field fundamentals through dynamic wave propagation, basic antenna theory, wire/loop antennas, arrays, to advanced antenna types, emphasizing practical concepts like radiation patterns, impedance, and self-learning extensions for antenna design applications. It builds analytical skills for EM theory and antenna engineering without heavy derivations, focusing on wireless systems. Thus the course systematically builds conceptual foundation for further courses such as wireless communications, radar, and sensor design.
Spanning over 6 modules with integrated self-learning topics, it emphasizes conceptual understanding over derivations, focusing on practical applications like impedance matching, radiation efficiency, and modern antenna deployments in 5G/IoT.

Module 1 Covers static Maxwell's equations, field potentials, current continuity, Laplace/ Poisson equations, and boundary conditions, establishing groundwork for electrostatic/ magnetostatic analysis with self-study on capacitor/inductor analysis.

Module 2 Explores dynamic Maxwell transformations, Helmholtz wave equation, propagation/ loss concepts (dielectrics, conductors, skin depth), Poynting theorem, TEM waves, and polarization, with self-study analyzing skin depth across materials/frequencies.

Module 3 Introduces radiation mechanisms, near/far fields, key parameters(patterns, directivity, gain, bandwidth, Friis formula), and efficiency metrics, extending to path loss analysis in self-study.

Module 4 Details dipole types (half-wave, monopole), loop antennas, their radiation/ impedance/ bandwidth comparisons, and polarizations, with self-study on folded dipole design for broadband applications.

Module 5 Focuses on linear/N-element arrays, pattern multiplication, and binomial synthesis, with self-study on grating lobe mitigation via element spacing.

Module 6 Examines broadband (Yagi, helical), frequency-independent (log periodic), reflector (parabolic, Cassegrain), patch/microstrip antennas, and reconfigurable/MIMO concepts, with self-study on modern wireless/IoT/5G antennas.

Course Outcomes	After successful completion of the course, the students will be able to	
	CO1	Student will be able to define and state fundamental concepts of static & time varying electric and magnetic fields, Maxwell's equations, computational methods, antenna parameters and antenna parameters. (Remembering)
	CO2	Student will be able to explain the significance and interrelationships of electromagnetic field concepts, computational methodologies, antenna operation mechanisms, and performance parameters of antennas. (Understanding)
	CO3	Student will be able to apply basic electromagnetic concepts and computational techniques to solve electromagnetic problems, to analyze antenna performance, and visualize field distributions and radiation patterns. (Applying)
	CO4	Student will be able to evaluate effects of antenna losses, impedance matching, and polarization on antenna performance. (Analyzing)
	CO5	Student will be able to compare antenna parameters of different antenna types. (Evaluating)
	CO6	Student will be able to design an antenna for given specifications. (Creating)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Fundamentals of Electromagnetic Theory**	07
		After completing this module, students will be able to: • Explain how static Maxwell's equations and describe boundary condition applications at dielectric/conductor interfaces. • Solve Laplace/Poisson equations for potential V	
	1.1	Review of 4 Maxwell's Equations for static conditions; Concepts of electric and magnetic fields – potential, potential gradient, drift velocity, current density and continuity of current.	
	1.2	Laplace & Poisson's equation, Electric and Magnetic Boundary Conditions.	
		Self-Learning Topics: Apply static Maxwell's equations and boundary conditions to solve capacitance/inductance of parallel-plate/coaxial structures using Laplace/Poisson equations incorporating concepts of current continuity and drift velocity for charge conservation analysis.	
2		**Time Varying Electromagnetic Fields**	07
		After completing this module, students will be able to: • Explain transformation from static to dynamic Maxwell's, interpret propagation constant, loss tangent role in classifying good dielectric versus good conductor, Poynting vector as power flow, TEM transverse fields, and polarization. • Identify good dielectrics/conductors from material parameters. • Analyze skin depth variation across frequencies for metals/ semiconductors/insulators	
	2.1	Transformation of Maxwell's Equations for dynamic fields. Generalized EM Wave Equations - Helmholtz equation. Concepts of propagation constant, loss tangent – leading to concept of good dielectric (No derivations), good conductor (No derivations), skin depth.	
	2.2	Poynting theorem, TEM waves (No derivations).	
	2.3	Polarization – linear, circular, and elliptical polarization (No derivations)	
		Self-Learning Topics: Analyze skin depth across a metal sheet, semiconductors, and insulators at frequencies at low, mid, and high frequencies using tables/plots	
3		**Basics of Antenna**	07
		After completing this module, students will be able to: • To define various basic parameters necessary to describe the performance of an antenna. • To apply and analyse FRISS transmission equation • Judge antenna suitability for applications based on their parametric performance.	

	3.1	Radiation mechanism, Near field and far field radiation	
	3.2	Radiation Pattern, Radiation Power Density, Radiation Intensity, Beam width and half power beam width, Thevenin's and Norton's Equivalent, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance, Antenna Radiation, Antenna Efficiency, Antenna Aperture, Antenna Temperature, Antenna Losses. FRII's transmission Formula.	
	3.3	Radiation integrals and auxiliary potential functions (no derivation)	
	Self-Learning Topics: Analysis of FRIIS transmission for different path loss scenario (free space and urban).		
4	**Linear Wire and Loop Antennas**		**06**
	After completing this module, students will be able to: • Define the dipole variants and to find the fields radiated by the element. • Explain far-field approximation (1/r decay). • Compare dipole types and analyze their radiation characteristics		
	4.1	Dipole, Comparison of types of dipole and Half-wavelength dipole, Monopole Antenna. Loop Antenna (no derivation)	
	4.2	Compare different dipole types and analyze their radiation characteristics. Comparison of loop antenna and dipole antenna polarisations.	
	Self-Learning Topics: Design a folded dipole and analyze its enhanced impedance bandwidth (300Ω input), radiation pattern similarity to half-wave dipole for TV/FM reception applications.		
5	**Antenna Arrays**		**08**
	After completing this module, students will be able to: • Understand the necessity to achieve high directivity. • Analyze the influence of arrays on the overall radiation characteristics.		
	5.1	Linear arrays of two isotropic point sources, linear arrays of N elements.	
	5.2	Principle of pattern multiplication.	
	Self-Learning Topics: Analyze grating lobes in antenna arrays and understand optimal spacing between antenna elements.		
6	**Types of Antennas**		**10**
	After completing this module, students will be able to: • Explain the working principle of various types of antennas. • Compare the characteristics of various antennas and mention its applications. • Design simple antenna configurations.		
	6.1	Working and design aspects of – Broadband Antennas: Yagi antenna, Helical antenna. Frequency Independent antennas: Log Periodic antenna	

	6.2	Reflector Antennas: Plane Reflectors, Corner Reflectors, Parabolic Reflector and Cassegrain reflector antenna.	
	6.3	Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch).	
	6..4	Introduction to reconfigurable antennas and MIMO antennas.	
	Self-Learning Topics: Explore types of antennas used in cellular mobile handsets, Bluetooth and WiFi applications, IOT applications and 5G networks.		
		TOTAL	**45**

Suggested List of Experiments:

Experiment No.	Title of Experiment/Task
1	To understand dBm (power relative to 1 mW) and dBuV (voltage relative to 1 μV in 50Ω). Analyze sample E-field data, compute beamwidths, and plot polar patterns. **Objective:** To develop practical skills in antenna and electromagnetic engineering students to generate practical skills in antenna measurement and analysis. **Outcome:** Upon successful completion of this experiment students will be able to explain the physical meaning of dBm and dBuV, calculate beamwidths from radiation pattern data normalize radiation patterns for comparison and process raw E-field measurement data.
2	To plot Laplace/Poisson's equation for given boundary conditions, plot potential gradient and continuity equation. **Objective:** To provide hands-on experience with the mathematical tools used in antenna field calculations **Outcome:** Upon successful completion of this experiment, students will be able to identify appropriate boundary conditions for real-world electromagnetic problems (e.g., fixed potential on conductors, zero normal derivative on symmetry planes)..
3	To evaluate transition from electrostatics to time-harmonic fields, extract $\gamma=\alpha+j\beta$, and relate it to material parameters. **Objective:** To empirically investigate the breakdown of the quasi-static approximation under time-varying excitation and to characterize electromagnetic wave propagation within a specific medium. **Outcome:** Upon successful completion of this experiment, students will be able to understand the physical threshold where electrostatic and magnetostatic approximations fail, recognizing the critical role of displacement current in Maxwell's equations and evaluate how the transition to time-harmonic fields is governed by the ratio of the physical dimensions of the system to the operating wavelength

4	To quantitatively analyze skin depth variation with frequency in metals, semiconductors, and insulators. **Objective:** To validate the mathematical relationship between the excitation frequency (f), intrinsic material properties (conductivity σ, permittivity ϵ, permeability (μ), and the resulting electromagnetic penetration depth. **Outcome:** After completing this experiment, students will make informed engineering choices for material selection in applications like EMI shielding and antenna substrates, based on frequency-dependent characteristics.
5	To visualize Poynting vector and polarization (linear, circular, elliptical) in time and space. **Objective:** To construct a robust physical and mathematical understanding of electromagnetic wave propagation, specifically focusing on energy flux and the spatial-temporal evolution of the electric field vector. **Outcome:** Upon successful completion of this experiment, student will be able to mathematically and computationally model the propagation of Transverse Electromagnetic (TEM) waves, manipulating the phase difference $\Delta\phi$ and amplitude ratio between orthogonal electric field components.
6	To utilize SCILAB/MATLAB/PYTHON to plot the electric potential functions in 3D, make appropriate measurements to decide on the type of the field and to compare them with valid conclusions. **Objective:** To correlate the mathematical form of the potential function with the physical characteristics of the electric field **Outcome:** Upon successful completion of this experiment, student will be able to generate 3D surface plots, contour plots, and quiver plots (for field vectors) to visualize the potential and field.
7	To measure and verify the power loss caused by misalignment between transmitting and receiving antennas. **Objective:** To empirically quantify the degradation of received Radio Frequency (RF) power resulting from spatial and angular misalignment between a transmitting (Tx) and receiving (Rx) antenna. This experiment aims to validate theoretical propagation models specifically the Friis Transmission Equation and the Polarization Loss Factor (PLF). **Outcome:** Upon successful completion of this experiment, student will be able to analyze the mathematical relationship between the rotation angle (cross-polarization) of the antennas and the resulting power attenuation
8	To evaluate and analyze the V, I, H, E changes in a half-wave dipole along varying frequency, with suitable plots. Comment on pattern changes if operated much lower or higher than optimal frequency, with plots (Compare with short, infinitesimal & half wave dipoles).

	Objective: To do a frequency dependent analysis of the half wave dipole antenna. **Outcome:** Upon successful completion of this experiment, student will be able to do a radiation pattern analysis above and below the optimal frequency of the dipole's resonant frequency.
9	To measure return loss, impedance bandwidth of a printed antenna using a vector network analyzer. **Objective:** To quantitatively characterize the impedance matching and frequency-domain performance of a printed antenna by measuring its input reflection coefficient (S_{11}) using a Vector Network Analyzer (VNA). Specifically, the experiment aims to extract the resonant frequency f_r, calculate the maximum return loss, and determine the operational impedance bandwidth defined by the -10 dB threshold (or VSWR ≤ 2). **Outcome:** Upon successful completion of this experiment, student will be able to measure and interpret the complex scattering parameter S_{11} (reflection coefficient, Γ) on both a logarithmic magnitude scale (dB) and a Smith Chart and accurately identify the resonant frequency fr of the printed antenna, recognizing it as the frequency point where the return loss is maximized (i.e., where S_{11} is at its minimum).
10	To compare the radiation pattern of the antenna under test and to measure its gain using the two-antenna method. **Objective:** To apply the Friis transmission formula with two identical (or known) antennas. Determine the power transfer ratio between antennas at a fixed distance to calculate absolute gain without requiring a reference standard. **Outcome:** Upon successful completion of this experiment, student will be able to characterize antenna that is directly applicable in industries such as telecommunications, radar, satellite systems, and IoT device development.
11	To analyze gain measurements at different antenna polarizations. **Objective:** To measure and compare the gain of a test antenna under different polarization configurations and to quantify the impact of polarization mismatch on received power **Outcome:** Upon successful completion of this experiment, student will be able to distinguish between actual antenna gain changes and apparent gain changes due to polarization mismatch.
12	To measure and compare radiation pattern of a Printed Microstrip Antenna with the radiation pattern of Printed Microstrip Array Antenna. **Objective:** To experimentally measure, analyze, and compare the far-field radiation characteristics of a single-element printed microstrip patch antenna with those of a printed microstrip antenna array.

