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Item No. 06

The Bombay Salesian Society's

Don Bosco Institute of Technology, Mumbai

(An Autonomous Institute affiliated to University of Mumbai)

CURRICULUM STRUCTURE FOR THIRD YEAR ENGINEERING

SEMESTER V

Department of Mechanical 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 renew our pledge to produce graduates who are not only professionally competent but also committed to the greater good of society.

2. Vision and Mission

Vision:

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

Mission:

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

3. Curriculum Design Philosophy

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

Key design principles include:

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

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

4. Credit Guidelines and Allocation

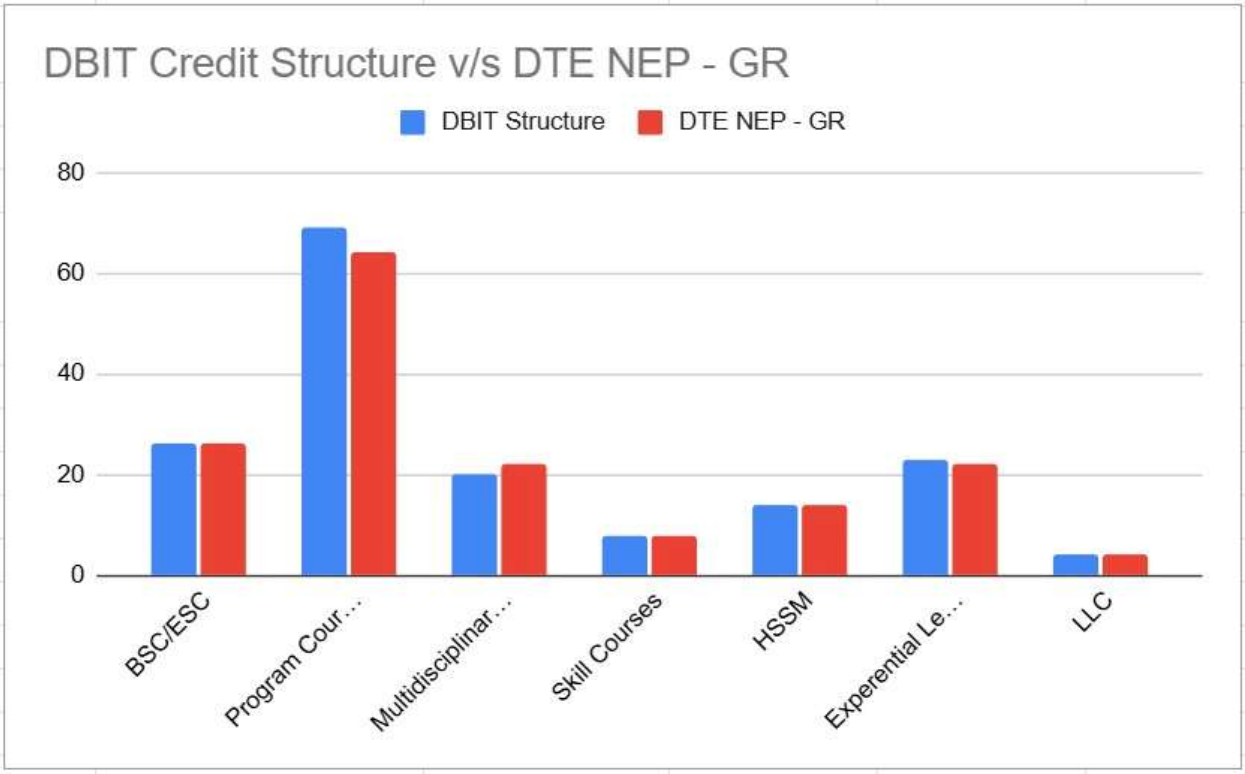
The curriculum is delivered through a structured credit system as follows:

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 Curriculum Credit Structure: (FE to BE)

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits	DTE Credits
Basic Science Course	BSC/ESC	9	6							15	14-18
Engineering Science Course		7	4							11	12 - 16
Programme Core Course (PCC)	Program Courses		3	16	14	8	8	7		56	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				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	22	23	21	19	169	160- 176

Graphical Representation:



5. Degree Options and Exit Pathways

Students are offered flexible learning pathways through the following options:

Undergraduate Degree Options:

- B.E. –169 credits
- B.E. with Minor/Honors – 187 credits
- B.E. Honors with Research – 187 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 Third Year Mechanical Engineering Program
Curriculum Scheme and structure
Semester V

Course Code	Course Vertical	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
			L	P	T	L	P	T	Total
25ME5PCC01	PCC	Heat Transfer & IC Engine	3	2	-	3	1	-	**4**
25ME5PCC02	PCC	Mechanical Vibrations	3	2	-	3	1	-	**4**
25ME5PECXX	PEC	Program Elective	2	2	-	2	1	-	**3**
25XX5MDMYY	MDM	MDM 02@	3	2	-	3	1	-	**4**
25IL5OEXX	OE	Open Elective 01*	2	-	-	2	-	-	**2**
25IL5AEC02	AEC	Professional Communication Skills	-	2#+2	-	-	2	-	**2**
25IL5ELC01	ELC	Research Methodology	2	-	-	2	-	-	**2**
25ME5CEP01	CEP	Community Engagement Project - 3	-	2	-	-	1	-	**1**
		Total	**15**	**14**	**-**	**15**	**7**	**-**	**22**

@ List of MDM courses is attached as annexure. *** Online NPTEL courses approved by Institute.**

$ Two hours of practical class to be conducted for full class as demo/discussion.

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UG Third Year Mechanical Engineering Program
Examination Scheme & Assessment Structure
Semester V

Course Code	Course Vertical	Course Name	Examination Marks						
			CA	MSE	ESE	TW	OR	OR/ PR	Total
25ME5PCC01	PCC	Heat Transfer & IC Engine	20	30	50	25	-	25	**150**
25ME5PCC02	PCC	Mechanical Vibrations	20	30	50	25	-	25	**150**
25ME5PECXX	PEC	Program Elective	20	30	50	25	25	-	**150**
25XX5MDMYY	MDM	MDM 02	20	30	50	25	-	-	**125**
25IL5OEXX	OE	Open Elective 01	20	-	30	-	-	-	**50**
25IL5AEC01	AEC	Professional Communication Skills	-	-	-	50	-	-	**50**
25IL5ELC01	ELC	Research Methodology	-	-	-	50	-	-	**50**
25ME5CEP01	CEP	Community Engagement Project - 3	-	-	-	25	-	25	**50**
		Total Marks	**130**	**120**	**230**	**225**	**50**	**75**	**775**

List of Program Elective Courses (PEC) courses

Sr. No.	Course Code	Name of the Course
1	25ME5PEC01	Finite Element Analysis
2	25ME5PEC02	Tool Design & Engineering
3	25ME5PEC03	Industrial Utility Systems

List of Multidisciplinary Minor (MDM) courses

Sr. No.	Course Code	Name of the Course	Department offering the course
1	25CE5MDM01	Android App Development	Computer Engineering
2	25IT5MDM01	Database Management System	Information Technology
3	25ET5MDM01	IOT System Design	Electronics & Telecommunications Engineering
4	25ET5MDM02	Data Acquisition and Industrial Monitoring	

List of Open Elective Courses (OE)

Sr. No.	Course Code	Name of the Course
1	25IL5OE01	Energy Economics & Policy
2	25IL5OE02	Ethics in Engineering Practice
3	25IL5OE03	Intellectual Property & Rights & Competition Law
4	25IL5OE04	Principles of Human Resource Management
5	25IL5OE05	Patent Search for Engineers & Lawyers
6	25IL5OE06	Developing Soft Skills and Presentation Skills
7	25IL5OE07	Mastering Speaking & Presentation Skills

UG Second Year Mechanical Engineering 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**	Choose any Pedagogy from the following list summing upto 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
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	**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	**OR/PR-25**	Practical examination will be based on the experiments performed by the students during laboratory sessions followed by Oral examination.

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%**

Heads of Passing:

a. **Passing Criteria for Theory Course:** 40% of maximum marks in CA, MSE, ESE taken together

b. **Passing Criteria for Laboratory/Tutorial (Term Work):** 40% of maximum marks

c. **Passing Criteria for Oral/Practical:** 40% of maximum marks

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME54PCC01	Heat Transfer & IC Engine	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	OR/PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	-	25	50
		Total	150						

Pre-Requisite Courses:	25ME3PCC01: Mathematics for Mechanical Applications
	25ME3PCC04: Thermodynamics
	25FE4PCC03: Thermal Systems

Course Overview:

This course focuses on the fundamentals of heat transfer, heat exchangers, mass transfer, and internal combustion engines. It develops understanding of conduction, convection, radiation, boiling and condensation, heat exchangers, IC engine combustion, performance, emissions, and control technologies.

Module 1 introduces modes of heat transfer and steady-state conduction analysis.
Module 2 focuses on extended surfaces and transient heat transfer.
Module 3 covers convection, boiling, condensation, and radiation heat transfer.
Module 4 introduces mass transfer and heat exchangers.
Module 5 focuses on construction, operation, and combustion in SI and CI engines.
Module 6 covers engine testing, performance analysis, emissions, and control techniques.

Course Outcomes		After successful completion, the students will be able to
	CO1	**Understand** modes of heat transfer, conduction systems, convection, radiation, and IC engine terminology. **(Remembering)**
	CO2	**Explain** heat transfer mechanisms, fin analysis, boiling, condensation, radiation, and working of SI & CI engines. **(Understanding)**
	CO3	**Apply** governing equations to solve numerical problems related to heat conduction, convection, heat exchangers, and engine performance. **(Applying)**
	CO4	**Analyze** thermal systems, fin performance, heat exchanger effectiveness, combustion phenomena, and engine characteristics. **(Analysing)**
	CO5	**Evaluate** heat transfer enhancement methods, engine performance, emissions, and environmental impacts. **(Evaluating)**
	CO6	**Design and estimate** performance parameters of heat exchangers and thermal systems using engineering principles. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Heat transfer & Conduction**	07
		After completing this module, students will be able to: • Explain mechanisms of heat transfer. • Apply generalized conduction equations. • Analyze steady-state conduction systems.	
	1.1	**Modes of Heat Transfer:** Mechanism of conduction, convection, radiation, and governing laws.	
	1.2	**Conduction:** Generalized heat conduction equation in rectangular, cylindrical, and spherical coordinates. Steady-state heat conduction through plane wall, composite wall, cylinder, composite cylinder, sphere and composite sphere, Thermal contact resistance and critical radius of insulation	
		Self-Learning Topics: Identification and estimation of heat transfer rate industrial and residential applications.	
2		**Heat transfer through Fins & Unsteady Heat Transfer**	06
		After completing this module, students will be able to: • Explain fin applications and classifications. • Apply fin equations and transient heat transfer analysis • Evaluate thermal time constant	
	2.1	**Extended Surface**: Types and significance of fins, governing differential equation, finite and infinite fins, insulated tips, fin efficiency and effectiveness.	
	2.2	**Unsteady Heat Transfer:** Lumped heat capacity analysis, applications of transient heat transfer, thermal time constant, and Introduction of Heizleier chart.	
		Self-Learning Topics: Effect of response time error estimation, various fin tube heat exchanger	
3		**Heat Transfer under Convection and Two Phase Flow**	08
		After completing this module, students will be able to: • Analyses convection mechanisms. • Explain boiling and condensation. • Evaluate radiation heat transfer.	
	3.1	**Convection**: Free and forced convection, boundary layers, flow over flat plates and tubes.	
	3.2	**Two Phase Flow:** Boiling regimes, film condensation and dropwise condensation.	
	3.3	**Radiation**: Radiation laws and heat exchange between two bodies	
		Self-Learning Topics: Design of forging furnace, Concept of furnaces used in steel & Cement industries.	
4		**Mass transfer and Heat exchanger**	8
		After completing this module, students will be able to: • Explain mass transfer fundamentals. • Explain working of various heat exchanger • Design the heat exchanger	

