

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

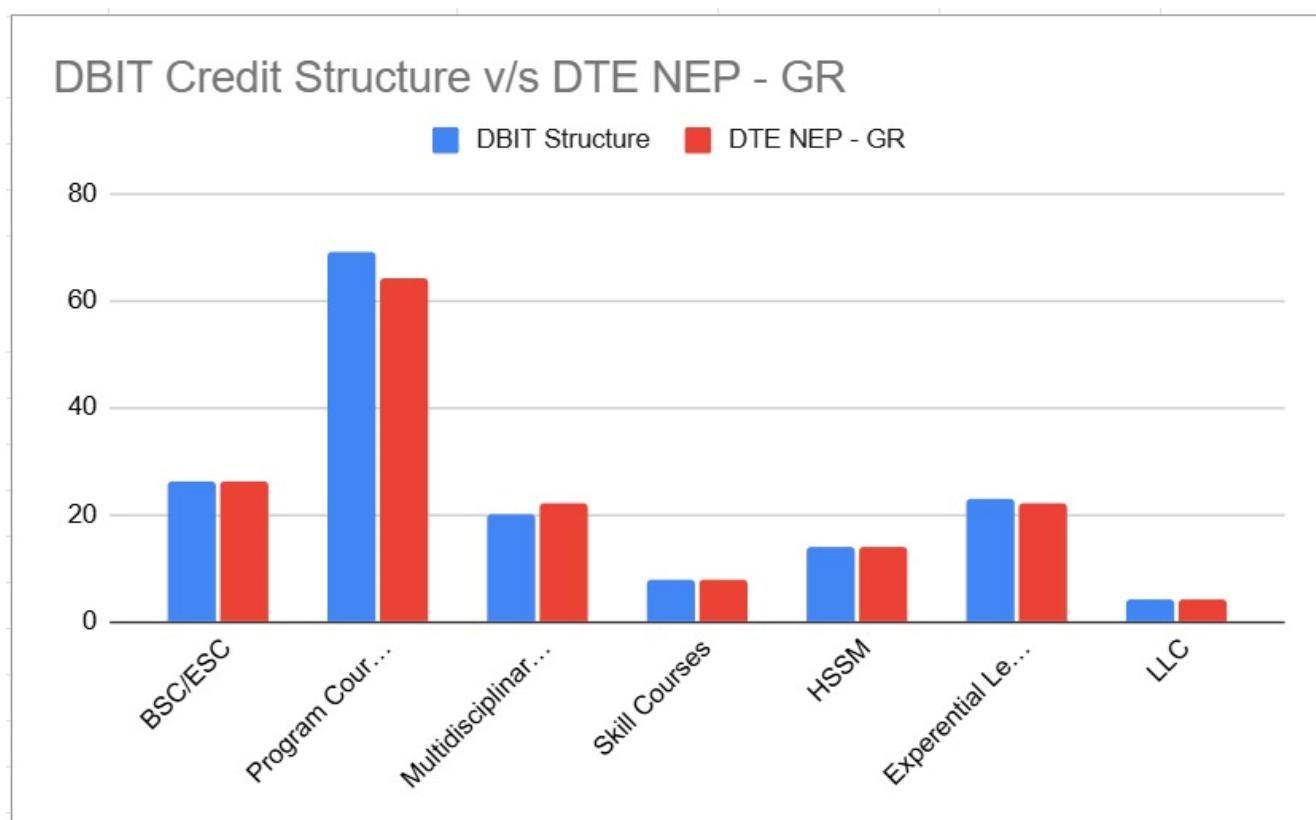
The curriculum is delivered through a structured credit system as follows:

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

Exit Options	Credits Structure
Certificate after Year 1:	42 Credits + 08 Credits (04 Credit Exit course + 04 Summer Internship).
Diploma after Year 2:	86 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).

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		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:	86 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 Engineering EXTC Program
Semester wise Curriculum Structure
Semester - IV

Course Code	Course Vertical	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
			T	P	T	T	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
25ET4MDMXX	MDM	MDMXX@	2	2	-	2	1	-	3
25ET4CEP02	CEP	Community Engagement Project – 2	-	2	-	-	1	-	1
25IL4EEM01	EEM	Entrepreneurship Essentials	2	-	-	2	-	-	2
25IL4ELLXX	LLC	Liberal Learning Course - 1	-	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 Scheme & Assessment Structure
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
25ET4MDMXX	MDM	MDMXX@	20	30	50	25	-	-	125
25ET4CEP02	CEP	Community Engagement Project - 2	-	-	-	25	25	-	50
25IL4EEM01	EEM	Entrepreneurship Essentials	50	-	-	-	-	-	50
25IL4ELLXX	LLC	Liberal Learning Course - 1	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 (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
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- Programme Core Course (PCC): Total Credits: 14