	Outcome: Upon completing this experiment, students will accurately assess critical far-field parameters from radiation plots, including Main Lobe magnitude, HPBW, and First Null Beamwidth (FNBW) using antenna arrays' 2D and 3D patterns.
13	To design and simulate a half wavelength dipole antenna for given specifications. **Objective:** The primary objective of this experiment is to design, simulate, and analyze the performance characteristics of a half-wavelength dipole antenna for specified operational parameters (e.g., frequency, impedance, radiation pattern. **Outcome:** Upon completing this experiment, students will predict, analyze, and optimize antenna performance essential skills for electromagnetic engineers in wireless communications and radar systems.
14	To design and simulate a Microstrip Patch Antenna for given specifications. **Objective:** The primary objective of this experiment is to design, simulate, and analyze the performance characteristics of a microstrip patch antenna for specified operational parameters (e.g., frequency, impedance, radiation pattern.) **Outcome:** Upon completing this experiment, students will predict, analyze, and optimize antenna performance essential skills for electromagnetic engineers in wireless communications and radar systems.
15	To design and implementation of a Yagi-Uda Antenna for given specifications. **Objective:** The primary objective of this experiment is to design, simulate, and analyze the performance characteristics of a Yagi Uda antenna for specified operational parameters (e.g., frequency, impedance, radiation pattern.) **Outcome:** Upon completing this experiment, students will predict, analyze, and optimize antenna performance essential skills for electromagnetic engineers in wireless communications and radar systems.
16	To evaluate and plot pattern of antenna array using Scilab/ MATLAB/Python. **Objective:** To evaluate antenna arrays' radiation characteristics and synthesize their 2D and 3D patterns using numerical computing environments. **Outcome:** Upon successful completion of this experiment, student will be able to mathematically and computationally apply the Principle of Pattern Multiplication by multiplying the single-element radiation pattern with the Array Factor (AF) to determine the total array radiation pattern.

Reference Books:

1.	Principles of Electromagnetics Engineering- Matthew N. O. Sadiku, S. V. Kulkarni, Oxford University Press, 6th edition.
2.	Constantine A. Balanis, Antenna Theory Analysis And Design, John Wiley Publication.
3.	Fundamentals of Electromagnetics With MATLAB, Karl E. Lonngren, Sava V Savov, Randy Jost, Prentice Hall India, Second Edition.
4.	Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
5.	Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition
6.	Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition

Useful Links:

Useful Links for Theory:

http://videolectures.net/mit802s02_electricity_magnetism/
https://royalsocietypublishing.org/doi/pdf/10.1098/rstl.1865.0008
https://www.youtube.com/watch?v=ASoCV5s3etw
https://nptel.ac.in/courses/108106152
https://www.microwaves101.com/encyclopedias/antenna-design
https://www.microwaves101.com/encyclopedias/antenna-measurements
https://www.microwaves101.com/encyclopedias/phased-array-antennas

Useful Links for Laboratory:

https://www.mathworks.com/help/antenna/ug/modeling-wire-antenna-and-arrays.html
https://www.mathworks.com/help/antenna/dipole-antennas.html
https://www.mathworks.com/help/antenna/ref/dipolefolded.html
https://gvpress.com/journals/IJHIT/vol7_no6/32.pdf
https://www.mathworks.com/help/antenna/ug/modeling-wire-antenna-and-arrays.html
https://www.mathworks.com/help/antenna/dipole-antennas.html
https://www.mathworks.com/help/antenna/ref/dipolefolded.html
https://gvpress.com/journals/IJHIT/vol7_no6/32.pdf

Virtual Lab Links:

https://eem-iitd.vlabs.ac.in/exp7.html
https://www.ee.iitb.ac.in/course/~vel/
https://eem-iitd.vlabs.ac.in/exp8.html

Assessment Methodology:

Assessment Tools	Marks Distribution
Term Work (25 Marks)	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by Instructor) **OR** Any two Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Tutorial • MOOCs Certification (Approved by Instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Exam (MSE) (30 Marks)	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
End Semester Exam (ESE) (50 Marks)	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 on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (2 hrs) • Total Marks: 50
Oral (25 Marks)	Oral examination will be based on the entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ET4PCC03	Digital VLSI Design	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	-	25	50

Pre-Requisite Courses:	25FE1ESC02 Basic Electrical and Digital Electronics
	25FE2PCC01 Analog and Digital Circuits
	25ET3PCC03 Digital System Design using Verilog

Course and Module Overview:

This course provides a structured and in-depth introduction to **CMOS VLSI design**, covering the complete spectrum from **MOSFET device fundamentals to system-level and physical design considerations**. The course begins with a review of MOSFET operation, scaling, fabrication processes, and performance metrics, establishing the device-level foundation essential for VLSI circuit design. It then progresses to the **analysis, design, and layout of combinational CMOS logic circuits**, emphasizing power, delay, noise margins, and optimization techniques. Various **MOS logic styles** are studied to enable efficient realization of combinational and sequential circuits, highlighting timing constraints and design trade-offs.

It is especially relevant for **Electronics and Telecommunication (EXTC) students**, as modern communication systems—such as **5G/6G transceivers, IoT devices, baseband processors, and embedded communication hardware**—are predominantly implemented as **CMOS VLSI chips and SoCs**.

Module 1 Establishes the **device-level foundation** by reviewing MOSFET operation, scaling, fabrication processes, and performance metrics. This knowledge enables EXTC students to understand how device non-idealities and scaling affect high-speed and low-power communication circuits.

Module 2 Focuses on the **analysis, design, and layout of combinational CMOS logic**, emphasizing inverter-centric design, delay, noise margins, and power dissipation. These concepts are essential for implementing digital blocks used in communication signal processing.

Module 3 Introduces **MOS logic styles** and their application to combinational and sequential circuits, enabling students to evaluate design trade-offs in terms of speed, power, and robustness— critical for reliable communication hardware.

Module 4 Covers **semiconductor memory architectures**, providing insight into ROM, SRAM, DRAM, and Flash memories commonly used in buffers, registers, and storage elements in communication systems.

Module 5 Addresses **datapath and system-level design issues**, including adder architectures, clock distribution, and interconnect effects, which are crucial for timing closure in high-performance VLSI systems.

Module 6 Integrates all prior knowledge through an **RTL-to-GDS design flow using open-source**, allowing students to connect RTL design with physical implementation and verification.

Overall, the course equips EXTC students with silicon-level understanding, design capability, and industry-relevant exposure, forming a strong foundation for advanced VLSI courses, internships, and semiconductor careers.

Course Outcomes	**After successful completion of the course, the students will be able to**	
	CO1	Describe MOSFET operation, MOSFET characteristics, fabrication steps, and basic VLSI design terminology.
	CO2	Explain CMOS circuit operation, working of combinational and sequential circuits, different logic styles, memory architectures, and VLSI design flow.
	CO3	Establish relation between input parameters and performance parameters for various VLSI circuits and VLSI sub-systems.
	CO4	Analyze power, delay, timing, and scaling effects in VLSI circuits and systems.
	CO5	Evaluate design trade-offs at circuit and system levels for performance and reliability.
	CO6	Design and implement a basic digital system using an RTL-to-GDS flow with open-source tools.

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Review of MOSFET operation and Fabrication**	08
		After completing this module, students will be able to: • Describe MOSFET operating regions and fabrication steps. • Explain various steps in design, fabrication and testing of VLSI chips. • Explain MOSFET capacitances, scaling laws, and short-channel effects. • Apply lambda-based design rules in basic layout scenarios. • Analyze the impact of scaling on device performance metrics.	
	1.1	Overview of VLSI Design Flow, Review of MOSFET operation, MOSFET Capacitances, MOSFET scaling, Short channel effects	
	1.2	Fabrication process flow of NMOS, PMOS and CMOS, Lambda based design rules	
	1.3	Performance Metric for VLSI circuit, MOSFET SPICE models and simulation	
		Self-Learning Topics: Study Technology nodes evolution (180 nm → 7 nm): challenges and scaling limits.	
2		**Combinational CMOS Logic Circuits**	09
		After completing this module, students will be able to: • Explain CMOS inverter characteristics, noise margins, and power dissipation • Analyze delay and power trade-offs in NAND, NOR, and complex logic gates • Design CMOS combinational circuits using equivalent inverter approach • Evaluate the impact of fan-in and fan-out on circuit performance	
	2.1	CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins, Propagation Delay, Power Dissipation, Design of CMOS Inverter, Layout of CMOS Inverter	
	2.2	Realization of CMOS NAND gate, NOR gate, Analysis and design of NOR and NAND gates, Equivalent inverter approach, Complex CMOS Logic Circuits, Layout of CMOS NAND, NOR and complex CMOS circuits	
	2.3	Fan-in, fan-out and its impact on delay, Design for large Fan-in, Power consumption in CMOS logic gates, Design Techniques to reduce Switching Activity (Dynamic power)	
		Self-Learning Topics: Effect of fan-in and fan-out on CMOS gate performance.	
3		**MOS Design Logic Styles**	08
		After completing this module, students will be able to: • Differentiate between static, dynamic, and pass-transistor logic styles • Analyze timing constraints such as setup and hold times in sequential circuits	

	• Design latches, flip-flops, and functional blocks using appropriate logic styles • Evaluate logic styles for power, speed, and robustness		
	3.1	Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Issues in Dynamic Design, Domino Logic, NORA, Zipper	
	3.2	Setup time, Hold time, clocked CMOS SR Latch, CMOS JK Latch, MS – JK Flip Flop, Edge triggered D-Flip Flop and their realization using design styles, C^2MOS logic	
	3.3	Realization of Shift Register, MUX, Decoders using above design styles ,1-bit full adder, comparator, barrel shifter	
	Self-Learning Topics: Power–delay trade-offs in pass transistor and transmission gate logic		
4	**Semiconductor Memories**		**06**
	After completing this module, students will be able to: • Explain the organization and operation of ROM, SRAM, and DRAM • Analyze stability, leakage, and sensing issues in SRAM cells • Design basic memory arrays and interpret their layouts • Compare different non-volatile memory technologies		
	4.1	ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of ROM Array, SRAM	
	4.2	Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory	
	Self-Learning Topics: Leakage reduction techniques in SRAM		
5	**Datapath and System Design Issues**		**05**
	After completing this module, students will be able to: • Explain the architecture of adders and multipliers • Analyze performance trade-offs among different adder architectures • Evaluate clock distribution and interconnect scaling effects		
	5.1	Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder, Array Multiplier	
	5.2	On chip clock generation and distribution, Interconnect delay model, interconnect scaling and crosstalk	
	Self-Learning Topics: Case study of Datapath design in Microprocessors.		
6	**RTL to GDS using Open-Source Tools**		**09**
	After completing this module, students will be able to: • Explain the complete RTL-to-GDS design flow • Apply RTL coding and synthesis using open-source EDA tools • Analyze synthesis and physical design reports • Design a simple digital block from RTL to GDS		
	6.1	RTL-to-GDS Design Flow and RTL Development	

	6.2	Logic Synthesis and Technology Mapping	
	6.3	Physical Design – Floorplanning, Placement, CTS, and Routing	
	6.4	Physical Verification, GDS Generation, and Case Study	
	Self-Learning Topics: Best practices for synthesizable Verilog coding, RTL- based power optimization methods.		
		TOTAL	**45**

Suggested List of Experiments:

Experiment No.	Title of the Experiment
1	MOSFET Characteristics and Scaling **Objective:** To study the DC characteristics of NMOS and PMOS transistors and analyze the effect of channel length scaling on device performance. **Outcome:** Students will be able to interpret MOSFET operating regions, analyze I–V characteristics, and relate scaling effects to performance parameters such as current drive and speed.
2	CMOS Inverter Analysis **Objective:** To design and simulate a CMOS inverter and analyze its voltage transfer characteristics, noise margins, propagation delay, and power dissipation. **Outcome:** Students will be able to analyze the fundamental CMOS building block and evaluate inverter performance in terms of noise immunity, speed, and power.
3	CMOS Inverter Layout **Objective:** To draw the stick diagram and layout of a CMOS inverter using lambda-based design rules and perform design rule checking. **Outcome:** Students will be able to translate a schematic into layout, apply layout rules, and understand fabrication-aware VLSI design.
4	CMOS NAND and NOR Gate Design **Objective:** To design and simulate CMOS NAND and NOR gates and compare their delay and power characteristics. **Outcome:** Students will be able to design basic combinational CMOS logic gates and analyze performance trade-offs among different logic functions.
5	Complex CMOS Logic and Fan-In Effects

	Objective: To implement a complex Boolean function using CMOS logic and study the impact of fan-in and fan-out on propagation delay. **Outcome:** Students will be able to design complex CMOS logic circuits and evaluate the effect of loading and fan-in on circuit performance.
6	Sequential Circuit Design – CMOS D Flip-Flop **Objective:** To design and simulate a CMOS D flip-flop and determine setup time and hold time requirements. **Outcome:** Students will be able to analyze timing constraints in sequential circuits and understand clocked CMOS design principles.
7	Functional Block Design – Full Adder / Multiplexer **Objective:** To design and simulate a basic functional block such as a 1-bit full adder or multiplexer using CMOS logic. **Outcome:** Students will be able to implement arithmetic or data-selection circuits and analyze their functional correctness and performance.
8	Memory Cell Design – 6T SRAM **Objective:** To study the operation of a 6T SRAM cell and analyze read, write, and stability characteristics. **Outcome:** Students will be able to explain SRAM cell operation and evaluate key memory parameters such as read/write margins and leakage effects.
9	RTL Design and Logic Synthesis **Objective:** To develop synthesizable Verilog code for a simple digital block and perform logic synthesis to obtain a gate-level netlist. **Outcome:** Students will be able to write RTL code, perform logic synthesis, and interpret synthesis reports related to area and timing.
10	RTL-to-GDS Mini Project **Objective:** To implement an end-to-end RTL-to-GDS flow for a simple digital block using open-source VLSI tools. **Outcome:** Students will be able to integrate RTL design, synthesis, physical design, and verification steps, demonstrating a complete VLSI chip design flow.

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition.
3. Frank Vahid, "Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011

Reference Books:

1. Neil H. E. Weste, David Harris and Ayan Banerjee, —CMOS VLSI Design: A Circuits and Systems Perspective‖, Pearson Education, 3rd Edition.
2. John P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley, Student Edition, 2013.
3. R. Jacob Baker, "CMOS Circuit Design, Layout and Simulation", Wiley, 2nd Edition, 2013

Useful Links:

1. https://nptel.ac.in/courses/117/101/117101058/
2. https://nptel.ac.in/courses/108/107/108107129/

Link for virtual lab

1. http://www.vlsi-iitg.vlabs.ac.in

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) **(20 Marks)**	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 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.
Mid Semester Examination (MSE) **(30 Marks)**	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
End Semester Examination (ESE) **(50 Marks)**	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 (02 hours) • Total Marks: 50
Term Work **(25 Marks)**	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks • Based on the performance & satisfactory completion of minimum 8 experiments.
Practical & Oral (25 Marks)	Practical examination will be based on the experiments performed by the students during laboratory sessions.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	T	P	L	T	P	Total
		-	-	2*2	2	-	1	**2**
		Examination Scheme						
25ET4PCC04	**Microcontrollers and Applications**	**Theory**	**CA 1**	**CA 2**	**MSE**		**ESE**	**Total**
			-	-	-		-	-
		Lab	**CA**	**TW**	**OR**		**PR**	
			50	25	-		25	**100**

Pre-Requisite Courses:	25FE1ESC02 Basic Electrical and Digital Electronics
	25FE2PCC01 Analog and Digital Circuits
	25FE1VSEC01 Programming in C

Course Objectives:

1. To develop background knowledge and core expertise in microcontrollers.
2. To understand peripheral devices and their interfacing to microcontrollers.
3. To write programs for microcontrollers and their applications in Assembly and Embedded C Language.

Course Outcomes	After successful completion of the course, the students will be able to	
	CO1	Know basic features, architecture and pin configuration of 8051 and ARM7 microcontroller. (Remembering).
	CO2	Demonstrate understanding of memory organization, Instruction set, addressing modes, I/O ports, counter/ timer, Interrupts, UART of 8051 and ARM7 microcontroller. (Understanding)
	CO3	Apply knowledge of instruction set to write assembly language program for given logic. (Applying)
	CO4	Analyze input/output interface and demonstrate knowledge via simulation. (Analyzing)
	CO5	Evaluate the interfacing techniques and performance of peripheral devices such as LED, LCD, seven segment displays, keyboard, ADC/DAC (0808/0809), stepper motor, DC motor, relay, switches and IR sensors with 8051 microcontroller. (Evaluating)
	CO6	Design a micro controller-based embedded system for real-time applications. (Creating)

Syllabus:

Module No.	Unit No.	Topics	Hours
1	**Introduction to Microcontroller 8051**		05
	After completing this module, students will be able to: • Understand the basic components of microcomputers and differentiate between a microprocessor and a microcontroller. • Analyze and compare RISC and CISC architectures, as well as distinguish between Harvard and Von Neumann architectures. • Explain the architecture of the 8051 microcontroller, including its pin configuration, registers, and memory organization.		
	1.1	Introduction to the basic components of microcomputers, Comparison between Microprocessor and Microcontroller. Concept of RISC & CISC Architecture. Harvard & Von Neumann Architecture.	
	1.2	Introduction to Microcontroller 8051, Pin configuration, Processor Architecture, Registers of 8051, Memory Organization.	
	Self -Learning Topics: Classification of MCS-51family based on their features (8051, 8052, 8031, 8751, AT89C51).		
2	**8051 Instruction Set & Assembly Language Programming**		08
	After completing this module, students will be able to: • Understand the need of assemblers and compilers and explain various assembler directives. • Apply different addressing modes and instruction sets to develop assembly language programs for arithmetic and logical operations. • Write and analyze 8051 programs in C, including the use of data types and implementation of time delays.		
	2.1	Need of Assembler & Compiler, Assembler Directives.	
	2.2	Addressing modes, Instruction set	
	2.3	Assembly language Programs for Arithmetic and Logical operations.	
	2.4	8051 programming in C, data types and time delays in 8051 C.	
	Self-Learning Topics: Write more sample programs using instructions like ADD, MOV, ANL, ORL etc.		
	8051 Microcontroller I/O ports, Timer/Counters, Interrupts, Serial port & Programming		

<table>
<tr><td rowspan="6">3</td><td colspan="2">After completing this module, students will be able to:
• Understand the operation of 8051 I/O ports and perform I/O bit manipulation programming.
• Explain the working of 8051 timers/counters, timer modes, and develop programs using assembly language and embedded C.
• Analyze the interrupt structure, priority of interrupts, and implement serial communication using 8051 programming in assembly language and embedded C.</td><td rowspan="5">08</td></tr>
<tr><td>3.1</td><td>8051 I/O ports, I/O bit manipulation programming.</td></tr>
<tr><td>3.2</td><td>8051 Timer/Counter, Timer modes. Programming of timers in Assemble language and embedded C.</td></tr>
<tr><td>3.3</td><td>Interrupt structure, Priority of interrupts.</td></tr>
<tr><td>3.4</td><td>Serial Communication & Modes. 8051 serial port programming in assembly language & Embedded C.</td></tr>
<tr><td colspan="2">Self-Learning Topics: 8051 external hardware Interrupt Programming</td><td></td></tr>
<tr><td rowspan="5">4</td><td colspan="2">ARM 7</td><td rowspan="4">02</td></tr>
<tr><td colspan="2">After completing this module, students will be able to:
• Understand the features of ARM 7 and explain the concepts of Cortex-A, Cortex-R, and Cortex-M architectures.
• Explain the concept of pipelining and its role in improving processor performance.
• Describe the programmer’s model of ARM architecture, including registers and operating modes.</td></tr>
<tr><td>4.1</td><td>Introduction and Features of ARM 7, Concept of cortex A, cortex R and Cortex M.</td></tr>
<tr><td>4.2</td><td>Pipelining, Programmer's Model.</td></tr>
<tr><td colspan="2">Self-Learning Topics: Learn about Architectural Inheritance in ARM (Von- Neumann vs Harvard).</td><td></td></tr>
<tr><td rowspan="5">5</td><td colspan="2">ARM7 Programming</td><td rowspan="4">02</td></tr>
<tr><td colspan="2">After completing this module, students will be able to:
• Understand the ARM instruction set and apply it to develop basic programs.
• Analyze and implement data processing instructions in ARM programming.
• Explain and use data transfer and control flow instructions to design efficient ARM programs.</td></tr>
<tr><td>5.1</td><td>Instruction Set, Programming with ARM.</td></tr>
<tr><td>5.2</td><td>Data Processing, Data Transfer, Control flow.</td></tr>
<tr><td colspan="2">Self-Learning Topics: Write simple ARM assembly snippets for arithmetic and branching.</td><td></td></tr>
<tr><td rowspan="2">6</td><td colspan="2">8 bit microcontroller Interfacing Applications</td><td rowspan="2">05</td></tr>
<tr><td colspan="2">After completing this module, students will be able to:
• Understand the concept and components of embedded systems and identify factors for selecting a suitable microcontroller for a given application.</td></tr>
</table>

	• Explain the interfacing of basic devices such as LEDs, 7-segment displays, relays, and IR sensors with the 8051 microcontroller. Design and implement interfacing of actuators like stepper motors and DC motors using the 8051 microcontroller		
	6.1	Definition of Embedded System, Components of Embedded Systems, Factors to be Considered in Selecting a Microcontroller for an Application.	
	6.2	Interfacing LEDs, 7 segment Display, Relay, IR sensors, Stepper motor and DC motor with 8051 Microcontroller.	
	Self-Learning Topics: Analyze case studies of micro controller-based applica- tions in domains like automation, healthcare, or IoT.		
		TOTAL	**30**

Suggested List of Experiments:

Sr. No.	List of experiments
1	Program to perform 8-Bit Arithmetic operations using 8051 **Objective:** Students will be able to understand various arithmetic instructions of 8051 microcontroller. **Outcome:** Students will be able to Perform arithmetic operations to observe status of parity, carry and overflow flags
2	Program to study various addressing Modes of 8051 **Objective:** Students will be able to understand various addressing modes of 8051 microcontroller. **Outcome:** Students will be able to access data stored in various ways and use in the programming and differentiate among the various addressing modes
3	Program to perform block transfer of 10 data bytes in internal memory **Objective:** Students will be able to understand various data transfer instructions of 8051. Microcontroller. **Outcome:** Students will be able to perform block transfer within internal memory of 8051 using indirect addressing mode of 8051 microcontroller.
4	Program to perform exchange a block of 10 bytes from internal memory **Objective:** Students will be able to understand various data transfer instructions of 8051. microcontroller. **Outcome:** Students will be able to perform block exchange within internal memory of 8051 using indirect addressing mode of 8051 microcontroller.
5	Program to perform inverted block transfer and subsequently verify if it's a Palindrome or not. **Objective:** Students will be able to understand various data transfer instructions of 8051. microcontroller. **Outcome:** Students will be able to perform inverted block transfer and subsequently verify if it's a Palindrome or not using compare or subtraction.

6	Program to arrange set of 10 number stored in internal memory in ascending order and finding the highest value number **Objective:** Students will be able to understand sorting algorithms (such as Bubble Sort or Selection Sort) to arrange a dataset in ascending order **Outcome:** 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
7	Program to Interface LED's at Port 1 of 8051 Microcontroller **Objective:** Students will be able to understand Assembly instructions to toggle individual LEDs. **Outcome:** Students will be able to generate delay by means of the Rx registers and blink the LEDs connected to Port 1
8	Program for perform Serial Communication using UART1 **Objective:** Students will be able to understand concept of serial data transmission the string " via UART. **Outcome:** Students will be able to configure serial registers and timer-based baud rates to perform serail data transmission.
9	Program to utilize basic instruction set in ARM7 **Objective:** Students will be able to understand the ARM7 instruction set architecture and focusing on data processing, arithmetic, and logical operations. **Outcome:** Students will be able to write and execute assembly programs using Barrel Shifter, ALU, and comparison instructions to manipulate 32-bit data.
10	Program to perform data transfer using ARM7 **Objective:** Students will be able to understand the Load-Store architecture and memory addressing modes used in ARM7 for moving data between registers and memory. **Outcome:** Students will be able to implement single-register (LDR/STR) and multiple-register (LDM/STM) data transfer instructions to handle memory-based arrays and blocks

Suggested List of Task:

Task No.	Title of the Experiment
1	You are appointed as a junior embedded engineer in a product development team. Before development begins, you must set up and validate the toolchain. **Task Description** • Install and configure an IDE (Keil / EdSim51 / Tinkercad). • Create a sample embedded project and simulate execution. • Identify the role of assembler, linker, compiler, simulator, and emulator in product development.