	4.1	**Mass Transfer:** Introduction to mass transfer, governing equations, mass transfer coefficient.	
	4.2	**Heat exchanger:** Types of heat exchangers, LMTD, effectiveness, ε-NTU methods, correction factor and cross-flow heat exchangers, Kern's method, pressure drop calculation.	
	Self-Learning Topics: Plate heat exchanger, Reboiler. Fin tube heat exchanger, waste heat recovery systems		
5	**Introduction to ICE and Combustion Mechanism**		**07**
	After completing this module, students will be able to: • Explain engines operation. • Analyze fuel-air cycles and combustion. • Explain fuel injection systems.		
	5.1	**Internal Combustion Engine:** Classification of IC engines, working of four-stroke and two-stroke engines, valve timing diagrams, concept of multiple cylinder engine.	
	5.2	**Combustion:** Fuel-air cycles, combustion, knocking phenomenon, MPFI system, detonation in CI engines	
	5.3	**Fuel Supply:** Carburetor and Fuel injection systems, fuel ignition system	
	Self-Learning Topics: Various fuels and their impact on performance of engine		
6	**Testing and Performance of Engine**		**09**
	After completing this module, students will be able to: • Explain engine testing methods. • Analyze engine performance. • Evaluate engine emissions and control techniques		
	6.1	**Performance of IC Engine:** Measurement of engine performance parameters, performance characteristics of SI and CI engines, Heat balance sheet	
	6.2	**Engine Pollution:** Sources of engine emissions, Euro and Bharat stage norms, emission control methods	
	Self-Learning Topics: Conventional vs Electric Vehicle, cogeneration based on DG set.		
		Total	**45**

List of Experiments:

Sr. No.	Title of Experiments
1	**Measurement of Thermal Conductivity of Metal Rod / Liquids / Insulating Powder** **Objectives:** • To understand the concept of heat conduction • To determine the thermal conductivity of different materials • To compare heat conduction characteristics of metals, liquids, and insulating materials **Outcomes:** • Determine thermal conductivity experimentally • Compare thermal performance of conducting and insulating materials • Apply Fourier's law of heat conduction to practical systems
2	**Measurement of Heat Transfer Coefficient for Flow over Vertical pipe in Free Convection**

	Objectives: • To study natural convection heat transfer • To determine the convective heat transfer coefficient • To understand the effect of temperature difference on heat transfer **Outcomes:** • Evaluate heat transfer coefficient under free convection conditions • Correlate experimental results with theoretical relations • Understand buoyancy-driven heat transfer phenomena
3	**Measurement of Heat Transfer Coefficient for Flow over/inside Tubes in Forced Convection** **Objectives:** • To study forced convection heat transfer • To determine the convective heat transfer coefficientt • To understand the effect of fluid velocity on heat transfer **Outcomes:** • Calculate heat transfer coefficient • Analyze the influence of flow rate • Apply Nusselt number correlations
4	**Measurement of Emissivity of Grey Surface** **Objectives:** • To study thermal radiation. • To determine emissivity experimentally. • To compare radiative characteristics. **Outcomes:** • Determine emissivity of engineering surfaces. • Apply Stefan-Boltzmann law. • Understand radiation heat transfer.
5	**Determination of Time Constant under Unsteady State Heat Transfer** **Objectives:** • To study transient heat transfer. • To determine thermal time constant. • To understand lumped parameter analysis. **Outcomes:** • Evaluate thermal response. • Determine time constant experimentally. • Analyze transient heating and cooling
6	**Estimation of Overall Heat Transfer Coefficient and Effectiveness of Heat Exchanger under Parallel and Counter Flow** **Objectives:** • To study heat exchanger performance • To determine overall heat transfer coefficient • To evaluate effectiveness **Outcomes:** • Calculate overall heat transfer coefficient • Determine effectiveness

	• Compare actual and theoretical performance
7	**Study and Compare Various Types of Condensers** **Objectives:** • To study construction and operation of condensers • To understand design parameters • To analyze heat rejection processes **Outcomes:** • Identify condenser types • Evaluate performance parameters • Understand condenser design considerations
8	**Performance Test on Single-Cylinder Petrol Engine** **Objectives:** • To study performance characteristics. • To determine brake power and efficiency. • To understand engine operation. **Outcomes:** • Evaluate engine performance. • Calculate brake thermal efficiency. • Analyze effect of load.
9	**Performance Test on Diesel Engine with Heat Balance Sheet** **Objectives:** • To study diesel engine performance. • To prepare heat balance sheet. • To determine energy distribution. **Outcomes:** • Evaluate engine performance. • Prepare heat balance sheet. • Analyze energy losses.
10	**Study of Electrical Vehicle and Conventional Engine** **Objectives:** • To study EV construction and operation. • To compare EV and IC engines. • To understand advantages and limitations. **Outcomes:** • Compare EV and IC systems. • Identify EV components. • Evaluate energy efficiency
11	**Study of Morse Test on Multi-Cylinder Petrol Engine** **Objectives:** • To determine indicated power. • To estimate friction power. • To study multi-cylinder engine performance. **Outcomes:** • Determine indicated power.

	• Evaluate mechanical efficiency. • Analyze engine performance
12	**Analysis effect of Ethanol Fuels on performance of engine** **Objectives:** • To study engine performance with alternative fuels • To compare fuel performance • To assess fuel economy and efficiency **Outcomes:** • Evaluate performance under alternative fuels • Compare efficiencies • Understand sustainable fuel applications

List of Assignments:

Sr. No.	Title of Assignments
1	**Modes of heat transfer** **Objectives:** • To understand the three modes of heat transfer: conduction, convection, and radiation • To identify practical applications of different modes of heat transfer. • To compare the mechanisms and governing laws of heat transfer. **Outcomes:** • Explain various modes of heat transfer and their characteristics. • Differentiate between conduction, convection, and radiation. • Identify suitable heat transfer mechanisms in engineering applications.
2	**Conduction** **Objectives:** • To study heat transfer through solids by conduction. • To understand Fourier's law of heat conduction. • To analyze thermal resistance and heat flow through different materials. **Outcomes:** • Apply Fourier's law to solve conduction problems. • Calculate heat transfer through plane and composite walls. • Evaluate the effect of material properties on heat transfer
3	**Convection and Radiation** **Objectives:** • To study the principles of convective and radiative heat transfer. • To understand Newton's law of cooling and Stefan-Boltzmann law. • To analyze factors affecting convection and radiation heat transfer. **Outcomes:** • Calculate convective and radiative heat transfer rates. • Compare free and forced convection processes. • Analyze the influence of surface and fluid properties on heat transfer.
4	**Heat exchanger** **Objectives:** • To study the construction and working of various heat exchangers.

	• To understand LMTD and effectiveness-NTU methods. • To evaluate heat exchanger performance. **Outcomes:** • Classify different types of heat exchangers and their applications. • Calculate heat exchanger effectiveness and heat transfer rate. • Analyze thermal performance of heat exchangers.
5	**Numerical on engines parameters and study of types of engines** **Objectives:** • To understand construction and classification of internal combustion engines. • To calculate important engine parameters such as swept volume, compression ratio, and mean effective pressure. • To compare different types of engines and their applications. **Outcomes:** • Calculate basic engine parameters. • Differentiate between SI and CI engines, two-stroke and four-stroke engines. • Select suitable engines for specific applications.
6	**Numerical on engine performance** **Objectives:** • To evaluate performance parameters of internal combustion engines. • To calculate brake power, indicated power, efficiencies, and fuel consumption. • To study the effect of operating conditions on engine performance. **Outcomes:** • Calculate engine performance parameters from experimental data. • Analyze engine efficiency and fuel economy. • Evaluate engine performance under different loading conditions

Text Books:

1. Heat and Mass Transfer, R.K. Rajput, S. Chand & Company Ltd., 6th Edition.
2. A Textbook of Heat Transfer, R.S. Khurmi and J.K. Gupta, S. Chand & Company Ltd., Revised Edition.
3. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, David P. DeWitt, Theodore L. Bergman and Adrienne S. Lavine, Wiley India, 8th Edition.
4. Internal Combustion Engines, V. Ganesan, McGraw Hill Education, 4th Edition.
5. A Course in Internal Combustion Engines, M.L. Mathur and R.P. Sharma, Dhanpat Rai Publications, 8th Edition.

Reference Books:

1. Heat Transfer, J.P. Holman, McGraw Hill Education, 10th Edition.
2. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel and Afshin J. Ghajar, McGraw Hill Education, 6th Edition.
3. Engineering Thermodynamics, P.K. Nag, McGraw Hill Education, 7th Edition.
4. Internal Combustion Engine Fundamentals, John B. Heywood, McGraw Hill Education, 2nd Edition.
5. Internal Combustion Engines and Air Pollution, Obert E.F., Waveland Press, 3rd Edition.
6. Fundamentals of Internal Combustion Engines, H.N. Gupta, PHI Learning Pvt. Ltd., 2nd Edition.

Useful Links:

1. NPTEL Courses on Heat Transfer and IC Engines, National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in
2. ASME Digital Library, American Society of Mechanical Engineers, https://asmedigitalcollection.asme.org
3. SAE International Technical Papers, SAE International, https://www.sae.org
4. MIT OpenCourseWare – Heat Transfer, Massachusetts Institute of Technology, https://ocw.mit.edu

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 (2 hours) • Total Marks: 50
Laboratory term Work (TW) (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.
OR/PR (25 marks)	Practical examination will be based on the experiments performed by the students during laboratory sessions followed by Oral examination.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME5PCC02	Mechanical Vibrations	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	OR/PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	-	25	50
		Total	150						

Pre-Requisite Courses:	25FE2ESC01: Engineering Mechanics
	25ME3PCC02: Strength of Materials

Course Overview:

This course provides a systematic understanding of the dynamic behavior of mechanical systems subjected to vibrations encountered in engineering applications. It enables students to represent and analyze vibrating systems using mathematical models and analytical methods, forming a foundation for studying system response under different operating conditions. The course emphasizes the relationship between mass, stiffness, damping, and external excitation in determining vibration characteristics and system performance. Students develop the ability to formulate equations of motion, determine vibration parameters, and interpret the response of mechanical systems. The course also introduces methods to control undesirable vibrations and techniques used for vibration measurement and condition monitoring. Through analytical and problem-solving approaches, students gain skills relevant to analysis, evaluation, and solution development in mechanical engineering practice. Overall, the course builds analytical thinking essential for advanced studies and engineering applications involving dynamic systems and vibration phenomena.

Module 1 establishes the foundational framework for understanding vibration terminology, system characteristics, and classification of vibrations. It forms the basis for modelling and analysis of vibrating systems.

Module 2 focuses on free undamped vibrations of single degree of freedom systems and the formulation of equations of motion using analytical methods. Emphasis is placed on determining vibration characteristics and developing equivalent system models.

Module 3 deals with damping mechanisms and the behavior of damped vibration systems. It emphasizes the influence of damping on vibration response and energy dissipation.

Module 4 examines the response of vibrating systems subjected to harmonic excitation. It emphasizes analysis of resonance, amplitude characteristics, and dynamic behavior under external excitation.

Module 5 addresses vibration transmissibility and vibration isolation techniques used to reduce undesirable vibrations. It focuses on understanding how system parameters affect vibration transmission and isolation performance.

Module 6 introduces vibration measuring instruments and condition monitoring techniques used in engineering systems. It focuses on understanding the principles of vibration measurement and the use of vibration data for fault diagnosis and predictive maintenance.