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ET4PCC01	Discrete Time Signal Processing	L	T	P	L	T	P	Total
		3	1	-	3	1	-	4
		Examination Scheme						
		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
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Course Objectives:

1. To develop a thorough understanding of the Discrete Fourier Transform and its use in spectral analysis and frequency domain filter designing.
2. To develop a thorough understanding of the Fast Fourier Transform and its use in spectral analysis
3. To design and realize IIR filters and FIR filters, and gain an appreciation for the trade-offs necessary in the filter design.
4. To understand the effects of Poles and Zeros in the frequency response of digital filters.
5. To evaluate the effects of finite word lengths on the filters

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
	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 ($N = 2 \times 3$, $N = 3 \times 2$)	
	Self-Learning Topics: Use of DFT in communication systems for spectrum analysis and interference identification.		
2	IIR Digital Filters		10
	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
	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
	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
	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
	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, etc		
TOTAL			45

Suggested List of Tutorial Topics:

Tutorial No.	Topic	Details
1	Discrete-Time Signals	Generate and analyse standard discrete-time signals such as unit impulse, unit step, ramp, exponential, and saw-tooth signals.
2	Sinusoidal Signals and Frequency Response	Generate sinusoidal signals and analyses their frequency response in terms of magnitude and phase.
3	Linear and Circular Convolution	Implement and differentiate between linear and circular convolution for discrete-time signals.
4	Auto-correlation and Cross-correlation	Compute and interpret auto-correlation and cross-correlation functions for discrete-time sequences.
5	Discrete Fourier Transform and Power Spectrum	Compute the N-point DFT of a sequence and analyse its power density spectrum.
6	FFT (DIT-FFT) and Frequency Response	Implement the DIT-FFT algorithm and evaluate the frequency response of signals.
7	Inverse FFT and Signal Reconstruction	Reconstruct time-domain signals using the inverse FFT.
8	IIR Butterworth Filter Design	Design Butterworth low-pass and high-pass IIR filters and analyse the effect of filter order on performance.
9	IIR Chebyshev Filter Design	Design Chebyshev low-pass and high-pass IIR filters and compare their performance with Butterworth filters.
10	FIR Filter Design using Windowing Technique	Design FIR filters using rectangular, Hamming, and Kaiser windows and analyze their frequency responses.
11	FIR Filter Design using Frequency Sampling Technique	Design FIR filters using the frequency sampling method and evaluate their characteristics.

12	Minimum, Maximum, and Mixed Phase Systems	Identify and analyze minimum phase, maximum phase, and mixed phase systems.
13	Symmetric and Anti-symmetric FIR Filters and Zero Locations	Verify symmetry properties of FIR filters and determine the locations of their zeros.
14	IIR Filter Realization (Cascade and Parallel Forms)	Realize IIR filters using cascade and parallel structures.
15	Lattice Structures and Coefficient Quantization	Obtain lattice parameters for FIR and IIR systems and analyze the effects of coefficient quantization using truncation and rounding.
16	Advanced DTSP Applications	Apply DTSP techniques to real-world applications such as ECG signal processing, echo cancellation, Speech and Audio AI systems, Computer Vision, and Image Processing, and musical tone generation

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	Credits Assigned
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		(Hrs. / Week)						
25ET4PCC02	Electromagnetics & Antennas	L	T	P	L	T	P	Total
		3	-	2	3	-	1	4
		Examination Scheme						
		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 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		07
	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 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.		07

	▪ 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 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.		07
	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 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		06
	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 After completing this module, students will be able to: ▪ Understand the necessity to achieve high directivity.		08

	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 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.		10
	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.	Topic of Experiment
1	To utilize scilab/MATLAB/Python in order 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
2	To plot Laplace/Poisson's equation for given boundary conditions, plot potential gradient and continuity equation.
3	To evaluate transition from electrostatics to time-harmonic fields, extract $\gamma = \alpha + j\beta$, and relate it to material parameters.
4	To quantitatively analyze skin depth variation with frequency in metals, semiconductors, and insulators.
5	To visualize Poynting vector and polarization (linear, circular, elliptical) in time and space.
6	To measure and plot radiation pattern using given readings and determine half power beam width and first null beam width.
7	Antenna Radiation Analysis and Retarded Potentials using MATLAB/ SciLab.
8	To compare different dipole types and analyze their radiation characteristics, impedance properties, and bandwidth performance, comparison of loop antenna and

	dipole antenna polarisations using practical setup or MATLAB/ SciLab.
9	To measure return loss, impedance bandwidth of a printed antenna using a vector network analyzer.
10	To measure gain of a Yagi-Uda antenna using Gain Comparison Method and compare the gain of single element dipole with a 3 element and 7 element Yagi antennas.
11	To analyze gain measurements at different antenna polarizations.
12	To measure and compare radiation pattern of a Printed Microstrip Antenna with the radiation pattern of Printed Microstrip Array Antenna.
13	To design and simulate a half wavelength dipole antenna for given specifications.
14	To design and simulate a Microstrip Patch Antenna for given specifications.
15	To design and implementation of a Yagi-Uda Antenna for given specifications.
16	To evaluate and plot pattern of antenna array using Scilab/ MATLAB/Python.