2	Design a basic calculator unit for an embedded device. **Task Description** • Implement addition, subtraction, multiplication, and division using 8051 assembly. • Validate correctness for multiple input values.
3	Develop a logic block for multi-byte decimal addition used in energy meter billing. **Task Description** • Add multi-byte BCD numbers representing power consumption. • Handle carry properly and store the final bill value.
4	Simulate sensor data buffering and transfer inside an embedded system. **Task Description** • Exchange sensor data blocks within internal memory. • Transfer logged data from internal RAM to external memory.
5	Prepare sensor data for efficient digital transmission. **Task Description** • Convert binary sensor data to BCD or Gray code. • Verify correctness for different input values.
6	Design a system to prioritize alarms or sensor readings. **Task Description** • Sort sensor values in ascending or descending order. • Store the sorted result for decision-making.
7	Detect critical sensor limits in a monitoring system. **Task Description** • Identify highest and lowest sensor values from sampled data. • Trigger appropriate status flags.
8	Develop a test signal generator for embedded hardware validation. **Task Description** • Generate square or triangular waveforms using timers. • Control frequency and duty cycle through software.
9	Design a status indicator for an embedded product. **Task Description** • Blink LED using software delay. • Blink LED using timer interrupt and compare accuracy.
10	Design a numeric display module for a digital device. **Task Description** • Interface 7-segment display. • Display numerical values such as count, speed, or temperature.
11	Develop a text-based user interface for an embedded system. **Task Description** • Interface 16×2 LCD. • Display system messages, sensor values, and alerts.
12	Design a motor positioning system for automation. **Task Description** • Control stepper motor direction and step angle. • Implement precise 180° rotation.

13	Develop a device-to-computer communication system. **Task Description** • Configure UART • Transmit diagnostic or sensor data serially. Implement arithmetic logic for a high-performance embedded controller. • Perform arithmetic operations using ARM assembly. • Analyze register usage and execution efficiency.
14	Implement arithmetic logic for a high-performance embedded controller. **Task Description** • Perform arithmetic operations using ARM assembly. • Analyze register usage and execution efficiency.
15	Design and simulate a complete embedded solution for a real problem. **Task Description** • Choose an application (Traffic Light, Touchless Doorbell). • Develop block diagram, algorithm, program, and simulation.

Text Books:

1. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006.
2. C. Kenneth J. Ayala and D. V. Gadre, "The 8051 Microcontroller & Embedded system using assembly & 'C' ", Cengage Learning, Edition 2010.
3. Raj Kamal, "Microcontrollers" Architecture, Programming, Interfacing and System Design", Pearson Education India, Second Edition 2011.
4. N. Senthil Kumar, M. S. P. S. A. Kumar, "Microprocessor and Microcontroller", Oxford University Press, 2nd edition.
5. Scott MacKenzie and Raphael C.W. Phan, "The 8051 Microcontroller", Pearson Education International, 4th edition.
6. Steve Furber, "ARM System on chip Architecture", Pearson, 2nd edition.

Reference Books:

1. ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash datasheet, Atmel.
2. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand& Sons Inc., Edition 2014.
3. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier.
4. "MCS@51 Microcontroller, Family User's Manual" Intel.

Useful Links:

1. Microprocessors and Microcontrollers By Prof. Santanu Chattopadhyay (IIT Kharagpur) – https://swayam.gov.in/nd1_noc20_ee42/preview.
2. PLC and Microcontroller By Dr Ritula Thakur (NITTTR, Chandigarh) - https://on- linecourses.swayam2.ac.in/ntr25_ed25/preview

Assessment Methodology:

Assessment Tools	Marks Distribution
Continuous Assessment (CA) (50 Marks)	Certification: NPTEL (20 Marks) (Approved by Instructor) **OR** Any two Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Tutorial • MOOCs Certification (Approved by Instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Term Work (25 Marks)	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.
Practical & Oral (25 Marks)	Practical examination will be based on the experiments performed by the students during laboratory sessions.

2. Course Vertical 2 – Entrepreneurship Course: Total Credits: 2

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

Pre-Requisites Courses	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 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 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 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 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 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 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.

Summary

The course offers a comprehensive blend of theory, practical insights, and self-learning components to equip students with entrepreneurial knowledge and skills. It prepares learners to identify opportunities, develop business plans, and understand the challenges and support mechanisms for successful entrepreneurial ventures.

Course Outcomes	After successful completion of the course, the students will be able to:	
	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:

Module No.	Unit No.	Topics	Hours
1	**Foundations of Entrepreneurship Development**		05
	After completing this module, students will be able to: • Explain the concept and need for entrepreneurship development. • Identify the characteristics and qualities of successful entrepreneurs. • Describe the importance of entrepreneurship in economic growth.		
	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.	
	Self-Learning Topics: Case studies of entrepreneurs from small towns in India.		
2	**Theories of Entrepreneurship & External Influences on Entrepreneurship Development**		05
	After completing this module, students will be able to: • Explain major theories of entrepreneurship proposed by Schumpeter, McClelland, Eisenstein, Knight, and Hagen. • Examine the influence of sociocultural, political, economic, and personal factors on entrepreneurship development. • Assess the role of entrepreneurial culture in promoting entrepreneurial activities		
	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.	
	Self-Learning Topics: Factors affecting entrepreneurship development.		
3	**Types & Classification of Entrepreneurs**		05
	After completing this module, students will be able to: • Distinguish between different types of entrepreneurs including intrapreneurs, women entrepreneurs, and social entrepreneurs. • Analyze the challenges faced by women entrepreneurs and the role of Self-Help Groups (SHGs). • Explain the importance of social entrepreneurship and the role of NGOs in social responsibility.		
	3.1	Entrepreneur: Types & classification, concept & development of entrepreneurship.	
	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.	
	Self-Learning Topics: Entrepreneurial Development Program (EDP): concept & factors influencing EDP.		

4	**Review of Module 4: Entrepreneur Project Development & Business Idea**		**05**
	After completing this module, students will be able to: • Differentiate between innovation, invention, and creativity in the context of entrepreneurship. • Apply idea generation techniques and environmental scanning to identify business opportunities. • Explain the entrepreneurship development cycle and use SWOT analysis for project evaluation.		
	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.	
	Self-Learning Topics: SWOT analysis.		
5	**Review of Module 5: Business Plan**		**05**
	After completing this module, students will be able to: • Identify the elements and objectives of a business plan. • Analyze market and feasibility aspects of entrepreneurial ventures. • Evaluate marketing, financial, organizational, and ownership structures of business plans.		
	5.1	Elements of business plan, objectives of business plan.	
	5.2	Market analysis and feasibility analysis.	
	5.3	Marketing, Finance, Organization & Management, Ownership.	
	Self-Learning Topics: Case study on takeover, mergers and acquisitions of start- ups in India & global.		
6	**Review of Module 6: Venture Development**		**05**
	After completing this module, students will be able to: • Explain the steps involved in starting a venture and sources of finance. • Identify legal requirements and marketing channels for establishing a new business unit. • Analyze the impact of COVID-19 and government policy responses on MSMEs in India.		
	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.	
	Self-Learning Topics: Self Learning topics: Government financing support programme for businesses Covid 19, relief measures to small businesses in India (Atma Nirbhar Bharat Abhiyan).		
		TOTAL	**30**

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

Assessment Methodology:

Assessment Tools	Marks Distribution
Continuous Assessment (CA) **(50 Marks)**	• Certification NPTEL: 20 Marks (Approved by instructor) ***And / Or*** **Any 05 Pedagogies (10 marks each)** • Assignment • Case Study Analysis (individual / group) • Certification: Udemy / Coursera (Approved by instructor) • Class Test • Discussion & Reflective Learning • Idea Generation & Opportunity Identification • MCQ Test • Open Book Test • Project Report: Venture Development Plan • Simulation of a course based concept.

3. Course Vertical 3- Community Engagement Project (CEP): Total Credits: 1

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	P	T	L	P	T	Total
		-	2	-	-	1	-	1
		Examination Scheme						
25ET4CEP01	Community Engagement Project		CA	MSE	ESE	TW	OR	PR	Total
		Theory	-	-	-	-	-	-	-
		Lab	-	-	-	25	25	-	50

Pre-Requisites Courses	25FE1ESC02 Basic Electrical and Digital Electronics
	25FE2PCC01 Analog and Digital Circuits
	25ET3PCC02 Linear Integrated Circuits
	25ET3PCC04 Analog and Digital Communication
	25IL3VEC01 Sustainable Development
Course Overview	Community Engagement Project 2 is an experiential learning course that enables students to apply core engineering concepts to address real-world community and societal challenges. The course emphasizes stakeholder interaction, systematic problem identification, and alignment with Sustainable Development Goals (SDGs). Students design, implement, and test practical hardware- and/or software-based solutions with a focus on functionality, reliability, and feasibility. Emphasis is placed on system analysis, validation, documentation, teamwork, and ethical responsibility, promoting socially relevant and technically sound engineering solutions.

Learning Objectives

1. To enable students to identify real-world community or societal problems through interaction, surveys, or observation and translate them into feasible engineering problem statements.
2. To guide students in planning and developing engineering solutions using a structured problem- solving approach and appropriate programming and/or hardware platforms.
3. To provide hands-on experience in designing, developing, and testing functional systems using embedded systems, analog/digital circuits, communication, or signal processing techniques.
4. To develop students' ability to analyze system performance, troubleshoot implementation issues, and refine solutions based on testing outcomes and stakeholder feedback.
5. To enhance students' skills in technical documentation, presentation, teamwork, and ethical responsibility while addressing community needs.

Course Outcomes	After successful completion of the course, the students will be able to	
	CO1	**Identify and describe** community needs or societal problems aligned with relevant Sustainable Development Goals (SDGs) through direct interaction, observation, surveys, or engagement with stakeholders. (Knowledge)
	CO2	**Explain** the context, relevance, and constraints of identified community problems and interpret requirements for feasible engineering solutions. (Understanding)
	CO3	**Apply** appropriate programming techniques and/or hardware platforms to develop solutions addressing identified community needs. (Applying)
	CO4	**Analyze** system performance, implementation challenges, and field observations to assess suitability of the solution in a community setting.(Analyzing)
	CO5	**Evaluate** the effectiveness, reliability, and societal impact of the developed solution based on community feedback and predefined criteria. (Evaluating)
	CO6	**Design and implement** a functional hardware/software-based engineering solution that addresses a real community problem and contributes to relevant SDGs. (Creating)

Syllabus:

Module No.	Unit No.	Topics	Hours
1	**Introduction to Community Engagement Project**		05
	1.1	Introduction to community engagement, its relevance, and an overview of the United Nations Sustainable Development Goals (SDGs) in the context of engineering solutions, with emphasis on translating identified community problems into implementable engineering prototypes.	
	1.2	Identification of societal or environmental problems through guided brainstorming and preliminary exploration, mapped to one or more relevant SDGs	
	1.3	Selection of a feasible community-based project idea and preparation of a basic project plan outlining objectives and approach.	
2	**Problem Identification and Need Assessment**		05
	2.1	Interaction with community stakeholders to understand problem requirements, expectations, and practical considerations.	
	2.2	Mapping community needs to possible engineering solutions; formulation of a basic block diagram or flowchart for the proposed project; identification of potential risks or constraints affecting feasibility and sustainability.	
	2.3	Assessment of overall technical, economic, and operational feasibility, including identification of implementation constraints.	