Course Outcomes	After successful completion of the course, the students will be able to	
	CO1	**Define** standard terminology, parameters, classifications, and measurement concepts related to mechanical vibrations. **(Remembering)**
	CO2	**Explain** basic concepts and terminology associated with mechanical vibrations. **(Explain)**
	CO3	**Apply** analytical methods to formulate mathematical models and derive governing equations of motion for mechanical systems. **(Applying)**
	CO4	**Analyze** the response of mechanical systems subjected to vibrations. **(Analysing)**
	CO5	**Determine** vibration characteristics, including natural frequency, of mechanical systems. **(Evaluating)**
	CO6	**Design** vibration isolation and/or vibration measuring systems. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Fundamentals of Mechanical Vibrations**	06
		After completing this module, students will be able to: • Define terminology and classifications associated with vibration systems. • Explain the causes, effects, and significance of vibrations in engineering systems. • Apply vibration parameters and classification concepts for modelling vibration systems.	
	1.1	**Basic Concepts of Vibrations** Vibration and oscillation, causes and effects of vibrations, importance of vibration analysis in engineering, elements of vibrating systems—mass, spring and damper, examples of vibrating systems.	
	1.2	**Vibration Characteristics and Classification** Periodic and non-periodic motion, degree of freedom, static equilibrium position, classification of vibrations—free and forced, damped and undamped, linear and non-linear vibrations, deterministic and random vibrations, steps involved in vibration analysis.	
		Self-Learning Topic: Harmonic motion	
2		**Free Undamped Single Degree of Freedom Systems**	09
		After completing this module, students will be able to: • Recall terminology associated with free vibration systems. • Explain vibration characteristics of undamped systems. • Apply analytical methods to formulate equations of motion and determine equivalent vibration parameters.	
	2.1	**Free Undamped Vibrations** Longitudinal vibration system, transverse vibration system, natural frequency and time period, phase plane representation.	
	2.2	**Formulation of Equations of Motion** Derivation of differential equations using Newton's method, Energy method, Lagrange's method and Rayleigh's method	
	2.3	**Equivalent Single Degree of Freedom Systems** Conversion of multi-spring and multi-mass systems into equivalent single	

		degree of freedom systems, determination of equivalent stiffness and equivalent mass.	
	Self-Learning Topic: Free Vibration of an Undamped Torsional System		
3	**Free Damped Single Degree of Freedom Systems**		**08**
	After completing this module, students will be able to: • Identify different damping mechanisms used in vibration systems. • Explain the influence of damping on vibration response. • Analyse damped vibration systems and equivalent damping models.		
	3.1	**Damping Mechanisms** Introduction to damping, types of damping, energy dissipation mechanisms, viscous damping and Coulomb damping	
	3.2	**Viscously Damped Systems** Equation of motion for viscously damped systems, underdamped, critically damped and overdamped systems, damping coefficient, damping ratio, logarithmic decrement.	
	3.3	**Coulomb Damping** Analysis of systems with dry friction damping, decay of amplitude, comparison with viscous damping	
	Self-Learning Topic: Equivalent damping systems, Practical applications of damping in engineering systems.		
4	**Forced Single Degree of Freedom Vibratory Systems**		**08**
	After completing this module, students will be able to: • Identify excitation sources and associated terminology. • Explain vibration response under harmonic excitation. • Analyse the response characteristics of forced vibration systems.		
	4.1	**Harmonic Force Excitation** Forced vibration of linear systems (Undamped & damped) subjected to harmonic force excitation, amplitude and phase relationships, magnification factor, resonance.	
	4.2	**Harmonic Motion Excitation (Base Vibration)** Forced vibration due to harmonic displacement excitation, transmissibility concepts, response characteristics.	
	Self-Learning Topics: Response of a Damped System under Rotating Unbalance		
5	**Vibration Isolation and Transmissibility**		**07**
	After completing this module, students will be able to: • Define transmissibility parameters and isolation characteristics. • Explain principles governing vibration isolation. • Evaluate vibration isolation performance of engineering systems.		
	5.1	**Force Transmissibility** Transmitted force, transmissibility ratio, influence of damping and frequency ratio on transmissibility	
	5.2	**Vibration Isolation** Principles of vibration isolation, isolation efficiency, selection criteria for isolators.	
	Self-Learning Topic: Vibration Absorbers		
6	**Vibration Measurement and Condition Monitoring**		**07**
	After completing this module, students will be able to: • Define terminology associated with vibration measuring instruments. • Explain operating principles of vibration sensors.		

	• Analyze vibration data for monitoring and fault diagnosis.		
	6.1	**Vibration Measuring Instruments** Principle and operation of seismic instruments, vibrometers, velometers and accelerometers, response characteristics, applications.	
	6.2	**Condition Monitoring and Fault Diagnosis** Introduction to condition monitoring, machine fault diagnosis, predictive maintenance and its applications**.**	
	Self-Learning Topic: Frequency measuring instruments		
		Total	**45**

List of Experiments:

Experiment No.	Title of the Experiment
1	Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system
2	Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel
3	Experimental prediction of natural frequencies, and nodal points for single rotor vibratory system, and comparison with theoretical results.
4	Experimental prediction of natural frequencies, and nodal points for two-rotor vibratory system, and comparison with theoretical results.
5	Experimental and theoretical investigation of whirling of shaft (i.e. comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory).
6	Experimental investigation of undamped SDOF torsional system.
7	Experimental investigation of viscously damped SDOF torsional system.
8	Experimental investigation of coulomb damping.
9	Plotting amplitude-frequency response of forced vibration
10	Experimental balancing of single and multi-rotor system.
11	Vibration analysis of mechanical system using MATLAB.

Text Books:

1. Mechanical Vibrations by S.S.Rao, fifth edition, Pearson Education
2. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
3. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill

Reference Books:

1. Mechanical Vibrations by G.K.Grover
2. Elements of Vibration Analysis by Leonard Meirovitch, McGrav- Hill, New York
3. Mechanical Vibrations: Theory and Applications by S.Graham Kelly, Cengage Learning

Useful Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ae08

2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me80
3. tinyurl.com/MATLABModular

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 (2 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.
OR/PR (25 Marks)	• Practical examination will be based on the entire syllabus followed by the oral examination.

Course Code	Course Name	Teaching Scheme (Hrs./ Week)			Credits Assigned			
25IL5AEC01	Professional Communication Skills	L	P	T	L	P	T	Total
		*2+2	-	-	2	-	-	2
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	-	-	-	-	-	-	-
		Lab	-	-	-	50	-	-	50

Pre-Requisite Courses:	25FEAEC01: Effective Communication Skills
	Theory of Communication, Communication cycle, effective use of body language and barriers to communication

Course and Module Overview:

This course is designed to develop professional communication competencies required in academic, technical, corporate, and global workplace environments. The course focuses on enhancing verbal, written, interpersonal, digital, and presentation communication skills essential for engineering graduates and professionals. Students will develop the ability to communicate effectively in professional settings through technical writing, presentations, group discussions, workplace interactions, and digital communication platforms.

The course also emphasizes leadership communication, critical thinking, emotional intelligence, corporate etiquette, teamwork, and interview readiness. Practical activities such as mock interviews, presentations, group discussions, report writing, and role play simulations provide experiential learning opportunities to prepare students for placements, internships, entrepreneurship, and professional careers.

The course integrates modern communication practices including AI-assisted communication tools, digital collaboration platforms, professional networking, and global workplace communication standards to ensure industry relevance and employability readiness.

Module 1: Develops advanced professional communication competencies required in workplace and corporate environments. It focuses on persuasive communication, negotiation skills, emotional intelligence, workplace ethics, and cross-cultural communication. Students will learn to communicate strategically, handle professional interactions effectively, and resolve workplace conflicts through appropriate communication practices.

Module 2: Emphasizes professional writing skills required for technical and corporate communication. Students will learn technical report writing, proposal drafting, executive summaries, research documentation, professional emails, meeting documentation, and AI-assisted writing practices used in industry and academic environments.

Module 3: Develops professional speaking and interpersonal communication abilities. It focuses on presentations, group discussions, panel discussions, interview communication, storytelling techniques, and corporate meeting simulations. Students will strengthen public speaking confidence, teamwork communication, and leadership interaction skills.

Module 4: Introduces modern digital communication platforms and AI-based communication tools used in professional environments. Students will learn professional networking, digital etiquette, prompt engineering basics, AI-assisted content generation, online collaboration, and personal branding strategies for digital workplace communication.

Module 5: Prepares students for internships, placements, and professional careers through resume building, portfolio development, interview preparation, corporate professionalism, and workplace communication practices. Students will gain confidence in handling HR, technical, behavioral, and stress interviews effectively.

Module 6: Focuses on leadership communication, innovation pitching, entrepreneurship communication, design thinking, crisis communication, and multicultural workplace interaction. Students will develop the communication competencies required for leadership roles, global collaboration, and future workplace environments.

Course Outcomes (COs)	**After successful completion of the course, the students will be able to**	
	CO1	**Define** the fundamentals of professional, technical, digital, and workplace communication**. (Remembering)**
	CO2	**Explain** communication models, professional ethics, corporate communication practices, and workplace interaction strategies. **(Understanding)**
	CO3	**Apply** verbal, written, presentation, and digital communication skills in academic, technical, and professional contexts. **(Applying)**
	CO4	**Analyze** workplace communication situations, group discussions, negotiation scenarios, and professional challenges to identify suitable communication strategies. **(Analyzing)**
	CO5	**Evaluate** leadership communication, ethical communication practices, and cross-cultural workplace interactions in professional environments. **(Evaluating)**
	CO6	**Create** technical reports, business documents, presentations, resumes, portfolios, and AI-assisted communication content for industry readiness. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1	**Advanced Professional Communication**		06
	After completing this module, students will be able to: • Define advanced workplace communication concepts and communication models. • Analyze workplace communication scenarios and conflict situations. • Demonstrate emotional intelligence and ethical communication practices. • Communicate effectively in multicultural and global workplace settings.		
	1.1	Fundamentals of Professional Communication: Types of professional communication and principles of effective communication.	
	1.2	Workplace Communication Skills: Formal and informal workplace communication, Internal and external communication, Corporate communication structure, Professional interaction techniques	
	1.3	Persuasive Communication and Influencing Skills: Persuasion techniques, Negotiation communication, Influencing strategies Assertive communication	

	1.4	Emotional Intelligence, Interpersonal Skills and Professional Etiquettes: Ethical communication practices, Professional behavior and etiquette, corporate responsibility in communication and Confidentiality and professionalism.	
	Self-Learning Topics: Watch corporate communication videos and prepare observation report.		
2	**Technical and Business Writing**		**08**
	After completing this module, students will be able to: • Draft technical reports, proposals, and executive summaries professionally. • Prepare professional emails, meeting agendas, and minutes. • Apply concise and structured business writing principles.		
	2.1	Technical Report Writing: Structure of technical reports, Formal writing style, Data presentation techniques, Report formatting standards.	
	2.2	Business Correspondence: Professional email writing, Escalation and response mails, and corporate communication drafting.	
	2.3	Technical proposal Writing: Proposal writing structure, Writing executive summaries, Parts a technical proposal documentation standard.	
	2.4	Business Meeting Documentation: Notice and agenda preparation, writing meeting minute, Documentation practices, Official communication records, conducting business meeting and AI tools for professional writing Content refinement techniques, Grammar and style checking tools, Ethical use of AI in documentation	
	Self-Learning Topics: Create documentation using AI tools.		
3	**Corporate Speaking & Group Communication**		**06**
	After completing this module, students will be able to: • Deliver professional and impactful presentations confidently. • Participate effectively in group discussions, panel discussions, and meetings. • Demonstrate leadership and teamwork communication skills. • Apply storytelling and audience engagement techniques in presentations. • Handle interview communication professionally.		
	3.1	Professional Presentation Skills**:** Presentation structure Visual aids and slide design, Voice modulation and body language, Audience engagement techniques.	
	3.2	Group Discussions**:** GD strategies and participation, Analytical and critical discussion skills, Leadership during discussions Professional interaction techniques.	
	3.3	Team Communication and Collaboration: Team interaction methods, Collaborative communication, Workplace coordination, Communication in projects, Storytelling techniques, Persuasive presentation methods, corporate storytelling and Influencing audience perception	
	3.4	Interview Communication Mastery: HR interview communication, technical interview interaction, Behavioral interview handling and Mock interview practice	
	Self-Learning Topics: Record and analyze personal presentation videos.		