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://videlectures.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.

Module-wise Specific Outcomes:

Module 1: Review of MOSFET Operation and Fabrication

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

Module 2: Combinational CMOS Logic Circuits

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

Module 3: MOS Design Logic Styles

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

Module 4: Semiconductor Memories

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

Module 5: Datapath and System Design Issues

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

Module 6: RTL to GDS Flow Using Open-Source Tools

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

Syllabus:

Module No.	Unit No.	Topics	Hours
1	Review of MOSFET operation and Fabrication		08
	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
	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
	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 ² MOS 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
	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	Data path and system design issues		05
	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
	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			
25ET4PCC04	Microcontrollers and Applications	L	T	P	L	T	P	Total
		-	-	2*2	2	-	1	2
		Examination Scheme						
		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
	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-51 family based on their features (8051, 8052, 8031, 8751, AT89C51).		
2	8051 Instruction Set & Assembly Language Programming		08
	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.		
3	8051 Microcontroller I/O ports, Timer/Counters, Interrupts, Serial port & Programming		08
	3.1	8051 I/O ports, I/O bit manipulation programming.	
	3.2	8051 Timer/Counter, Timer modes. Programming of timers in Assemble language and embedded C.	
	3.3	Interrupt structure, Priority of interrupts.	
	3.4	Serial Communication & Modes. 8051 serial port programming in assembly language & Embedded C.	
	Self-Learning Topics: 8051 external hardware Interrupt Programming		
4	ARM 7		02
	4.1	Introduction and Features of ARM 7, Concept of cortex A, cortex R and Cortex M.	
	4.2	Pipelining, Programmer's Model.	
	Self-Learning Topics: Learn about Architectural Inheritance in ARM (Von-Neumann vs Harvard).		
5	ARM7 Programming		02
	5.1	Instruction Set, Programming with ARM.	
	5.2	Data Processing, Data Transfer, Control flow.	
	Self-Learning Topics: Write simple ARM assembly snippets for arithmetic and branching.		

6	8 bit microcontroller Interfacing Applications		05
	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 applications in domains like automation, healthcare, or IoT.		
TOTAL			30

Suggested List of Experiments:

Experiment 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. Task Description • 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.
- I. Scott MacKenzie and Raphael C.W. Phan, “The 8051 Microcontroller”, Pearson Education International, 4th edition.
5. 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) (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 (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				
25IL4EEM01	Entrepreneurship Essentials	L	P	T	L	P	T	Total	
		2	-	-	2	-	-	2	
		Examination Scheme							
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	50	-	-	-	-	-	50
		Lab/Tut	-	-	-	-	-	-	

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: Foundations of Entrepreneurship Development

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

Module 2: Theories of Entrepreneurship & External Influences

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

Module 3: Types & Classification of Entrepreneurs

This module focuses on different types of entrepreneurs, including intrapreneurs, women entrepreneurs, and social entrepreneurs. It discusses challenges faced by women entrepreneurs and the role of Self-Help Groups (SHGs). The module also highlights social entrepreneurship in India and the importance of NGOs in social responsibility and development.

Module 4: Entrepreneur Project Development & Business Idea

This module emphasizes innovation, creativity, and idea generation. Students learn about identifying business opportunities through environmental scanning and change. The entrepreneurship

development cycle and SWOT analysis help learners understand how to convert ideas into viable entrepreneurial ventures.

Module 5: Business Plan

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

Module 6: Venture Development

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

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 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.	06
	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 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.		06
	2.1	Theories by: Schumpeter, McClelland, Eisenstein, 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 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.		06
	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	Entrepreneur Project Development & Business Idea 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.		06

	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	Business Plan 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.		06
	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	Venture Development 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.		06
	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			36

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) <u>And / Or</u> 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				
25ET4CEP02	Community Engagement Project 2	L	P	T	L	P	T	Total	
		-	2	-	-	1	-	1	
		Examination Scheme							
			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.	
	After successful completion of the course, the students will be able to

Course Outcomes	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.