3	**Project Planning and Solution Design**		**05**
	3.1	Task allocation among team members and planning of resources required for project execution.	
	3.2	Design of system architecture, circuits, algorithms, or software logic appropriate to the selected solution.	
	3.3	Preparation of design sketches, models, or simulations, where applicable, to support solution development.	
4	**System Implementation**		**05**
	4.1	Development, coding, and assembly of the proposed hardware and/or software system.	
	4.2	Functional testing, debugging, and troubleshooting of the implemented system.	
	4.3	Documentation of implementation observations, challenges faced, and refinements carried out.	
5	**Testing and Validation of Results**		**05**
	5.1	Testing of the developed system in a suitable real, controlled, or simulated environment.	
	5.2	Collection of feedback, observations, and performance data relevant to system objectives.	
	5.3	Analysis of results and identification of possible improvements, including assessment of societal impact and relevance to the selected SDGs.	
6	**Outcome Analysis and Reflection**		**05**
	6.1	Preparation of structured project documentation detailing problem definition, solution approach, implementation, and outcomes.	
	6.2	Presentation and demonstration of project outcomes as part of the evaluation process.	
	6.3	Reflection on learning achieved through the project, teamwork, and societal relevance of the developed solution.	
		TOTAL	**30**

Suggested Software tools:

1. **Arduino IDE** – *Embedded programming and rapid prototyping*
2. **Keil µVision** – Microcontroller programming, simulation, and debugging
3. **MPLAB X IDE** – Embedded system development for microcontroller-based applications
4. **Proteus Design Suite** – Simulation and validation of microcontroller-based systems
5. **MATLAB / Simulink** – Algorithm development, data analysis, modeling, and simulation
6. **PlatformIO** – Embedded system development with advanced debugging support
7. **Python (with relevant libraries)** – Data processing, interfacing, automation, and analysis
8. **LTspice / Multisim** – Analog and digital circuit design and simulation (as required)

NOTE: The listed tools are indicative and support embedded, circuit, and software-based community engagement projects; equivalent tools may be used as per project requirements. Any equivalent open-source or institutionally available tools may also be used.

Suggested Online References:

1. **All India Council for Technical Education (AICTE)** – Activity Points for Students and Community Service Guidelines https://www.aicte-india.org
2. **AICTE Internship Policy and Activity Points Programme** – Official policy document detailing student engagement and activity points https://internship.aicte-india.org
3. **IEEE Humanitarian Activities Committee (HAC)** – Resources for humanitarian technology projects and community-oriented engineering solutions https://cmte.ieee.org/r9-hac/hac-overview/
4. **IEEE SIGHT (Special Interest Group on Humanitarian Technology)** – Project toolkits, case studies, and best practices for community projects https://sight.ieee.org/resources/
5. **United Nations Sustainable Development Goals (SDGs) Portal** – Official UN platform describing the 17 SDGs and global targets https://sdgs.un.org/goals
6. **United Nations Sustainable Development** – Overview of sustainability initiatives and development frameworks https://www.un.org/sustainabledevelopment/
7. **United Nations Development Programme (UNDP) – SDGs Hub** – Implementation resources and SDG-aligned development practices https://www.undp.org/sustainable-development-goals
8. **National Service Scheme (NSS), Government of India** – Community engagement models and youth-led social initiatives https://nss.gov.in
9. **Engineering for Change (E4C)** – Practical engineering solutions, project examples, and tools for global and community challenges https://www.engineeringforchange.org
10. **MIT D-Lab** – Development through engineering projects focusing on community-driven and sustainable solutions https://d-lab.mit.edu
11. **Our World in Data – SDG Tracker** – Data-driven insights and indicators for monitoring Sustainable Development Goals https://ourworldindata.org/sdgs

Available Online Repository:

1. **Arduino Documentation & Project Hub** – Official documentation, tutorials, and community projects for embedded system development and rapid prototyping using Arduino platforms. https://docs.arduino.cc
2. **Microchip Developer Help & Code Examples** – Technical documentation, application notes, and example codes for 8051, PIC, and other Microchip microcontroller families. https://developerhelp.microchip.com
3. **STMicroelectronics Application Notes & Examples** – Reference designs, application notes, and firmware examples for STM32 microcontrollers, digital signal processing, and embedded communication systems. https://www.st.com
4. **Xilinx (AMD) FPGA Documentation & Learning Resources** – Design tools, tutorials, and reference projects for FPGA-based system design using Verilog/VHDL and high-level synthesis. https://www.xilinx.com/support.html
5. **Intel FPGA (Altera) Resources** – Documentation, design examples, and development tools for FPGA implementation and digital system design. https://www.intel.com/fpga

6. **NPTEL Online Courses and Labs** – Video lectures and virtual labs covering analog circuits, digital electronics, linear integrated circuits, signal processing, communication systems, and embedded systems. https://nptel.ac.in
7. **Electronics For You (EFY)** – Practical electronics articles, project ideas, and tutorials on analog/digital circuits, communication systems, and embedded applications. https://www.electronicsforu.com
8. **Circuit Digest** – DIY electronics projects, tutorials, and hardware–software interfacing examples using microcontrollers, sensors, and communication modules. https://circuitdigest.com
9. **All About Circuits** – Educational resources and discussions on analog circuits, digital logic, linear ICs, and signal processing fundamentals. https://www.allaboutcircuits.com
10. **Texas Instruments (TI) Analog & Linear IC Design Resources** – Datasheets, reference designs, and application notes for operational amplifiers, linear ICs, and analog signal processing. https://www.ti.com
11. **MathWorks File Exchange & Documentation** – Algorithms, examples, and simulation models for signal processing, control systems, and communication system analysis. https://www.mathworks.com/help
12. **GNU Radio** – Open-source software toolkit for implementing software-defined radio (SDR) and digital communication systems. https://www.gnuradio.org
13. **OpenCores** – Open-source hardware IP cores for digital design, FPGA implementation, and communication system components. https://opencores.org
14. **GitHub (Open-source Hardware and Software Projects)** – Repositories containing embedded systems, FPGA designs, signal processing codes, and hardware–software co-design projects. https://github.com

Note: The listed repositories support **microcontroller-based systems (Arduino, 8051, PIC)**, **FPGA- based design**, **analog and digital circuits**, **linear integrated circuits**, **signal processing**, and **communication systems**, enabling both **hardware implementation and software-based simulation or control**. Equivalent open-source or institutionally available repositories may also be used as per project requirements.

Course Guidelines

1. **Student Group Formation:** Students shall form groups consisting of exactly four (4) members, in accordance with AICTE guidelines for project-based learning. Groups with fewer or more than four students shall not be permitted.
2. **Alignment with Sustainable Development Goals (SDGs):** Each group shall identify at least one relevant United Nations Sustainable Development Goal (SDG) addressed by the project and clearly justify its alignment in the project report, in line with AICTE's emphasis on social relevance and sustainability.
3. **Problem Identification and Need Assessment:** Students shall identify a real-world problem relevant to industry or society/community through brainstorming, surveys, stakeholder interactions, or domain research. The identified problem shall be translated into a clear, well-defined, and feasible problem statement, in consultation with the assigned faculty mentor.
4. **Project Continuity and Approval:** Students may continue the project initiated in the previous semester or undertake a new project, subject to technical feasibility, relevance, and approval by the concerned faculty mentor, as per NBA's outcome-based curriculum flexibility.
5. **Implementation Planning**: Each group shall prepare a structured implementation plan, including project objectives, system block diagram or flowchart, required hardware/software resources, risk factors, and a tentative timeline. The plan shall be reviewed and approved by the faculty mentor to ensure systematic project execution.
6. **Design and Development:** The project shall involve design, simulation, development, testing, and assembly of a functional prototype or system using appropriate engineering tools and available laboratory facilities, supporting experiential learning and hands-on skill development as prescribed by AICTE.
7. **Project Monitoring and Documentation**: Students shall maintain a project logbook or progress record documenting weekly activities, observations, challenges faced, corrective actions taken, and learning outcomes. The faculty mentor shall periodically review and authenticate the logbook to ensure continuous monitoring.
8. **Testing, Validation, and Refinement:** Emphasis shall be given to troubleshooting, testing, validation, and refinement of the proposed solution through laboratory experiments and, wherever feasible, limited field testing or simulated deployment, aligning with NBA's focus on analytical and problem-solving skills.
9. **Project Report Preparation:** Students shall submit a comprehensive project report covering the problem statement, objectives, methodology, design approach, implementation details, results and analysis, limitations, societal impact, and relevance to identified SDGs.
10. **Assessment through Presentation and Demonstration:** Each group shall deliver periodic progress presentations and a final project demonstration before a faculty evaluation panel as part of continuous internal assessment.
11. **Student-Centric Learning:** While faculty mentors shall provide guidance and technical direction, the project shall be student-driven, promoting self-learning, teamwork, innovation, ethical responsibility, and lifelong learning skills as envisioned under Outcome-Based Education (OBE).

Assessment Methodology:

Assessment Tools	Marks Distribution
Term Work (25 Marks)	Active Participation and Team Involvement – 5 marks Project Report and Logbook / Progress Record – 10 marks Progress Presentations (minimum two) and Demonstration – 10 marks
Oral (25 Marks)	Oral examination shall be based on the design, implementation, working of the prototype, and project report with emphasis on understanding of the problem, solution approach, and societal relevance.

The Bombay Salesian Society's

Don Bosco Institute of Technology, Mumbai

(An Autonomous Institute Affiliated to the University of Mumbai)

CURRICULUM STRUCTURE

Multi-Disciplinary Minor (MDM) Courses

(As Per NEP 2020)

Scheme: DB25-V1

(w.e.f. AY 2025-2026)

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			
25CE4MDM01	Web Development	L	P	T	L	P	T	Total
		2	2	-	2	1	-	3
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	-	–	25
		Total	125						

Pre-Requisite Courses:	25FE1VESC02 - Problem Solving using C programming

Course and Module Overview:

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.

Further, the course introduces modern full-stack development using the **MERN stack (MongoDB, Express.js, React.js, Node.js)**. 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

Module 1: Introduces fundamentals of web development including HTTP, clients, servers, HTML, and CSS. Helps students understand webpage structure and styling

Module 2: Covers JavaScript, DOM, and event handling for adding interactivity. Enables dynamic content manipulation and basic form validation.

Module 3: Introduces MERN stack components and basics of Node.js and Express.Helps in understanding backend development and simple API creation.

Module 4: Focuses on React.js including components, props, state, and hooks. Enables development of reusable and interactive user interfaces.

Module 5: Covers MongoDB operations and Express.js backend development.Helps in building APIs and connecting applications with databases.

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	After successful completion of the course, the students 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.