4	**Digital Communication & AI Tool**		06
	After completing this module, students will be able to: • Use professional digital communication platforms effectively. • Build professional online profiles and digital presence. • Apply AI tools for presentations, reports, and communication tasks. • Demonstrate digital etiquette and cyber professionalism. • Develop personal branding and online reputation management strategies.		
	4.1	Digital Communication Platforms: Professional communication tools, Email and virtual communication, Online collaboration platforms and Digital workplace communication	
	4.2	LinkedIn and Professional Networking: LinkedIn profile optimization, Professional networking strategies, Building online professional identity and Networking etiquette	
	4.3	AI Tools for Communication: AI tools for presentations, AI-assisted report writing, Communication automation tools and Productivity enhancement using AI	
	4.4	Digital Etiquette and Cyber Professionalism: Online professional behavior, Cyber ethics and safety, Responsible digital communication and Professional conduct in virtual environments, Personal branding strategies, Online presence management, Digital reputation building and Professional portfolio creation	
	Self-Learning Topics: Build personal online portfolio		
5	**Placement and Career Readiness**		06
	After completing this module, students will be able to: • Prepare ATS-friendly resumes and professional portfolios. • Demonstrate effective communication during HR and technical interviews. • Apply the STAR method while answering interview questions. • Exhibit corporate professionalism and workplace readiness. • Communicate confidently during placement and internship processes.		
	5.1	Resume and Portfolio Development: Resume writing techniques, ATS-friendly resume preparation, cover letters, Portfolio building methods and Career documentation standards	
	5.2	Placement Communication Skills: Internship communication, Placement interaction strategies, corporate communication readiness and Professional self-introduction.	
	5.3	HR and Technical Interviews: HR interview preparation, technical interview handling, Stress interview techniques, Behavioral interview strategies, Structured interview responses, Situation-based communication and Answer organization techniques	
	5.4	Corporate Professionalism and Workplace Readiness: Workplace expectations Professional ethics and conduct, Office communication etiquette and Time and task communication, Career planning communication, Workplace adaptability, Professional relationship management, and Industry communication practices.	
	Self-Learning Topics: Watch placement interview sessions and prepare reflection report.		

6	**Leadership, Innovation & Global Workplace Skills**		04
	After completing this module, students will be able to: • Demonstrate leadership and innovation communication skills. • Present entrepreneurial and technical ideas effectively. • Apply design thinking and workplace problem-solving communication. • Handle crisis communication situations professionally. • Work effectively in multicultural and global professional environments.		
	6.1	Leadership Communication: Leadership communication styles, Motivational communication, Decision-making communication and Team leadership interaction.	
	6.2	Innovation and Entrepreneurial Communication: Startup pitching techniques, Entrepreneurial communication and Innovation presentations and Business idea communication	
	6.3	Crisis Communication and Media Handling: Crisis management communication, Media interaction basics, Reputation management and Emergency communication strategies.	
	6.4	Future Workplace Skills and Industry 5.0 Communication: Future communication trends, Human-AI workplace collaboration, Smart workplace communication and Industry 5.0 professional competencies	
	6.5	Smart manufacturing and Industry 4.0	
	Self-Learning Topics: Study successful startup presentations.		
		Total	**36**

List of Assignments:

1. Case studies on ethical communication practices.
2. Draft a technical proposal on a given topic.
3. Presentation on Interpersonal Skills.
4. Short note on AI Tools for communication.
5. Prepare a cover letter with resume for the given position
6. Write a detailed note on industry 5.0 professional competencies.

Suggested List of Activities:

Sr. No.	Title of the Experiment
1	**Mock GD 1** **Objective:** To develop students' ability to participate actively and effectively in group discussions. **Outcome:** Students will be able to present opinions logically, listen actively to others, and contribute meaningful ideas during group discussions.
2	**Business Meeting** **Objective:**

	To train students in professional communication and collaboration during formal business meetings. **Outcome:** Students will be able to participate professionally in meetings, communicate ideas clearly, and demonstrate teamwork and meeting etiquette.
3	**Mock GD 2** **Objective:** To enhance students' confidence and communication skills in group discussion settings. **Outcome:** Students will be able to articulate viewpoints confidently, support arguments with relevant points, and engage constructively in discussions.
4	**Presentation on Interpersonal Skills** **Objective:** To develop students' presentation and interpersonal communication skills. **Outcome:** Students will be able to organize and deliver structured presentations while demonstrating effective verbal and non-verbal communication skills.
5	**Mock Interviews** **Objective:** To prepare students for professional interviews through practice and self-assessment. **Outcome:** Students will be able to answer interview questions confidently, exhibit professional behavior, and communicate their strengths effectively.
6	**Creation of LinkedIn profile** **Objective:** To guide students in building a professional online presence for career opportunities. **Outcome:** Students will be able to create a professional LinkedIn profile showcasing their qualifications, achievements, skills, and career interests effectively.
7	**Debate on emerging technologies** **Objective:** To encourage critical thinking and effective public speaking through debate activities. **Outcome:** Students will be able to express arguments logically, defend viewpoints confidently, and participate actively in formal debates.
8	**Pitching a startup idea / Pitching idea presentation** **Objective:** To enable students to present innovative business ideas persuasively and professionally. **Outcome:** Students will be able to explain a startup idea clearly, justify its feasibility and value, and deliver an effective pitch presentation.

9	**Final Group Discussion** **Objective:** To assess a students' overall group discussion and communication skills. **Outcome:** Students will be able to participate confidently in discussions, present relevant ideas effectively, and demonstrate collaborative communication skills.
10	**Final presentation on Project** **Objective:** To develop students' ability to present project work in a structured and professional manner. **Outcome:** Students will be able to prepare and deliver organized project presentations with clarity, confidence, and effective audience engagement.

Text Books:

1. Business Communication Today – Bovee & Thill
2. Technical Communication – Meenakshi Raman

Reference Books:

1. Business Communication Today – Bovee & Thill
2. Technical Communication – Meenakshi Raman
3. HBR Guide to Persuasive Presentations
4. Crucial Conversations – Patterson et al.
5. The Quick and Easy Way to Effective Speaking – Dale Carnegie

Assessment Methodology:

Type of Assessment	Assessment Tools
Term Work (50 Marks)	• Active Participation (Lab) = 05 marks • Assignments = 10 marks • Activity = 10 marks Total = 25 Marks Based on the performance & satisfactory completion of all activities. • Book Report = 05 marks • Presentation + 10 Marks • Final Group Discussion +10 Marks

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25IL5ELC01	Research Methodology	L	P	T	L	P	T	Total
		2	-	-	2	-	-	2
		Examination Scheme						
			CA	MSE	ESE	TW	OR	OR / PR	Total
		Theory	-	-	-	50	-	-	50
		Lab / Tut	-	-	-	-	-	-	-
		Total	50						

Pre- Requisite Course	25FE1BSE01 - Foundations of Engineering Mathematics - I

Course and Module Overview:

This course introduces engineering students to the principles and practices of scientific research. It covers problem identification, literature review, research design, experimental methods, data analysis, technical writing, research ethics, and intellectual property rights. The course equips students with the skills required to undertake research projects, publish technical papers, and pursue innovation in engineering.

Module 1 introduces the fundamentals of engineering research, including its purpose, significance, and role in technological innovation. It covers the research process, scientific inquiry, and various types of research such as basic, applied, experimental, and computational research. Students will gain an understanding of how research contributes to solving engineering problems and advancing technology.

Module 2 focuses on identifying research problems and conducting effective literature reviews. It introduces techniques for searching, evaluating, and synthesizing scholarly literature to identify research gaps and formulate research objectives, questions, and hypotheses. Students will develop the ability to define meaningful engineering research problems based on existing knowledge and emerging challenges.

Module 3 introduces the principles of research design and methodology used in engineering research. It covers the selection of appropriate research approaches, methods, and procedures for conducting systematic investigations. Students will learn to design research studies, develop experimental plans, select data collection methods, and ensure the reliability and validity of research outcomes.

Module 4 focuses on methods of data collection, organization, and analysis in engineering research. It introduces primary and secondary data sources, sampling techniques, and statistical tools used for data interpretation. Students will learn to apply descriptive and inferential statistics to analyze research data, draw meaningful conclusions, and support evidence-based decision-making.

Module 5 introduces the ethical, legal, and professional aspects of engineering research. It covers research integrity, plagiarism, intellectual property rights (IPR), patents, copyrights, and scholarly publishing practices. Students will gain an understanding of ethical research conduct, protection of research outcomes, and the process of publishing technical papers in journals and conferences.

Module 6 focuses on the effective communication of research findings through technical writing and professional presentations. It covers the preparation of research papers, technical reports, theses, and research proposals, along with citation and referencing practices.

Course Outcomes	**After successful completion of the course, the students will be able to**	
	CO1	**Explain** the fundamental concepts, types, and processes of research in engineering and technology. **(Remembering)**
	CO2	**Identify** research problems, formulate objectives and hypotheses, and conduct a comprehensive literature review using scientific databases. **(Understanding)**
	CO3	**Design** appropriate research methodologies, experiments, and data collection procedures for engineering investigations. (**Applying)**
	CO4	**Apply** statistical and analytical techniques to collect, process, analyze, and interpret research data. **(Analysing)**
	CO5	**Demonstrate** awareness of research ethics, plagiarism, intellectual property rights (IPR), and publication practices. **(Evaluating)**
	CO6	**Prepare and present** research proposals, technical reports, dissertations, and research papers in a professional format. **(Creating)**

Syllabus:

Module No.	Topics	Hours
1	**Introduction to Engineering Research Concepts and Types of Research**	04
	After completing this module, students will be able to: Students will understand the fundamentals and scope of engineering research.	
	Meaning, objectives, and significance of research; Types of research: Basic research, Applied research, Experimental research, Computational research, Action research; Characteristics of good research, Research process and scientific method, Engineering research challenges and opportunities	
	Self-Learning Topics: Emerging Research Paradigms, Research Impact Assessment, Global Research Trends, AI in Engineering Research, Technology Transfer.	
2	**Literature Review and Research Problem Formulation**	
	After completing this module, students will be able to: Students will be able to formulate research problems and conduct literature reviews.	
	Identification of research problems, Selection of research topics, Research objectives and questions, Hypothesis formulation, Research gap identification, Sources of technical literature, Literature survey techniques, Citation and referencing methods, Use of digital databases and search engines.	
	Self-Learning Topics: Research Question Development Frameworks**,** AI-Assisted Literature Reviews**,** Critical Analysis of Research Papers	
3	**Research Design and Methodology**	08
	After completing this module, students will be able to: Students will be able to design suitable methodologies for engineering research.	
	Research design concepts, Quantitative and qualitative research methods, Experimental research design, Survey methods, Case study approach, Modeling and simulation-based research, Variables and measurement scales, Reliability and validity.	

	Self-Learning Topics: Bibliometric Analysis, AI-Assisted Research	
4	**Data Collection and Statistical Analysis**	**06**
	After completing this module, students will be able to: Students will be able to collect and analyze engineering data.	
	Sources of data, Primary and secondary data, Sampling methods, Questionnaire design, Data coding and classification, Descriptive statistics, Probability distributions, Hypothesis testing, Correlation and regression analysis, Analysis of Variance (ANOVA)	
	Self-Learning Topics: Data Ethics and Privacy, Open Data Repositories, Uncertainty Analysis, and Perform exploratory analysis on an open dataset.	
5	**Research Ethics, IPR, and Technical Publications**	**04**
	After completing this module, students will be able to: • Students will understand ethical and legal aspects of research.	
	Research ethics, Plagiarism and academic integrity, Ethical issues in engineering research, Intellectual Property Rights (IPR), Patents, copyrights, trademarks, Patent search and filing basics, Journal publications and conferences, Peer-review process.	
	Self-Learning Topics: Responsible Conduct of Research, Ethics in Emerging Technologies, Open Science Practices, Predatory Publishing, Research Visibility and Scholarly Identity	
6	**Technical Writing and Research Presentation**	**04**
	After completing this module, students will be able to: Students will be able to communicate research findings effectively.	
	Scientific Writing, Research proposal writing and Funding Agencies, Thesis and dissertation preparation, writing journal papers, Preparation of tables, figures, and references IEEE and APA, MLA, Chicago Style and Harvard, Vancouver referencing styles, Use of Reference Management Tools (Zotero, Mendeley, EndNote), Responding to Reviewers' Comments and Manuscript Revision, Research Communication through Blogs and social media	
	Self-Learning Topics: Graphical Abstracts and Infographics, Digital Tools for Academic Writing, Peer Review and Manuscript Revision.	
	TOTAL	**30**

Text Books:

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, John W. Creswell, J. David Creswell 6th Edition, SAGE Publications, 2023.
2. Research Methodology: Methods and Techniques, C. R. Kothari, Gaurav Garg, 5th Edition, New Age International Publishers, 2024
3. Research Methodology for Engineers, by R. Ganesan, MJP Publishers, 2024

Useful Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ge66

2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ge79
3. https://ocw.mit.edu/courses/esd-932-engineering-ethics-spring-2006/
4. https://ocw.mit.edu/courses/15-348-doctoral-seminar-in-research-methods-ii-spring-2004/

Assessment Methodology:

Type of Assessment	Assessment Tools
Term work (50 Marks)	Any two pedagogy (10 marks each) for an individual student. Literature Review Assignment Statistical Analysis Using Software Patent Search Activity The following technical Group activity/Tasks of 10 Marks each to be completed during the semester. Technical Paper Review and Presentation Research Problem Identification Exercise Research Proposal Preparation So Total 50 Marks are assigned as a part of term work in the course.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
		L	P	T	L	P	T	Total
		-	2	-	-	1	-	1
25ME5CEP01	Community Engagement Project	Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	-	-	-	-	-	-	-
		Lab / Tut	-	-	-	25	25	-	50
		Total	50						

Course Overview:

This course focuses on transforming identified community needs into structured engineering opportunities through systematic study, feasibility evaluation, stakeholder engagement, and implementation planning. Students may or may not fabricate or develop prototypes. The emphasis is on evidence-based engineering decisions and preparation for future implementation.

Course Outcomes	After successful completion of this course the students will be able to	
	CO1	**Identify** technical, social, environmental and operational requirements of a selected community challenge. **(Remembering)**
	CO2	**Explain** constraints and opportunities influencing engineering intervention. **(Understanding)**
	CO3	**Apply** engineering tools to generate and compare alternative solution approaches. **(Applying)**
	CO4	**Analyse** feasibility of proposed solutions using technical and economic criteria. **(Analysing)**
	CO5	**Evaluate** alternative interventions and justify the most suitable solution strategy. **(Evaluating)**
	CO6	**Develop** an implementation roadmap for future execution or scale-up. **(Creating)**

Course Content:

Unit 1: Community Problem Validation

- Revisit previous engagement findings
- Stakeholder mapping
- Need verification and prioritization
- Data collection and interpretation
- Problem statement formulation

Unit 2: Engineering Solution Exploration

- Brainstorming and concept generation
- Functional decomposition
- Alternative solution matrix
- Sustainability and SDG alignment
- Preliminary technical calculations

Unit 3: Feasibility and Risk Assessment

- Technical feasibility
- Economic feasibility
- Operational feasibility
- Risk identification and mitigation
- Resource planning

Unit 4: Implementation Planning

- Project charter preparation
- Activity scheduling (Gantt chart)
- Budget estimation
- Success metrics and KPIs
- Final concept presentation

Teaching–Learning Methods:

- Convert observed issue into validated engineering problem
- Generate and compare solution alternatives
- Decide whether solution should proceed
- Convert concept into executable plan

Assessment Criteria:

Assessment Tool	Marks Distribution
Term Work (25 Marks)	• Active Participation = 05 marks • Project Report = 10 marks • Progress presentations (min 02) & demonstration = 10 marks
Oral (25 Marks)	Oral examination will be based on the presentation slides or demonstrating models by the group

The Bombay Salesian Society's

Don Bosco Institute of Technology, Mumbai

(An Autonomous Institute affiliated to University of Mumbai)

CURRICULUM STRUCTURE
Program Elective Courses (PEC)

Semester V

(As Per NEP 2020)

Scheme: DB25-V1

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

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME5PEC01	Finite Element Analysis	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	-	50
		Total	150						

Pre-Requisite Courses:	25FE2ESC01: Engineering Mechanics
	25ME3PCC01: Mathematics for Mechanical Applications
	25ME3PCC02: Strength of Materials

Course Overview:

This course introduces the fundamental concepts of the Finite Element Method (FEM) for solving engineering problems governed by differential equations. It covers weighted residual techniques, energy methods, finite element formulation, and the development of stiffness matrices for one- and two-dimensional problems. The course further explores elasticity theory, coordinate transformations, numerical integration schemes, and finite element analysis of structural, thermal, and fluid systems. Through theoretical foundations and engineering applications, students develop the ability to formulate, analyze, and evaluate finite element models for modern design and computational engineering applications.

Module 1 introduces the fundamentals of FEM, mathematical modelling of engineering problems, and weighted residual techniques including Galerkin and Rayleigh-Ritz methods.

Module 2 develops the basic concepts of finite elements, interpolation functions, coordinate systems, and stiffness matrix formulation using energy principles.

Module 3 focuses on finite element analysis of one-dimensional structural, thermal, and fluid problems along with truss and beam applications.

Module 4 presents two-dimensional finite element formulations, approximation techniques, natural coordinates, and shape function development.

Module 5 covers elasticity theory, plane stress and plane strain formulations, coordinate transformations, and stress analysis using two-dimensional elements.

Module 6 introduces iso-parametric formulations and numerical integration techniques used in finite element computations.

Course Outcomes	After successful completion of this course the students will be able to	
	CO1	**Identify** methods to solve differential equations using weighted residual methods. (**Remembering**)
	CO2	**Describe** the finite element equations of engineering problems governed by second order differential equations. (**Understanding**)
	CO3	**Solve** the engineering problems by using 1D & 2D Finite element methods (**Applying**)
	CO4	**Investigate** field variables of finite element domain using jacobian matrix. (**Analyzing**)
	CO5	**Examine** field variables for their optimum values within finite element domain (**Evaluating**)

	CO6	**Design** the system using optimized finite element field variables (**Creating**)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to FEM and Weighted Residual Methods**	04
		After completing this module, students will be able to: • Define the fundamental concepts, terminology, applications, advantages, and limitations of the Finite Element Method. • Explain mathematical modelling concepts including governing differential equations, field variables, and boundary conditions. • Apply Galerkin and Rayleigh-Ritz methods to obtain approximate solutions of engineering problems governed by differential equations.	
	1.1	**Introductory Concepts** Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM.	
	1.2	**Mathematical Modeling of field problems** Governing Differential equations, primary/secondary variables, boundary conditions	
	1.3	**Weighted residual techniques** Approximate solution of differential equations using Galerkin Method (non-weak form type), Rayleigh Ritz Method (weak form type) mapped over entire domain	
		Self-Learning Topics: Subdomain method, Petrov Galerkin, Point Collocation method	
2		**Basic Concepts of FEM and Energy Methods**	06
		After completing this module, students will be able to: • Explain finite element terminology including nodes, elements, degrees of freedom, coordinate systems, and interpolation functions. • Apply Rayleigh-Ritz based finite element formulations to develop element stiffness matrices and system equations. • Analyze finite element formulations using energy principles and assembly procedures.	
	2.1	**Basic Concepts of the Finite Element Method** Rayleigh Ritz Method mapped over general element, Basic Concepts of the Finite Element Method, Nodes, Elements, internal and external node, degree of freedom, Co-ordinate Systems, Shape and Interpolation Functions	
	2.2	**Principle of minimum total potential** Minimization of a functional, Formulation of 'stiffness matrix', assembly concepts to develop system equations.	
		Self-Learning Topics: Functional Minimization using Calculus of Variations, Comparison of Galerkin and Ritz Methods in FEA	
3		**One-Dimensional Finite Element Problems**	06
		After completing this module, students will be able to:	

	• Apply finite element procedures to solve one-dimensional structural, thermal, and fluid flow problems • Analyze truss and beam structures using stiffness matrix formulations. • Evaluate finite element solutions of one-dimensional engineering systems with respect to accuracy and physical behavior		
	3.1	**1D Structural, Thermal and Fluid Analysis** Stepped and taper bars, spring-Cart Systems, heat transfer through walls/composite walls, fluid network problems.	
	3.2	**Analysis of Trusses and Beams** Stiffness of Truss Members, Analysis of Plane trusses, Stiffness of Beam Members, Analysis of Beams	
	Self-Learning Topics: Comparison of stiffness matrices of 1D truss and 1D beam elements		
4	**Two-Dimensional Finite Element Formulations**		**06**
	After completing this module, students will be able to: • Apply approximation techniques to formulate two-dimensional finite elements using triangular and quadrilateral elements. • Analyze natural coordinate systems and shape function development using Lagrange and Serendipity formulations. • Evaluate finite element models based on convergence requirements and sources of numerical errors.		
	4.1	**Approximation of Geometry and Field Variable** Element analysis of three node triangular element, four node rectangular element.	
	4.2	**Natural coordinates in two dimensions:** serendipity and Lagrange's methods for deriving shape functions for triangular element, quadrilateral element, Convergence criterion, sources of errors	
	Self-Learning Topics: Compatibility, patch test, band width		
5	**Two-Dimensional Vector Variable Problems**		**04**
	After completing this module, students will be able to: • Explain the equations of elasticity for plane stress, plane strain, and axisymmetric problems Explain the working of reciprocating, centrifugal, and axial compressors with and without intercooling. • Analyze stress-strain relationships, strain-displacement matrices, and element stiffness formulations for two-dimensional elements. • Evaluate stress distributions and finite element results for engineering applications using CST and quadrilateral elements.		
	5.1	**Equations of elasticity** Plane stress, plane strain and axi-symmetric problems.	
	5.2	**Coordinate Transformations** Stress-Strain Matrix, Strain-Displacement Relation Matrix, Element Stiffness Matrix, Jacobian Matrix, and stress analysis of CST element & 4-noded quadrilateral element, Isoparametric, Superparametric and Subparametric Elements	

	Self-Learning Topics: Plane Stress vs Plane Strain Case Studies in FEM		
6	**Numerical Integration**		**04**
	After completing this module, students will be able to: • Explain isoparametric, subparametric, and superparametric finite element formulations. • Apply numerical integration techniques such as Newton-Cotes and Gauss Quadrature for finite element computations • Develop finite element solution strategies by selecting appropriate element formulations and numerical integration schemes for engineering problems		
	6.1	**Numerical Integration Schemes** Trapezoidal Rule, Simpson's 1/3 Rule, Newton-Cotes Formula, Gauss Quadrature Formula,	
	6.2	**Numerical Integration Schemes in 2D** Gauss Quadrature in Two Dimensions, Incorporation of Boundary Conditions in Numerical Schemes	
	Self-Learning Topics: Comparative Study of Trapezoidal, Simpson's, and Newton-Cotes Methods		
		Total	**30**

List of Experiments:

Sr. No.	Title of the Experiment
1	**Analysis of Axial Bar** **Objective:** To develop and analyze a finite element model of an axially loaded bar using APDL/Python. **Outcome:** Students will be able to determine nodal displacements, reaction forces, and stress distribution in simple axial members.
2	**Analysis of Stepped Bar** **Objective:** To analyze the effect of varying cross-sections on stress and displacement behavior. **Outcome:** Students will be able to compare analytical and FEM solutions for stepped structural members.
3	**Analysis of Tapered Bar and Design Optimization** **Objective:** To investigate structural response of tapered members and optimize dimensions for weight and strength. **Outcome:** Students will be able to perform parametric studies and identify optimized geometric configurations.
4	**Analysis of Cantilever Beam under Self-Weight** **Objective:** To determine beam deflection and stress due to distributed body loads. **Outcome:** Students will be able to validate beam behavior predicted by FEM with classical beam theory.