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Web Development**	06
		After completing this module, students will be able to: • Describe basic web concepts including clients, servers, and communication protocols • Explain HTTP request-response cycle and working of web applications • Understand HTML structure and semantic elements for webpage design • Apply CSS for styling web pages using different selectors and properties • Analyze how web pages are structured and rendered in bro	
	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.	
	1.2	**CSS3:** Inline, embedded and external style sheets – Rule cascading,Syntax, Inclusion, Color, Background, Fonts, Tables, lists, CSS3 selectors.	
		Self -Learning Topics HTML5 Audio Video controls	
2		**Front End Development**	04
		After completing this module, students will be able to: • Describe basic concepts of JavaScript including variables, operators, and functions • Apply conditional statements and functions to solve simple problems • Explain the Document Object Model (DOM) and its role in web development • Implement form validation using regular expressions • Analyze and handle events to create interactive web pages	
	2.1	**Java Script:** 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.	
	2.2	Event Handling- Events, Fetch & Callbacks: Event Flow, Event Handlers/Listeners, The Event Object, Types of Events.	
		Self-Learning Topics: Date Object - Getting and setting date & time values	
		Introduction to MERN Stack	
		After completing this module, students will be able to: • Describe the components of the MERN stack and their roles	

3	• Install and set up Node.js and MongoDB environments • Explain the concept of npm and package management • Develop basic server-side programs using Node.js • Create simple APIs using Express and understand JSON data format		**05**
	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)	
	Self-Learning Topics: Understanding JSON Data Format		
4	**Web Programming using React JS**		**05**
	After completing this module, students will be able to: • Describe the fundamentals of React and its component-based architecture • Develop UI components using React elements and components • Explain and use state and props for dynamic data handling • Implement event handling and hooks in React applications • Display and manage lists of data in user interfaces		
	4.1	**React Framework:** 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.	
	Self-Learning Topics: Passing props between components		
5	**MongoDB-Database Operations and Express.js**		**05**
	After completing this module, students will be able to: • Describe NoSQL databases and their advantages over traditional databases • Perform CRUD operations using MongoDB • Connect MongoDB with Node.js applications • Develop backend services using Express framework and routing • Explain middleware and handle HTTP request–response objects		
	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	
	Self-Learning Topics: Difference Between SQL and NoSQL Databases		
6	**MERN Integration**		**05**
	After completing this module, students will be able to: • Explain the integration of frontend, backend, and database in MERN stack • Connect React applications with Express backend APIs • Perform basic CRUD operations using MongoDB • Fetch and display API data in React applications		

	• Develop a simple full-stack MERN application		
	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	
	Self-Learning Topics: Testing APIs in Postman		
		Total	**30**

Suggested List of Experiments

Sr. No.	List of experiments
1	Design a static web page using headings, paragraphs, lists, tables, images, and semantic elements. **Objective:** To identify and apply basic concepts of web technologies and use HTML elements to design a structured static web page. **Outcome:** 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. **Objective:** To understand how web pages collect user input and use HTML5 form elements to design interactive forms . **Outcome:** Students will be able to design forms that capture user data effectively and explain how form data is used in web applications.
3	Apply inline, internal, and external CSS for colors, fonts, layout, and basic responsiveness. **Objective:** To identify front-end styling techniques and apply CSS to improve layout, design, and responsiveness of web pages . **Outcome:** Students will be able to style web pages using different CSS methods and evaluate suitable styling approaches for better UI design.
4	Implement JavaScript programs using variables, operators, conditions, and functions. **Objective:** To understand scripting in web applications and implement JavaScript programs using basic programming constructs. **Outcome:** Students will be able to develop scripts that add dynamic behavior to web pages and explain how scripts interact with web content.
5	Implement mouse and keyboard events such as click, hover, and keypress on a web page. **Objective:** To analyze user interaction with web pages and implement event handling using JavaScript. **Outcome:**

	Students will be able to create interactive web applications by handling events and analyzing how user actions affect application behavior.
6	Validate user inputs using DOM manipulation and regular expressions. **Objective:** To evaluate input validation techniques and implement validation using DOM manipulation and regular expressions. **Outcome:** Students will be able to validate user inputs effectively and ensure data correctness in web applications.
7	Develop a basic server and implement GET and POST APIs using Express.js. **Objective:** To understand server-side components and APIs and develop a basic server using Express.js. **Outcome:** Students will be able to build server-side applications and explain how APIs handle client-server communication.
8	Perform Create and Read operations in MongoDB and connect the database with Node.js. **Objective:** To identify database concepts and perform Create and Read operations while connecting MongoDB with Node.js. **Outcome:** Students will be able to interact with databases, manage data, and analyze data flow between server and database.
9	Create a React application using components, props, state, and hooks to render data. **Objective:** To understand front-end frameworks and develop dynamic user interfaces using React components, props, state, and hooks . **Outcome:** 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. **Objective:** To design and integrate frontend, backend, and database components of a MERN stack application and analyze interaction between them. **Outcome:** Students will be able to develop a complete full-stack web application and evaluate the performance and integration of different MERN components.

Text Books:

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. Banks and E. Porcello, *Learning React: Modern Patterns for Developing React Apps*, 2nd edition, O'Reilly Media, 2020.

Reference Books:

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
4. JavaScript Programming with React, Node & MongoDB (Coursera Specialization): https://www.coursera.org/specializations/javascript-programming-with-react-node-mongodb

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) **(20 Marks)**	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 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.
Mid Semester Examination (MSE) **(30 Marks)**	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

End Semester Examination (ESE) **(50 Marks)**	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 (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25IT4MDM01	Data Structure and Algorithm	L	P	T	L	P	T	Total
		2	2	-	2	1	-	3
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	-	–	25
		Total	125						

Pre-Requisite Courses:	25FE1VESC02 - Problem Solving using C programming

Course and Module Overview:

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.

Module 1 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.

Module 2 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, 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 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: 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 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 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.

	After successful completion of the course, the students will be able to	
Course Outcomes	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.
	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 processin techniques (infix, postfix, evaluation) using suitable data structures.
	CO6	Design and develop solutions for real-life problems using data structures .

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Data Structures and Algorithms**	05
		After completing this module, students will be able to: • Explain the need for data structures and classify them into primitive and non-primitive types. • Distinguish between linear and non-linear data structures and their use cases. • Define Abstract Data Types (ADTs) and relate them to practical implementations. • Describe fundamental algorithm properties and common design techniques. • Analyze time and space complexity using asymptotic notations (Big-O, Ω, Θ). Compare algorithms based on efficiency and performance metrics.	
	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	
	1.3	Raspberry Pi: Architecture, pin functions, and applications	
		Self -Learning Topics: Comparative growth analysis of functions	
2		**Linear Data Structure – LISTS**	04
		After completing this module, students will be able to: • Describe Lists as an Abstract Data Type and explain their characteristics. • Implement array-based and linked list representations. • Differentiate between singly, doubly, and circular linked lists. • Perform fundamental operations such as insertion, deletion, traversal, merging, updating, and copying. • Analyze the performance of list operations in different implementations. • Apply linked lists to solve problems such as polynomial arithmet	
	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.	
		Self-Learning Topics: Reversing a singly linked list, Applications of linked lists Polynomial arithmetic.	
		Linear Data Structure – STACKS & QUEUES	
		After completing this module, students will be able to:	

3	• Implement stacks and queues using arrays and linked lists. • Apply stack operations to problems such as data reversal and expression conversion. • Explain Stacks and Queues as Abstract Data Types. • Describe different queue types including linear, circular, priority, and double-ended queues. • Implement expression evaluation techniques using stacks. • Analyze the efficiency of stack and queue operations in sequential data processing		**06**
	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.	
	Self-Learning Topics: Evaluation of postfix and prefix expressions, Double Ended Queue		
4	**Non-Linear Data Structure – TREES**		**05**
	After completing this module, students will be able to: • Differentiate between various tree structures and representations. • Define trees and explain basic tree terminologies. • Perform tree traversal techniques such as preorder, inorder, and postorder. • Implement binary trees and binary search trees. • Analyze the time complexity of tree operations. • Apply tree-based structures to solve hierarchical data problems.		
	4.1	Tree Terminologies, Tree as an ADT, Binary Tree - Operations, Tree Traversals, Binary Search Tree (BST) - Operations	
	Self-Learning Topics: AVL Tree, Applications		
5	**Non-Linear Data Structure – GRAPHS**		**03**
	After completing this module, students will be able to: • Explain graph concepts, terminologies, and applications. • Represent graphs using adjacency matrices and adjacency lists. • Implement graph traversal techniques such as Breadth First Search (BFS) and Depth First Search (DFS). • Apply graph algorithms to problems such as topological sorting. • Analyze the computational complexity of graph traversal algorithms. • Relate graph concepts to real-world applications such as networking and routing.		
	5.1	Graph Terminologies, Graph representation: adjacency matrix and list	
	5.2	Graph traversal: BFS, DFS with applications, Applications of Graphs	

		-Topological sorting.	
	Self-Learning Topics: Graph applications in networking		
6	**Searching, Sorting & Hashing**		**07**
	After completing this module, students will be able to: • Implement linear and binary search algorithms. • Compare searching techniques based on time complexity and applicability. • Implement basic sorting algorithms such as selection, insertion, and bubble sort. • Explain hashing concepts, hash functions, and collision resolution techniques. • Apply hashing methods such as chaining and open addressing. • Explore advanced sorting techniques like merge sort as a self-learning component.		
	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.	
	Self-Learning Topics: Merge Sort.		
		Total	**30**

Suggested List of Experiments (Minimum 8)

Sr. No.	List of experiments
1	Implementation of Insertion and deletion in a specific position in an Array using Function. **Objective:** To understand and implement insertion and deletion operations at specific positions in an array using functions. **Outcome:** Students will be able to perform and analyze array operations and understand their time complexity.
2	Implementation of recursive programs using functions. **Objective:** To understand recursion and implement basic recursive algorithms using functions. **Outcome:** Students will be able to design recursive solutions and compare them with iterative

	approaches.
3	Array Implementation of Stack **Objective:** To implement stack operations (push, pop, peek) using arrays. **Outcome:** Students will be able to use stack ADT and understand the LIFO principle in problem solving.
4	Array Implementation of Linear and Circular Queue. **Objective:** To implement creation and operations (insertion, deletion, traversal) on singly linked lists. **Outcome:** Students will be able to differentiate between linear and circular queues and apply FIFO principle efficiently.
5	**Objective:** To implement creation and operations (insertion, deletion, traversal) on singly linked lists. **Outcome:** Students will be able to dynamically manage data using linked list structures.
6	Implementation of Doubly Linked List **Objective:** To implement doubly linked lists and perform bidirectional traversal and operations. **Outcome:** Students will be able to efficiently perform operations using forward and backward links.
7	Implementation of Stack using Linked List **Objective:** To implement stack ADT using linked list representation. **Outcome:** Students will be able to overcome array limitations and implement dynamic stack operations.
8	Implementation of Binary Search Tree and Traversals **Objective:** To implement Binary Search Tree (BST) and perform traversal techniques (inorder, preorder, postorder). **Outcome:** Students will be able to organize hierarchical data and apply traversal methods.
9	Reversing a List using Stack **Objective:** To use stack for reversing elements of a list. **Outcome:** Students will be able to apply stack concepts in solving practical problems.
10	Infix to Postfix Conversion using Stack **Objective:** To convert infix expressions to postfix using stack ADT. **Outcome:**

	Students will be able to understand operator precedence and expression handling.
11	Evaluation of Postfix Expression using Stack **Objective:** To evaluate postfix expressions using stack operations. **Outcome:** Students will be able to implement expression evaluation algorithms.
12	Implementation of Deque using Linked List **Objective:** To implement a double-ended queue (deque) using linked lists. **Outcome:** Students will be able to perform insertion and deletion at both ends efficiently.

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)

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) **(20 Marks)**	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 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.

Mid Semester Examination (MSE) **(30 Marks)**	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
End Semester Examination (ESE) **(50 Marks)**	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 (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.

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

Pre-Requisite Courses:	25FE1VESC02 - Problem Solving using C programming

Course and Module Overview:

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 **Industry 4.0/5.0**, digitization (IoT, Blockchain, AI), and sustainability practices like green logistics.

Module 1: 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

Module 2: 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.

Module 3: 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.

Module 4: 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).

Module 5: 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.

Module 6: 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.

Course Outcomes	**After successful completion of the 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 technique. **(Applying)**
	CO4	Analyze various strategies and techniques to minimize overall logistics cost. **(Analyzing)**
	CO5	Evaluate 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
1		**Introduction to Logistics and SCM**	04
		After completing this module, students will be able to: • Distinguish between Logistics and Supply Chain Management (SCM) and explain their strategic importance in achieving a competitive advantage. • Analyze the Value Chain Process to identify activities that add value for the end customer.	
	1.1	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	
	1.2	Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of Stream lined SCM.	
	1.3	Supplier Selection, Supplier quality audits, Contract management, Non-Disclosure Agreement (NDA), Make & Buy Decision while in-out sourcing.	
		Self -Learning Topics: Global Logistics & Trade, Sustainable & Circular Supply Chains, Risk Management & Resilience.	
2		**Supply Chain Performance**	04
		After completing this module, students will be able to: • Identify and analyze the key financial and operational drivers of supply chain performance, such as facilities, inventory, and transportation. • Map supply chain processes using the SCOR (Supply Chain Operations.	
	2.1	Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influences designing Global Supply Chain Network.	
	2.2	Supplier performance measurement – (Delivery & Quality performance, schedule adherence, Goods receipt compliance etc), Supplier Capacity Analysis, Supplier Score card.	
		Self-Learning Topics: Supply Chain Risk Management **(**Risks involved in supply chain which includes – Supplier Financial Risk, Performance Risk, Compliance Risk, Country specific Risk, Cyber Security.	
3		**Inventory and Warehouse management**	06
		After completing this module, students will be able to: • Apply inventory classification techniques like ABC and VED analysis to prioritize management efforts and optimize resource allocation. • Solve deterministic inventory problems using Economic order Quantity (EOQ) and Reorder point (ROP) models to minimise total holding and ordering costs.	
	3.1	Inventory classification and control models (EOQ, JIT, VMI).	