5	**Analysis of Simply Supported Beam under UDL and Design Optimization** **Objective:** To evaluate beam performance under uniformly distributed loading and optimize beam dimensions. **Outcome:** Students will be able to assess structural efficiency based on stress and deflection criteria.
6	**Analysis of Bridge Truss** **Objective:** To analyze force distribution and deformation characteristics in a bridge truss structure. **Outcome:** Students will be able to identify critical members and evaluate structural stability.
7	**Analysis of Roof Truss and Design Optimization** **Objective:** To analyze roof truss systems and optimize member sizes for improved structural performance. **Outcome:** Students will be able to propose efficient truss configurations satisfying design requirements.
8	**Heat Transfer through Composite Walls** **Objective:** To perform steady-state thermal analysis of multi-layer wall systems. **Outcome:** Students will be able to determine temperature distribution and heat flow through composite structures.
9	**Plane Stress Analysis of a Plate with Hole** **Objective:** To investigate stress concentration effects in structural components under tensile loading. **Outcome:** Students will be able to evaluate stress concentration regions and interpret contour plots.
10	**Axisymmetric Analysis of a Pressure Vessel under Internal Pressure** **Objective:** To analyze stresses and deformations in rotationally symmetric pressure vessels. **Outcome:** Students will be able to evaluate hoop and radial stresses using axisymmetric FEM models.
11	**Nonlinear Analysis of Beam** **Objective:** To study structural response under nonlinear loading conditions. **Outcome:** Students will be able to distinguish between linear and nonlinear finite element solutions.
12	**3D Analysis of Space Frame** **Objective:** To perform three-dimensional finite element analysis of skeletal structural systems. **Outcome:** Students will be able to develop and evaluate complete 3D structural models using FEM software.

13	**Case Study: Solution of a 2D Plane Stress Problem using Python Programming** **Objective:** To develop a Python-based finite element solution for a two-dimensional plane stress problem and compare the results with commercial FEM software. **Outcome:** Students will be able to formulate element stiffness matrices, assemble global equations, implement boundary conditions, and interpret stress and displacement results through custom FEM code.

Text Books:

1. Textbook of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by J N Reddy, TMH
3. Finite Element Analysis by S. S. Bhavikatti, New Age International Publishers

Reference Books:

1. Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu, Pearson Education
2. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
3. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
4. Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John-Wiley Sons
5. The Finite Element Method in Engineering by S. S. Rao, Butter Worth Heinemann
6. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd

Useful Links:

1. https://nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/105/106/105106051/
3. https://nptel.ac.in/courses/112/104/112104115/
4. https://nptel.ac.in/courses/112/103/112103295/
5. https://nptel.ac.in/courses/112/106/112106135/
6. https://nptel.ac.in/courses/112/106/112106130/
7. https://nptel.ac.in/courses/105/105/105105041/

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 (2 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.
Oral (25 Marks)	Oral examination will be based on the entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME5PEC02	Tool Design & Engineering	L	P	T	L	P	T	Total
		2	2	-	2	1	-	2
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	25	-	50
		Total	150						

Pre-Requisite Courses:	25FE2PCC01 : Materials & Metallurgy
	25ME3PCC03 : Manufacturing Processes

Course Overview

Tool Design and Engineering is a design-oriented course that introduces tooling systems used in modern manufacturing industries. The course covers the fundamentals of sheet metal press working, design principles of press tools, metal cutting mechanics, cutting tool materials, and the design of single-point and multi-point cutting tools. It also introduces basic tooling considerations for non-traditional machining processes such as Electrical Discharge Machining (EDM), Ultrasonic Machining (USM), and micro-machining. The course emphasizes the selection, analysis, and design of tooling solutions for improving manufacturing productivity and quality.

Module 1: Fundamentals of Press Working

This module introduces the basic concepts of sheet metal press working and common press operations used in manufacturing. It covers shearing action, cutting clearance, press tool elements, tool materials, strip feeding methods, and essential safety practices followed in press shops.

Module 2: Design of Press Tools

This module focuses on the design principles of press tools used for sheet metal component production. Students learn strip layout planning, force estimation, and design considerations of important tool elements. The module also introduces progressive, compound, bending, drawing, coining, embossing, and transfer dies along with their applications.

Module 3: Fundamentals of Tool Engineering

This module introduces the fundamentals of metal cutting and machining. Topics include chip formation, cutting forces, heat generation, cutting fluids, and machinability. The module helps students understand factors affecting machining performance and productivity.

Module 4: Cutting Tool Materials and Tool Performance

This module deals with the selection and performance of cutting tool materials. Students study HSS, carbides, ceramics, CBN, and PCD tools along with tool wear, tool life, and basic machining economics. The module develops an understanding of the relationship between tool materials and machining efficiency.

Module 5: Design of Single-Point and Special Machining Tools

This module covers the design aspects of single-point cutting tools, tool geometry, nomenclature systems, and insert-based tooling. It also introduces basic design considerations for EDM electrodes and micro-machining tools used in advanced manufacturing.

Module 6: Design of Multi-Point and Non-Traditional Machining Tools

This module focuses on the design principles of multi-point cutting tools such as broaches, milling cutters, drills, reamers, and taps. The module also introduces tooling considerations for USM and

micro-machining applications, highlighting their role in precision manufacturing		
Course Outcomes	After successful completion of this course, the students will be able to	
	CO1	**Recall** the fundamentals of press working operations, metal cutting processes, and tooling systems used in manufacturing. **(Remembering)**
	CO2	**Explain** the principles, constructional features, and applications of press tools and cutting tools. **(Understanding)**
	CO3	**Apply** design procedures, standards, and calculations for basic press tools and cutting tools used in manufacturing applications. **(Applying)**
	CO4	**Analyze** the influence of tool geometry, cutting conditions, and tool materials on machining performance and tool life. **(Analyzing)**
	CO5	**Evaluate** suitable tooling solutions, tool materials, and machining processes for conventional and non-traditional manufacturing applications. **(Evaluating)**
	CO6	**Design** basic press tools, cutting tools, EDM electrodes, and tooling solutions for precision and micro-manufacturing applications. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Fundamentals of Press Working**	04
		Outcomes: • Explain the principles of press working operations, shearing mechanisms, and cutting clearance used in sheet metal processing. • Describe the functions of press tool elements, tool materials, and strip feeding methods used in press shop operations.	
	1.1	Classification and applications of press working operations. Shearing mechanism and cutting clearance. Press tool terminology and basic tool elements.	
	1.2	Tool materials for punches and dies. Strip feeding methods and material handling. Safety considerations in press shops.	
		Self-Learning Topics: Comparison and Applications of Geometric Modeling Techniques	
2		**Design of Press Tools**	04
		Outcomes: • Apply design considerations for strip layout planning, cutting force estimation, and selection of major press tool components. • Differentiate between various press tools such as progressive, compound, bending, drawing, coining, embossing, and transfer dies based on their applications.	
	2.1	Economic strip layout and scrap minimization. Estimation of cutting force and press capacity. Design considerations of punches, die blocks and strippers. Centre of pressure concept.	

	2.2	Construction and applications of: Progressive dies, Compound dies, Bending dies, Drawing dies, Coining and embossing dies, Transfer dies	
	Self-Learning Topics: Case Study of Progressive Die Design for Mass Production of Sheet Metal Components		
3	**Design for Maintenance and Equipment Management**		**06**
	Outcomes: • Explain the mechanics of metal cutting, chip formation, and cutting force generation during machining operations. • Analyze the effects of machining parameters, cutting fluids, and machinability on machining performance and surface quality.		
	3.1	Mechanics of metal cutting. Orthogonal and oblique cutting. Chip formation and chip types.	
	3.2	Cutting forces and Merchant's force circle. Heat generation during machining. Introduction to cutting fluids. Machinability and surface integrity.	
	Self-Learning Topics: Recent Developments in Machining Processes and Their Impact on Manufacturing Productivity		
4	**Condition Monitoring Techniques**		**06**
	Outcomes: • Describe the characteristics and applications of various cutting tool materials used in manufacturing industries. • Analyze tool wear, tool life, and machining performance to select suitable tooling solutions for machining operations.		
	4.1	Properties and selection of cutting tool materials. High Speed Steel (HSS), Carbides, Ceramics, CBN and PCD. Tool wear mechanisms and tool failure.	
	4.2	Tool life and Taylor's tool life equation. Factors affecting machining performance. Introduction to machining economics.	
	Self-Learning Topics: Advanced Cutting Tool Materials and Coatings Used in High-Speed Machining Applications		
5	**Design of Single-Point and Special Machining Tools**		**06**
	Outcomes: • Apply tool nomenclature systems and design principles for single-point cutting tools and insert-based tooling. • Explain the basic design considerations of EDM electrodes and micro-machining tools for advanced manufacturing applications.		
	5.1	Tool nomenclature and tool geometry. MRS and ORS systems. Design features of: Solid cutting tools, Brazed tipped tools, Indexable insert tools	
	5.2	ISO coding system for inserts and tool holders.	

		Chip breaker concepts. Basic electrode design considerations for EDM. Introduction to micro-tool design and applications.	
	Self-Learning Topics: Applications of EDM Tooling and Micro-Tooling in Precision Manufacturing Industries		
6	**Design of Multi-Point and Non-Traditional Machining Tools**		**04**
	Outcomes: • Apply standard design principles for multi-point cutting tools such as broaches, milling cutters, drills, reamers, and taps. • Evaluate tooling requirements for USM, micro-drilling, and micro-milling applications used in precision manufacturing.		
	6.1	Design principles of: Form tools, Broaches, Milling cutters, Twist drills, Reamers, Taps	
	6.2	Tool selection criteria. Basic tooling design considerations for USM. Tooling requirements for micro-drilling and micro-milling. Applications in precision and micro-manufacturing.	
	Self-Learning Topics: Tooling Requirements and Industrial Applications of Micro-Machining and Non-Traditional Machining Processes		
		Total	**30**

List of Experiments:

Sr. No.	List Of Experiments
1	**Study and Identification of Various Press Working Operations and Press Tool Components Using Industrial Samples/Models** **Objective:** To familiarize students with different press working operations and the constructional features of press tool components. **Outcome:** Students will be able to identify various press working operations and describe the functions of major press tool components.
2	**Determination of Cutting Clearance and Estimation of Blanking Force for a Given Sheet Metal Component** **Objective:** To understand the significance of cutting clearance and calculate the blanking force required for sheet metal operations. **Outcome:** Students will be able to determine appropriate cutting clearance and estimate blanking force for press tool design.
3	**Design of Strip Layout and Calculation of Material Utilization for a Progressive Die** **Objective:** To develop strip layouts and evaluate material utilization in progressive die design. **Outcome:** Students will be able to prepare strip layouts and calculate material utilization for economical die design.
4	CAD Modeling and Assembly Drawing of a Simple Progressive or Compound Die

	Objective: To develop CAD models and assembly drawings of press tools using standard design practices. **Outcome:** Students will be able to create CAD models and assembly drawings of simple press tools.
5	**Analysis of Chip Formation and Influence of Cutting Parameters Using Machining Case Studies or Simulation Software** **Objective:** To study chip formation mechanisms and the effect of cutting parameters on machining performance. **Outcome:** Students will be able to analyze chip characteristics and evaluate the influence of cutting parameters on machining operations.
6	**Comparative Study and Selection of Cutting Tool Materials for Different Machining Applications** **Objective:** To understand the properties of cutting tool materials and their suitability for various machining applications. **Outcome:** Students will be able to select appropriate cutting tool materials based on machining requirements and operating conditions.
7	**Design and Nomenclature Study of Single-Point Cutting Tools Using MRS and ORS Systems** **Objective:** To understand tool nomenclature systems and design features of single-point cutting tools. **Outcome:** Students will be able to specify tool geometry and interpret tool nomenclature using MRS and ORS systems.
8	**Design Calculations for a Drill, Reamer, Milling Cutter, or Broach Based on Standard Design Procedures.** **Objective:** To apply standard design procedures for the design of multi-point cutting tools. **Outcome:** Students will be able to perform design calculations for commonly used multi-point cutting tools.
9	**Design Assignment on EDM Electrode and USM Tool for a Given Profile/Component** **Objective:** To understand the tooling requirements and design considerations for non-traditional machining processes. **Outcome:** Students will be able to develop basic designs of EDM electrodes and USM tools for specified applications.
10	**Mini-Project/Case Study on Tooling Solutions for Precision Manufacturing or Micro-Machining Applications** **Objective:** To integrate tool design principles for solving practical manufacturing problems in precision and micro-machining applications.