	3.2	Warehouse layout, material handling and automation. Demand forecasting techniques for optimization.	
	Self-Learning Topics: Replenishment systems (Q and P system)		
4	**Supply chain analytics and digitalization**		**06**
	After completing this module, students will be able to: • Describe the role of Industry 4.0/5.0 technologies, such as IoT, Blockchain, and AI, in transforming digital supply chains.		
	4.1	Role of data analytics and AI in SCM	
	4.2	Digital supply chain transformation (IOT, Block chain, Industry 4.0 &5.0), TMS (Transport Management System), WMS (Warehouse Management System).	
	Self-Learning Topics: Application of Bar coding, Significance of SAP/RFID.		
5	**Logistics Management and outsourcing**		**07**
	After completing this module, students will be able to: • Compare different transportation modes based on cost, speed, and suitability for various product types. • 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	
	Self-Learning Topics: Beyond 4PL: The Rise of 5PL and Lead Logistics Providers (LLPs), Intermodalism and Synchromodality, Cold Chain & Specialized Logistics.		
6	**Supply Chain Network Design**		**03**
	After completing this module, students will be able to: • Formulate and solve mathematical models (like Linear Programming or the Transshipment model) to optimize distribution networks. • 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.	
	Self-Learning Topics: Supply chain- Lead Time, Takt Time, Minimum Order Quantity (MOQ), Manufacturing Critical Path Time (MCT)		
		Total	**30**

Suggested List of Experiments (Minimum 8)

Sr. No.	List of experiments
1	**Inventory Management: ABC and VED Analysis** **Objective:** To apply inventory classification techniques to prioritize items based on their value and criticality. **Outcomes:** Students will be able to categorize items into A, B, and C classes based on annual usage value. Perform VED (Vital, Essential, Desirable) analysis based on functional criticality.
2	**Deterministic Inventory Modeling (EOQ & ROL)** **Objective:** To calculate optimal order quantities and timing to minimize total inventory costs. **Outcomes:** Students will be able to calculate the Economic Order Quantity (EOQ) for a manufacturing firm case study determine the Reorder Level (ROL) by considering lead time and buffer stock.
3	**Supply Chain Network Design & Optimization** **Objective:** To apply mathematical models for designing an efficient distribution network. **Outcomes:** Students will be able to Apply Transportation or Transshipment Problem models to a scenario. Use software (such as Excel Solver) to minimize shipping costs from factories to distribution centers while meeting demand and capacity constraints.
4	**Bullwhip Effect Simulation (The Beer Game)** **Objective:** To understand demand fluctuations, information distortion, and the "Bullwhip Effect" within a multi-stage supply chain. **Outcomes:** Students will be able to Track inventory and backorders through a four-stage role-playing simulation (Retailer, Wholesaler, Distributor, and Manufacturer). Identify causes of demand amplification and suggest reduction strategies like streamlined SCM or improved information sharing.
5	**Supply Chain Performance Benchmarking (SCOR Model)** **Objective:** To measure and analyze supply chain performance using standardized metrics. **Outcomes:** Students will be able to Analyze a case study using the SCOR framework across dimensions like Reliability, Responsiveness, and Agility. Develop a Supplier Scorecard to evaluate vendors based on delivery, quality, and compliance.

6	**Digitization and Sustainability Assessment** **Objective:** To evaluate the role of Information Technology and Green SCM in modern logistics. **Outcomes:** Students will be able to Analyze the application of RFID, Barcoding, or WMS in a warehouse environment. Calculate a Sustainability Index or CO2 emission impact for specific logistics routes
7	**The Bullwhip Effect: Information Distortion at P&G or "SmartTech"** **Objective:** To understand demand fluctuations, information distortion, and the "Bullwhip Effect" in a multi-stage supply chain. **Outcomes:** Students will be able to Identify the causes of demand amplification throughout the supply chain. Suggest reduction strategies, such as streamlined Supply Chain Management (SCM) or improved information sharing.
8	**Outsourcing Strategy: 3PL vs. 4PL Transition for Unilever or PUMA** **Objective:** To assess the benefits and risks of outsourcing to Third-Party Logistics (3PL) and Fourth-Party Logistics (4PL) providers for logistics activities. **Outcomes:** Students will be able to Analyze various strategies and techniques to minimize overall logistics costs. Evaluate the evolution of logistics management from 3PL to 4PL and beyond (such as 5PL or Lead Logistics Providers).
9	**Supply Chain Risk Management: The Ericsson/Philips Semiconductor Fire** **Objective:** To identify and analyze the key financial and operational risks involved in a supply chain, including supplier performance and compliance risks. **Outcomes:** Students will be able to Explain the impact of supply chain risks on overall performance and resilience. Identify specific risk categories such as supplier financial risk, performance risk, and country- specific risk.

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
2. https://onlinecourses.swayam2.ac.in/cec22_mg22/preview

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) **(20 Marks)**	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 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.
Mid Semester Examination (MSE) **(30 Marks)**	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

End Semester Examination (ESE) **(50 Marks)**	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 (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.

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

Pre-Requisite Courses:	25FE1VESC02 - Problem Solving using C programming
	Engineering Graphics

Course and Module 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: CAD Fundamentals
Introduces foundational CAD concepts including parametric modeling, file formats (STEP/IGES/BRep), and CSG/BRep representation methods for creating 3D geometry.

Module 2: Core AM Processes - FDM & SLA
Covers filament deposition and resin-based additive manufacturing processes with comparative analysis of material properties, applications, and process parameters for rapid prototyping.

Module 3: Advanced AM Processes
Explores powder bed fusion (SLS), binder jetting, and hybrid metal additive manufacturing techniques for complex multi-material prototypes.

Module 4: STL File Generation & Terminologies
Focuses on STL mesh generation, file format standards, mesh quality metrics, validation, and repair workflows for print-ready model preparation

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

Module 6: CAD with Reverse Engineering
Combines practical 3D printing, prototype assembly, dimensional assessment, and reverse engineering using 3D scanning for iterative design improvement.

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

Course Outcomes	CO1	Define CAD file formats, CSG/BRep modeling approaches, and parametric modeling terminology. (**Remembering**)
	CO2	Explain G-code and M-code execution workflow in 3D printer firmware and slicer parameter interpretation. (**Understanding**)
	CO3	Create 3D models from sketches and generate valid STL files with proper mesh validation (**Applying**)
	CO4	Compare and select FDM vs SLA processes based on prototyping requirements, material properties, and applications. (**Analyzing**)
	CO5	Assess advanced AM process suitability (SLS/Binder Jetting/Material Jetting) for complex prototype requirements (**Evaluating**)
	CO6	Design and integrate complete digital manufacturing workflows by combining CAD modeling, additive manufacturing, and reverse engineering concepts for intelligent prototype optimization (**Creating**)

Syllabus:

Module No.	Unit No.	Topics	Hours
1	**CAD Fundamentals**		05
	After completing this module, students will be able to: • Define parametric and geometric modeling techniques in CAD. • Explain the role and integration of CAD/CAM in the product life cycle.		
	1.1	Introduction to CAD: CAD/CAM In product life cycle, CAD/CAM integration and file formats.	
	1.2	Geometric Modeling Techniques: 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	
	Self -Learning Topics: Comparison and Applications of Geometric Modeling Techniques		
2	**Core AM Processes - FDM & SLA**		06
	After completing this module, students will be able to: • Define AM and its classification • Explain SLA and FDM Processes in AM • Apply SLA and FDM Processes as per application		
	2.1	AM Processes Classification: SLA Process Fundamentals History of AM, classification, and materials. SLA Process Overview, Advantages, Disadvantages, Applications	
	2.2	FDM Process Fundamentals: FDM Process Overview, Advantages, Disadvantages, Applications.	
	Self-Learning Topics: Comparative Study of SLA and FDM in Terms of Working Principle, Applications, Advantages, and Limitations		
3	**Advanced AM Processes**		06
	After completing this module, students will be able to: • Explain SLS, Binder Jetting, DMLS/SLM Processes in AM • Apply SLS, Binder Jetting, DMLS/SLM Processes for prototyping • Analyze Process Selection Matrix for complex prototyp		
	3.1	SLS Process Fundamentals SLS Process Overview, Advantages, Disadvantages, Applications	
	3.2	Binder Jetting, DMLS and SLM: Process Overview, Advantages, Disadvantages, Applications. Process Selection Matrix: Material properties, resolution, strength, cost analysis for complex prototypes	

	Self-Learning Topics: Comparative Study of SLS, Binder Jetting, DMLS/SLM in Terms of Working Principle, Applications, Advantages, and Limitations		
4	**STL File Generation & Terminologies**		**05**
	After completing this module, students will be able to: • Apply STL generation techniques for prototyping • Analyze STL File for different product requirements • Evaluate STL Mesh for efficiency and suitability • Validate mesh using Cura Slicer		
	4.1	STL File Format Basics: Triangle mesh representation, ASCII vs Binary formats, file structure. Mesh Terminologies, Facets, vertex normals, triangulation, watertight condition, manifold meshes, and Mesh Quality Metrics	
	4.2	Hands-on Practice: Export STL from CAD (Solidworks), validate mesh using Cura Slicer, repair tools	
	Self-Learning Topics: Understanding STL File Generation and Its Role in Rapid Prototyping Workflows		
5	**G-code & M-code Fundamentals**		**04**
	After completing this module, students will be able to: • Analyze Slicer Parameters for process optimization • Evaluate Process parameters for cost and time effectiveness		
	5.1	G-code and M-code Basics: Movement commands (G0 rapid move, G1 linear interpolation), coordinate systems (XYZ) and essential G-codes & M-codes with extrusion control, M104/M109 (hot end temperature), M140/M190 (bed temperature), M106/M107 (cooling fan)	
	5.2	Slicer Parameters in G-code: Layer height, print speed, extrusion width, flow rate, retraction settings, Firmware Interpretation, Marlin, Repetier firmware execution	
	Self-Learning Topics: Understanding. G-code file format used by 3D printer to print prototype		
6	**CAD with Reverse Engineering**		**04**
	After completing this module, students will be able to: • Analyze reverse engineering workflows for accuracy and efficiency • Evaluate reverse engineering for cost and time savings • Design a complete reverse engineering workflow for a product		
	6.1	Reverse Engineering: Reverse Engineering: Noncontact surface scanning, point cloud data processing, and CAD model development	
	6.2	Project Planning:	

		Prototype design, part decomposition, printing strategy, assembly workflow, Hands-on Projects, e.g., Phone stand, sensor housing, drone parts, custom enclosures for IT projects	
	Self-Learning Topics: Case study with Step-by-Step Workflow for Developing CAD Models from Non-Contact Scanning		
		Total	**30**

Suggested List of Experiments

Sr. No.	List of experiments
1	2D Sketching & Parametric Constraints **Objective:** To understand basic sketching tools and apply geometric & dimensional constraints for parametric design. **Outcome:** Learner will be able to create fully constrained 2D sketches and modify dimensions parametrically.
2	Complex 2D Profiles for Extrusion **Objective:** To develop complex multi-contour sketches and prepare them for manufacturing/export. **Outcome:** Learner will be able to design complex profiles and export them for fabrication (DXF).
3	Basic 3D Features - Extrude & Revolve **Objective:** To introduce basic 3D modelling operations and feature creation. **Outcome:** Learner will be able to generate 3D components using standard features and understand feature tree.
4	Boolean Operations & Pattern Features **Objective:** To apply Boolean operations and pattern features in product design. **Outcome:** Learner will be able to create repetitive features and modify models using Boolean operations.
5	Simple Assembly - Phone Stand Components **Objective:** To understand assembly constraints and simulate basic motion. **Outcome:** Learner will be able to assemble parts, apply mates, and perform motion/interference analysis.
6	Multi-Part IoT Enclosure Assembly **Objective:**

	To learn multi-part assembly design with tolerance considerations. **Outcome:** Learner will be able to can create assemblies with proper fit and generate BOM.
7	STL Export & Basic Slicing **Objective:** To understand file conversion and basic 3D printing preparation. **Outcome:** Learner will be able to export models and configure basic slicing parameters.
8	Advanced Slicer Optimization **Objective:** To optimize printing parameters for quality, strength, and time. **Outcome:** Learner will be able to evaluate and optimize slicer settings for different requirements.
9	First Print - Quality Control **Objective:** To evaluate printed parts for dimensional and surface quality. **Outcome:** Learner will be able to measure, analyze, and improve print quality.
10	Multi-Part Assembly Printing **Objective:** To validate assembly fit through real printed components. **Outcome:** Learner will be able to analyze assembly issues and improve design tolerances.
11	IoT Enclosure Project **Objective:** To integrate mechanical design with electronics components. **Outcome:** Learner will be able to design functional enclosures and validate real-world applications.
12	Reverse Engineering Project **Objective:** To understand reverse engineering and product improvement cycle. **Outcome:** Learner will be able to recreate and improve existing products using CAD tools.

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

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) **(20 Marks)**	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 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.
Mid Semester Examination (MSE) **(30 Marks)**	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

End Semester Examination (ESE) **(50 Marks)**	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 (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.

The Bombay Salesian Society's

Don Bosco Institute of Technology, Mumbai

(An Autonomous Institute Affiliated to the University of Mumbai)

CURRICULUM STRUCTURE

LIBERAL LEARNING COURSES (LLC)

(As Per NEP 2020)

Scheme: DB25-V1

(w.e.f. AY 2025-2026)

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 (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LL C01	Rhythm & Motion: A Journey Through Dance	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LL C01	Rhythm & Motion: A Journey Through Dance	30	5	10	5	50	1

Course Overview:

- 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	After successful completion of the course, the students will be able to	
	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:

Module No.	Unit No.	Topics	Hours
1	**Foundations of Dance and Body Awareness**		02
	1.1	Understanding the role of dance in culture Importance of body posture, balance, and rhythm Warm-up techniques and movement preparation.	
2	**Introduction to Indian and Contemporary Dance Forms**		02
	2.1	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.	
3	**Peer Group Formation and Planning for Choreography**		02
	3.1	Formation of student groups Selection of dance form(s) for performance Setting group goals and distributing roles (lead, scribe, music, etc.).	
4	**Choreography, Practice & Feedback**		12
	4.1	Step-by-step choreography building through peer learning Weekly practice and feedback loops Focus on synchronization, formations, and transitions.	
5	**Layouts & Composition**		08
	5.1	Integration of expression (bhava), facial movements, and stage presence Full performance rehearsals Guidance and critiques from teacher-in- charge and peers.	
6	**Final Performance and Reflective Practice**		04
	6.1	Group performances (3–5 minutes per group) Reflective presentations on the learning journey and group collaboration Submission of group logbooks and performance details.	
		Total	**30**

Suggested Activities for Rhythm & Motion: A Journey Through Dance Course:

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
6. Depict social messages: education, freedom, equality**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 (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LL C02	Introduction to Dramatics: Exploring Theatre Arts	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LL C02	Introduction to Dramatics: Exploring Theatre Arts	30	5	10	5	50	1

Course Overview:

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

Course Outcomes	After successful completion of the course, the students will be able to	
	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:

Module No.	Unit No.	Topics	Hours
1	**Stagecraft and Self- Awareness**		02
	1.1	Theatre basics, warm-ups, body/voice awareness.	
2	**Acting Essentials and Theatre Forms**		04
	2.1	Voice projection, improvisation, intro to theatre styles.	
3	**Script to Stage: Forming Dramatic Teams**		02
	3.1	Peer group formation, script selection/creation.	
4	**Rehearse, Reflect, Repeat**		12
	4.1	Blocking, dialogues, emotions, peer feedback.	
5	**Character, Costume, and Confidence**		06
	5.1	Character work, stage elements, rehearsal polishing.	
6	**Curtains Up: Performance and Reflection**		04
	6.1	Final performance + reflective presentations.	
		Total	**30**

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 (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC03	Swaranjali: Introduction to Vocal Music (Singing)	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LLC03	Swaranjali: Introduction to Vocal Music (Singing)	30	5	10	5	50	1

Course Overview:

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

Course Outcomes	After successful completion of the course, the students will be able to	
	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.
	CO4	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:

Module No.	Unit No.	Topics	Hours
1	**Basics of Indian Vocal Music**		02
	1.1	Sound, pitch (swar), rhythm (taal), laya, introduction to saptak (scale), shruti, swaras.	
2	**Voice Culture & Alankars**		04
	2.1	Breathing, pitch practice, alankars (note patterns), vocal warm-ups, intro to raag-based practice.	
3	**Raag & Taal Practice**		02
	3.1	Simple raags like Bhupali/Yaman, Teen Taal, Dadra; clapping cycles, rhythm coordination.	
4	**Song Practice in Peer Groups**		12
	4.1	Group division; learning bhajans, folk songs, patriotic songs, or classical compositions.	
5	**Expression, Bhava & Presentation Skills**		06
	5.1	Understanding meaning, emotion (bhava), and improving stage confidence, posture, and projection.	
6	**Group Performance & Reflection**		04
	6.1	Final group performance (3–5 min); sharing experiences; submission of logbooks/journals.	
		Total	**30**

Suggested Activities for Swaranjali: Introduction to Vocal Music (Singing) Course:

- "Raag Rang: Colors of Melody": A performance based on a single or combination of simple raags (e.g., Bhupali, Yaman), showcasing how mood and emotion can be conveyed through melody.
- "Voices of Unity": Group performance using patriotic or unity-based songs (e.g., Vande Mataram, Desh Mera Rangeela) to represent harmony and national spirit.
- "Bhakti & Bhava": Present devotional or bhajan-based compositions that emphasize expression (bhava), simplicity, and spiritual connection.
- "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.
- "Seasons in Song": A musical expression of seasons (spring, monsoon, winter) through selected compositions or original adaptations, using changes in tempo and pitch to reflect mood.
- "Swar Se Shanti" (Peace Through Voice): Soothing compositions or raag-based presentations that focus on calmness, wellness, and introspection—ideal for a soft, expressive performance.
- "Story Through Song": A mini musical narrative told through 2–3 linked compositions expressing a journey or message (e.g., struggle to peace, darkness to light).

Course Code	Course Name	Teaching Scheme (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC04	Strings & Strokes: An Introduction to Musical Instruments	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LLC04	Strings & Strokes: An Introduction to Musical Instruments	30	5	10	5	50	1

Course Overview:

- 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, a 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	After successful completion of the course, the 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.

Syllabus:

Module No.	Unit No.	Topics	Hours
1	**Musical Foundations: Sound, Rhythm & Melody**		02
	1.1	Introduction to sound, rhythm, pitch; clapping exercises, ear training.	
2	**Instrument Basics: Form, Function & Playing Technique**		04
	2.1	Introduction to Instruments: tabla, djembe, harmonium, keyboard, flute, ukulele, etc. (Instruments will vary based on student's choice) .	
3	**Group Formation & Instrument Selection**		02
	3.1	Peer grouping, instrument choice, practice plan.	
4	**Practice, Play & Peer Learning**		12
	4.1	Guided group practice, simple compositions, internal peer reviews.	
5	**Building an Ensemble: Sound & Synchrony**		06
	5.1	Coordination of parts, ensemble play, polishing performance.	
6	**The Final Note: Performance & Reflection**		04
	6.1	Final group performance, presentation, peer feedback.	
		Total	**30**

Suggested Activities for Swaranjali: Introduction to Vocal Music (Singing) Course:

- "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.

Course Code	Course Name	Teaching Scheme (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC05	Traditional Rangolis of India	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LLC05	Traditional Rangolis of India	30	5	10	5	50	1

Course Overview:

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

Course Outcomes	After successful completion of the course, the students will be able to	
	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:

Module No.	Unit No.	Topics	Hours
1	**Introduction to Kolams**		04
	1.1	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 Margasheers.	
2	**Dot-Based Kolams**		06
	2.1	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.	
3	**Sikku Kolam (Twisted Loops)**		06
	3.1	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.	
4	**Kambi Kolam (Line Patterns)**		04
	4.1	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.	
5	**Flower Rangoli and Thematic Designs**		03
	5.1	Basic Rangoli patterns with flowers, Rangoli with themes, Rangoli during festivals, Creation of theme- based Rangoli design.	
6	**Kolams and Society**		03
	6.1	Community Kolams, Kolams during marriages, Kolams during Margasheersha month, Social and cultural relevance of Rangolis.	
		Total	**30**

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 (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC06	Foundations of Photography	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LLC06	Foundations of Photography	30	5	10	5	50	1

Course Overview:

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

Course Outcomes	After successful completion of the course, the students will be able to	
	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:

Module No.	Unit No.	Topics	Hours
1	**Introduction to Digital Photography**		05
	1.1	History of photography, Photographic styles, Rule of thirds, Basic DSLR settings, Necessary gears, Sensors and mirrors in cameras, Full frame vs crop sensor.	
2	**Working with Your Camera**		05
	2.1	Commanding the mode dial, Lens structure and types, Prime lenses, cleaning lenses, Introduction to shutter speed, aperture and ISO, White balance, Introduction to light.	
3	**Balancing Light: The Exposure Triangle**		05
	3.1	Detailed understanding of shutter speed, ISO, and aperture, Practical application of exposure triangle, Managing lighting conditions for better image capture.	
4	**Com Photoshop – Interface and Post- Production**		05
	4.1	Opening files in Photoshop, Understanding the Photoshop interface, Basic post-production techniques, Color correction and exposure adjustments.	
5	**Photoshop – Tools and Editing Techniques**		05
	5.1	Different tools used in Photoshop, Image enhancement techniques, Cropping, retouching, layering basics.	
6	**Lightroom – Editing and Enhancement**		05
	6.1	Lightroom interface overview, Using filters to enhance photographs, Basic workflow for organizing and refining images.	
		Total	**30**

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 (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC07	Tradition & Craft: Hands-On Indian Art	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LLC07	Tradition & Craft: Hands-On Indian Art	30	5	10	5	50	1

Course Overview:

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

Course Outcomes	After successful completion of the course, the students will be able to	
	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:

Module No.	Unit No.	Topics	Hours
1	**Introduction to Tanjore art**		06
	1.1	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.	
2	**Lipan Art (Mud & Mirror Work)**		06
	2.1	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.	
3	**Quilling Art – Paper Filigree**		06
	3.1	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.	
4	**Creative Clay Modeling**		04
	4.1	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.	
5	**DIY Home Décor**		04
	5.1	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.	
6	**Creative Hands: Traditional Meets Contemporary**		04
	6.1	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.	
		Total	**30**

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 (Hrs./ Week)			Credits Assigned			
		L	P	T	L	P	T	Total
25IL4LLC08	Sports & Fitness	-	2	-	-	1	-	1

Course Code	Course Name	Assessment Methods					
		Mentor Assessment	Course Attendance	Cultural Fest Participation	Technical Fest Participation	Total Marks	Total Credits
25IL4LLC08	Sports & Fitness	30	5	10	5	50	1

Course Overview:

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

Course Outcomes	After successful completion of the course, the students will be able to	
	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:

Module No.	Unit No.	Topics	Hours
1	**Foundations of Physical Fitness & Team Formation**		05
	1.1	Introduction to Sports & Physical Fitness – Importance of sports, fitness components, warm-up and team formation.	
2	**Basic Fitness Conditioning & Injury Prevention**		04
	2.1	Basic Fitness & Conditioning – Stretching, endurance activities, light strength exercises, safety measures.	
3	**Skill Development in Indoor Sports**		06
	3.1	Indoor Sports Participation – Practice of badminton, table tennis, chess, carrom and basic rules.	
4	**Skill Development in Outdoor Sports**		06
	4.1	Outdoor Sports Participation – Practice of cricket, football, volleyball, basketball, kho-kho and kabaddi.	
5	**Team Dynamics, Leadership & Sports Ethics**		05
	5.1	Teamwork, Leadership & Sports Ethics – Role of captain, discipline, fair play, managing wins and losses.	
6	**Recreational Sports, Wellness & Lifelong Fitness**		05
	6.1	Recreational Sports & Wellness – Sports for stress management and semester-end sports activity.	
		Total	**30**

Suggested Activities for Sports & Fitness Art Course:

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