	Outcome: Students will be able to propose and justify suitable tooling solutions for advanced manufacturing applications.

Text Books:

1. Press Tools: Design and Construction, Author: P. H. Joshi, Publisher: S. Chand Publishing Edition: 3rd Edition, 2022
2. Cutting Tools, Author: P. H. Joshi, Publisher: A.H. Wheeler Publishing Co. Ltd. Edition: Latest Reprint Available
3. Production Engineering, Author: P. C. Sharma, Publisher: S. Chand Publishing Edition: Latest Revised Edition

Reference Books:

1. Machine Tools Handbook: Design and Operation, P. H. Joshi, McGraw Hill Education (India), 1st Edition
2. Fundamentals of Metal Cutting and Machine Tools, B. L. Juneja, G. S. Sekhon and Nitin Seth, New Age International Publishers, 3rd Edition
3. Manufacturing Technology, Volume–II: Metal Cutting and Machine Tools, P. N. Rao Publisher: McGraw Hill Education (India), 4th Edition, 2018
4. Tool Design,Cyril Donaldson, George H. LeCain and V. C. Goold, McGraw Hill Education, 5th Edition
5. Fundamentals of Metal Machining and Machine Tools, Authors: Winston A. Knight and Geoffrey Boothroyd, Publisher: CRC Press, 3rd Edition

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 (2 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.
Oral (25 Marks)	Oral examination will be based on the entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME5PEC03	Industrial Utility Systems	L	P	T	L	P	T	Total
		2	2	-	2	1	-	3
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR/OR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	25	-	50
		Total	150						

Pre-Requisite Courses:	25ME3PCC04: Thermodynamics
	25ME4PCC02: Fluid Mechanics & Hydraulic machinery

Course Overview:

The Industrial Utility Systems course introduces students to the various utility systems used in industrial plants and commercial buildings for effective operation, energy management, and process support. The course focuses on steam generation and distribution, refrigeration and HVAC systems, pumping and compressed air systems, electrical utilities, and utility energy auditing practices. Emphasis is given to energy efficiency, utility optimization, maintenance, safety practices, and sustainable industrial operations.

Module 1 introduces the fundamentals, classification, plant layout, integration, and safety aspects of industrial utility systems.

Module 2 covers steam generation, steam distribution systems, thermic fluid heating systems, industrial furnaces, fuel handling systems, and energy conservation in boiler operations.

Module 3 focuses on refrigeration, cooling towers, chillers, HVAC systems, industrial water systems, and cooling utility applications.

Module 4 deals with pumps, compressors, fans, blowers, compressed air systems, maintenance practices, and energy-efficient utility equipment operation.

Module 5 introduces industrial electrical utility systems including transformers, motors, VFDs, power factor improvement, harmonics, and electrical safety.

Module 6 covers utility energy auditing, benchmarking, instrumentation, waste heat recovery, and industrial utility optimization techniques.

Course Outcomes	After successful completion, the students will be able to	
	CO1	**Recall** the fundamental concepts related to industrial utility systems. **(Remembering)**
	CO2	**Explain** the construction, working principles, and operation of industrial utility systems used in industries and buildings. **(Understanding)**
	CO3	**Apply** engineering principles to evaluate the performance of utility systems such as boilers, pumps, compressors, refrigeration, and electrical utilities. **(Applying)**
	CO4	**Analyze** the effect of operating parameters, losses, and system characteristics on utility system performance and efficiency. **(Analyzing)**
	CO5	**Evaluate** utility systems and energy conservation techniques based on efficiency, safety, reliability, and industrial applications. **(Evaluating)**
	CO6	**Propose** suitable utility optimization and energy-efficient solutions for industrial utility systems. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Industrial Utility Systems**	04
		Learning Outcomes: • Recall the classification and importance of industrial utility systems. • Explain utility flow, plant layout, and utility integration in industries.	
	1.1	Introduction to industrial utilities, Classification of utility systems, Importance of utilities in industries and buildings	
	1.2	Utility flow and plant layout, Utility integration in manufacturing industries, Industrial utility safety practices	
	Self-Learning Topics: Smart utility management systems, Green building utility integration		
2		**Steam Generation, heating and Distribution Systems**	05
		Learning Outcomes: • Explain the working of boilers, steam distribution systems, burners, and industrial furnaces. • Apply boiler efficiency calculations and steam system performance evaluation methods. • Evaluate steam recovery and energy conservation techniques in utility systems.	
	2.1	Steam and its industrial applications, Industrial Boilers and Boiler house layout, Steam quality and steam distribution systems, Steam traps, Flash steam recovery and condensate recovery systems, Pressure Powered Pumping Packaged Unit (PPPPU)	
	2.2	Boiler efficiency and heat losses, Boiler energy conservation measures, Boiler maintenance and safety practices	
	2.3	Thermic fluid heaters, Heat transfer fluids, Industrial furnaces, Burners and combustion systems, Fuel handling systems (coal, biomass, liquid and gaseous fuels)	
	Self-Learning Topics: Biomass-fired industrial heating systems, Boiler automation and monitoring systems		
3		**Refrigeration, Cooling and HVAC Utility Systems**	08
		Learning Outcomes: • Explain the working of refrigeration systems, chillers, cooling towers, and HVAC systems • Apply performance parameters to evaluate cooling tower and refrigeration system performance • Analyze industrial water and cooling utility systems for efficient operation.	
	3.1	Fundamentals and Components of HVAC, Vapour compression refrigeration system	
	3.2	Industrial chillers and cooling towers – types, components and working, Heat pumps, Chilled water and condenser water systems, Cooling tower water treatment methods	
	3.3	Refrigeration and Cooling tower performance parameters	
	Self-Learning Topics: Green refrigerants and environmental regulations, Building automation systems in HVAC		

4		**Pumps, Compressors and Utility Equipment**	**06**
		Learning Outcomes: • Explain the construction and working of pumps and compressors. • Apply pump and compressor performance characteristics for utility applications. • Analyze cavitation, leakage losses, and energy-efficient operation of utility equipment. • Evaluate preventive maintenance and heat recovery techniques for utility systems.	
	4.1	Types of pumps, Dynamic and positive displacement pumps – types, construction and working, Industrial pumping systems, Pumps in series and parallel, Pump operating and system characteristics, Cavitation and NPSH (Introduction), Applications	
	4.2	Types of compressors – Construction and working, Compressed air systems, Compressed air distribution and leak management, Energy-efficient compressed air systems, Heat recovery from compressors	
	4.3	Fans and blowers, Affinity laws, Energy-efficient operation of pumps and compressors, Preventive maintenance of utility equipment,	
	Self-Learning Topics: IoT-based predictive maintenance systems, Variable speed pumping systems		
5		**Electrical Utilities for Mechanical Engineers**	**05**
		Learning Outcomes: • Explain industrial electrical power distribution and utility equipment operation. • Apply electrical utility performance concepts such as power factor and motor efficiency. • Analyze harmonics and energy losses in industrial electrical systems. • Evaluate electrical safety and energy conservation techniques in industrial utilities.	
	5.1	Industrial electrical utility systems, Power distribution in industries, Transformers, Transformer losses and efficiency	
	5.2	Motors used in utility systems, IE3 and IE4 energy-efficient motors, Variable Frequency Drives (VFD), Power factor and its improvement techniques, Harmonics in industrial systems	
	5.3	Electrical safety in utility systems, Electrical measurements for utility systems, Energy conservation in electrical utilities	
	Self-Learning Topics: Smart motor control systems		
6		**Utility Energy Audit and Optimization**	**05**
		Learning Outcomes: • Explain utility auditing procedures and optimization techniques. • Apply utility measurements and benchmarking methods for industrial systems. • Analyze utility system performance using audit data and case studies. • Propose suitable energy conservation and optimization techniques for industrial utilities.	
	6.1	Introduction to utility energy auditing, Utility performance indicators and benchmarking, Boiler and steam system audit, Pump and compressor audit, Cooling tower and chiller audit	

	6.2	Utility instrumentation and measurements, Waste heat recovery systems, Industrial utility optimization techniques, Case studies on industrial utility energy conservation	
	Self-Learning Topics: Energy management systems (EnMS), AI applications in industrial utility optimization		
		Total	**30**

List of Experiments:

Experiment. no.	Title of the Experiment
1	**Study of industrial utility layout and utility integration in manufacturing industries**. **Objective:** To understand utility flow and integration in industrial plants. **Outcome:** Students will be able to identify utility systems and explain utility integration practices in industries.
2	**Demonstration/ e-learning of industrial boilers, steam traps, condensate recovery, and flash steam recovery systems.** **Objective:** To study steam generation and recovery systems. **Outcome:** Students will be able to explain steam distribution and recovery systems used in industries.
3	**Study of boiler efficiency and heat loss analysis.** **Objective:** To evaluate boiler performance and heat losses. **Outcome:** Students will be able to calculate boiler efficiency and identify methods to improve performance.
4	**Study of thermic fluid heaters, burners, and industrial furnace systems.** **Objective:** To understand industrial heating systems and combustion equipment. **Outcome:** Students will be able to explain industrial heating equipment and combustion systems.
5	**Demonstration of refrigeration and HVAC systems.** **Objective:** To study components and working of refrigeration and HVAC systems. **Outcome:** Students will be able to identify HVAC components and explain refrigeration cycle operation.

6	**Performance study of cooling tower and chiller systems.** **Objective:** To evaluate cooling tower and chiller performance parameters. **Outcome:** Students will be able to analyze cooling utility system performance.
7	**Trial on centrifugal pump characteristics and pumps in series/parallel.** **Objective:** To study pump performance characteristics. **Outcome:** Students will be able to evaluate pump operating characteristics and system performance.
8	Trial/ e-learning on regenerative pump. **Objective:** To study pump working and it performance characteristics. **Outcome:** Students will be able to explain the working and evaluate pump performance.
9	**Study of compressed air systems and leak detection methods.** **Objective:** To analyze compressed air distribution and leakage management. **Outcome:** Students will be able to identify leakages and recommend energy conservation measures.
10	**Study of industrial compressors, fans, and blowers.** **Objective:** To understand utility equipment operation and applications. **Outcome:** Students will be able to explain construction and working of compressors, fans, and blowers.
11	**Study of transformers, motors, VFDs, and power factor improvement methods.** **Objective:** To study industrial electrical utility systems. **Outcome:** Students will be able to explain industrial electrical utility components and energy-saving techniques.
12	**Utility energy audit case study on boiler/pump/compressor/chiller systems.** **Objective:** To perform utility performance assessment and benchmarking. **Outcome:** Students will be able to evaluate utility performance and suggest optimization methods.

Text Books:

1. Refrigeration and Air Conditioning — C. P. Arora, Publisher: McGraw Hill Education India, Latest Edition: 4th Edition
2. Fluid Power – Generation, Transmission and Control — Jagadeesha T., Thammaiah Gowda,

Publisher: Wiley India, Edition: 2019

3. Pumps, Compressors, Fans and Blowers — S. M. Yahya, Publisher: McGraw Hill Education India, Latest Edition: Latest Reprint
4. Electrical Technology (Vol. I & II) — B. L. Theraja & A. K. Theraja, Publisher: S. Chand Publications, Latest Edition: Latest Multicolor Edition
5. Thermal Engineering — R. S. Khurmi & J. K. Gupta, Publisher: S. Chand Publications, Latest Edition: Latest Revised Edition
6. Energy Management Handbook for Energy Auditors and Managers — K. V. Sharma , Publisher: S. K. Kataria & Sons, Latest Edition/Reprint: 2023
7. Handbook of Energy Efficiency for Industry — Ramesh Bhatia, Publisher: Associated Publishing Company, Edition: 2021

Reference Books:

1. Energy Conservation and Management — S. C. Tripathy, Publisher: McGraw Hill Education India, Latest Edition: Revised Edition
2. Utilization of Electrical Energy — E. Openshaw Taylor revised by Indian editions, Publisher: Orient Longman / Universities Press, Latest Edition: Latest Indian Edition
3. Boilers: Operation, Maintenance and Management — Mohamed A. Malek, Publisher: CRC Press, Latest Edition: Latest Edition
4. ASHRAE Handbook – HVAC Systems and Equipment — ASHRAE, Publisher: ASHRAE, Latest Edition: Current Handbook Series

Useful Links:

1. https://www.udemy.com/course/industrial-utilities-steam-air-cooling-power-systems/?couponCode=KEEPLEARNING
2. https://datastatresearch.com/courses/plant-utility-systems-management-training-course
3. https://www.coursera.org/specializations/design-of-utility-systems-for-industrial-plants
4. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ch28
5. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me85

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 (2 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.
Oral (25 Marks)	Oral examination will be based on the entire syllabus.

The Bombay Salesian Society's

Don Bosco Institute of Technology, Mumbai

(An Autonomous Institute affiliated to University of Mumbai)

CURRICULUM STRUCTURE
Multi-Disciplinary Minor (MDM) Courses
Semester V

(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, 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			
25ET5MDM01	Design of IoT	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	OR/PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	-	-	25
		Total	125						

Pre-Requisite Courses:	25FE1BSC01: Engineering Physics
	25FE1VSEC01: C Programming
	25FE1ESC02: Basic Electrical and Digital Electronics
	25ET4MDM0: Embedded Systems

Course Overview:

This course gives students a complete guide to building smart, connected systems using the Internet of Things (IoT). It is highly useful for Computer Science (Comp) and Information Technology (IT) students because it teaches them how to collect big data, use cloud platforms like ThingSpeak, and manage network protocols like MQTT. These students will learn to write code that safely connects hardware to web servers and handles data visualization. Mechanical (Mech) students will benefit greatly because modern machinery, factories, and vehicles rely heavily on smart sensors and automatic actuators to run smoothly. They will learn how to read physical values like temperature or motion and turn them into digital data to automate tasks. By bringing these fields together, the course allows Comp and IT students to understand physical machine parts, while Mech students learn how to make their mechanical designs smart and connected. Everyone will gain hands-on skills in prototyping with Arduino and Raspberry Pi, which are highly valued in smart manufacturing and automation jobs. Ultimately, this course helps students from different fields work together to design, build, and secure real-world smart systems.

Module 1 introduces the fundamental concepts of the Internet of Things (IoT), including its architecture, components, and characteristics. It also explains the differences between M2M and IoT systems and introduces Cloud, Fog, and Edge computing paradigms used in IoT applications.

Module 2 focuses on popular IoT development platforms such as Arduino, NodeMCU, and Raspberry Pi. Students learn to interface sensors and actuators with microcontrollers and develop basic programs for data acquisition and device control.

Module 3 covers common wireless communication technologies used in IoT, including Wi-Fi, Bluetooth, ZigBee, and LoRaWAN. It also introduces IoT communication protocols such as MQTT and CoAP and compares them with traditional HTTP communication.

Module 4 explains the role of cloud computing in IoT systems and demonstrates how sensor data can be transmitted, stored, and visualized using cloud platforms such as ThingSpeak. Students also learn to create dashboards and configure simple automated alerts.

Module 5 introduces the security challenges associated with IoT devices and networks. It covers fundamental security practices such as authentication, encryption, password management, and firmware updates to protect IoT systems from common threats.

Module 6 presents the complete workflow of an IoT system, from data collection to cloud-based analytics and decision-making. It explores real-world applications of IoT in smart homes, healthcare monitoring, and intelligent transportation systems through practical case studies.

Course Outcomes (COs)	After successful completion of the course, the students will be able to:	
	CO1	**State** the basic differences between standard Machine-to-Machine (M2M) communication and cloud, fog, or edge computing. **(Remembering)**
	CO2	**Describe** the pin outs and features of development boards like Arduino Uno, NodeMCU, and Raspberry Pi. **(Understanding)**
	CO3	**Construct** simple Arduino IDE sketches to read data from sensors and trigger physical actuators like relays. **(Applying)**
	CO4	**Analyze** cloud based IoT data and configure automated alert mechanisms. **(Analyzing)**
	CO5	**Evaluate** and **select** appropriate IoT communication protocols for specific applications **(Evaluating)**
	CO6	**Build** a step-by-step IoT case study application that connects physical sensors to a functional web dashboard. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to IoT Basics**	07
		After completing this module, students will be able to: • Define what IoT is and identify its basic structural building blocks. • Explain the main differences between standard Machine-to-Machine (M2M) communication and IoT. • Understand the basic concepts of Cloud, Fog, and Edge computing.	
	1.1	Definition, characteristics, and basic components of an IoT system. Physical and logical design of IoT.	
	1.2	Difference between M2M (Machine to Machine) and IoT. Introduction to Cloud computing, Fog computing, and Edge computing in IoT.	
		Self-Learning Topics: Basic real-world examples of IoT like Smart Homes and Smart Agriculture.	
2		**IoT Hardware and Prototyping (Arduino & Raspberry Pi)**	08
		After completing this module, students will be able to: • Differentiate between common IoT development boards like Arduino Uno, NodeMCU, and Raspberry Pi. • Connect common sensors (Temperature, Motion, and Gas) and actuators (Relays, Motors) to a microcontroller. • Write simple Arduino IDE sketches to read sensor data and control outputs.	
	2.1	Introduction to popular IoT boards: Arduino Uno, NodeMCU (ESP8266/ESP32), and Raspberry Pi pin outs and features.	
	2.2	Interfacing Sensors: DHT11 (Temperature & Humidity), PIR (Motion Sensor), Ultrasonic (Distance), and MQ-2 (Gas/Smoke Sensor).	

	2.3	Interfacing Actuators: Relays (for switching AC home appliances), LEDs, Buzzers, and Servo Motors.	
	2.4	Programming Basics: Writing, compiling, and uploading basic C/C++ code using the Arduino IDE.	
	Self-Learning Topics: Understanding the "Blink" and "Serial Monitor" examples in Arduino IDE.		
3	**Wireless Technologies and IoT Protocols**		**08**
	After completing this module, students will be able to: • Identify common wireless technologies used in IoT and their basic ranges (Wi-Fi, Bluetooth, ZigBee, LoRa). • Explain how the MQTT protocol works using the Publish-Subscribe model. • Compare HTTP protocol with lightweight IoT protocols like MQTT and CoAP.		
	3.1	Overview of IoT connectivity: Wi-Fi, Bluetooth/BLE, ZigBee, and LoRaWAN (Basic features, range, and use cases).	
	3.2	Introduction to IoT Application Protocols: MQTT (Publish/Subscribe, Broker, Client concept) and CoAP (Request/Response).	
	3.3	Comparison between HTTP and MQTT protocols for small devices.	
	3.4	Overview of REST APIs: Architectural Constraints and HTTP Methods mapped to CRUD operations	
	Self-Learning Topics: Study how a wireless Wi-Fi router connects IoT devices to the internet.		
4	**Cloud Platforms for IoT**		**08**
	After completing this module, students will be able to: • Send sensor data from an IoT board to a free cloud platform over Wi-Fi. • Create online dashboards with graphs to view live data remotely on a phone or laptop. • Set up simple automatic alerts (like an email notification when temperature crosses a limit).		
	4.1	Introduction to IoT Cloud platforms: Why do we need the cloud? Overview of free platforms like ThingSpeak.	
	4.2	Data Logging: Sending sensor data to ThingSpeak channels using API keys.	
	4.3	Data Visualization: Creating online charts, gauges, and graphs. Setting up simple triggers (e.g., using IFTTT for email alerts).	
	Self-Learning Topics: Creating a free account on ThingSpeak and exploring its public channels. Overview of Industrial Platforms (AWS IoT, Azure IoT hub etc.)		
5	**Basic IoT Security**		**08**
	After completing this module, students will be able to: • Identify the common security risks and attack points in a simple IoT setup. • Understand the basic importance of passwords, encryption, and secure updates for smart devices.		
	5.1	Introduction to IoT security challenges: Privacy issues, weak passwords, and physical tampering of devices.	

	5.2	Basic security practices: Device authentication, data encryption basics, and the importance of regular firmware updates.	
	Self-Learning Topics: Reading about famous IoT cyberattacks (like the Mirai Botnet) in plain language.		
6	**IoT Applications and Case Studies**		**07**
	After completing this module, students will be able to: • Explain the step-by-step working mechanism of a complete IoT system. • Discuss how IoT is transforming industries like healthcare, home automation, and city planning.		
	6.1	Step-by-step design of an IoT project: From sensor data collection to cloud storage.	
	6.2	Real-world Applications: Smart Home Automation (Lights/Fans control).	
	6.3	Smart Health Monitoring (Pulse/Heart rate tracking), and Smart Traffic Management.	
	Self-Learning Topics: Finding a simple DIY IoT project tutorial on Hackster.io and summarizing it. Writing report on various case studies.		
		Total	**45**

List of Experiments:

Experiment No.	Title of the Experiment
1	**Network Architecture Simulation: Cloud vs. Edge Computing** **Objective:** To understand the differences between Cloud, Fog, and Edge processing models by analyzing data latency and bandwidth usage. **Outcome:** Simulate network topologies to evaluate the structural building blocks and communication delays of an IoT system.
2	**M2M vs. IoT Communication Framework Analysis** **Objective:** To study the distinct architectural differences between point-to-point Machine-to Machine (M2M) communication and internet-connected IoT structures. **Outcome:** Model and distinguish data flows for isolated M2M setups versus internet-routed cloud IoT networks.
3	**Sensor Interfacing and Serial Monitoring** **Objective:** To interface environmental sensors like the DHT11 (Temperature & Humidity) or MQ-2 (Gas) with an Arduino Uno/NodeMCU board using the Arduino IDE. **Outcome:** Write, compile, and upload sketches to read analog/digital sensor inputs and view real-time data on the Serial Monitor.
4	**Actuator Control and Relay Interfacing** **Objective:**

	To interface high-power actuators like AC home appliances via Relays, LEDs, and Buzzers with an IoT development board. **Outcome:** Develop an Arduino IDE program to trigger physical actuators based on specific sensory threshold inputs.
5	**Wireless Connectivity Setup and Wi-Fi Configuration** **Objective:** To configure a NodeMCU (ESP8266/ESP32) board to scan and connect to local wireless networks using local Wi-Fi router parameters. **Outcome:** Establish a stable local wireless link and verify the device network configurations and IP assignment.
6	**MQTT Publish-Subscribe Communication Modeling** **Objective:** To implement lightweight application protocol communication using the MQTT Publish-Subscribe model via an external MQTT Broker. **Outcome:** Create an MQTT client to publish sensor payloads and subscribe to control topics, comparing it against heavy HTTP transactions.
7	**Cloud Data Logging on ThingSpeak** **Objective:** To upload real-time sensor data packets from an internet-connected NodeMCU board to a free cloud platform over Wi-Fi using Write API keys. **Outcome:** Configure remote IoT data streaming channels on ThingSpeak to systematically store long-term sensor logs.
8	**Cloud Visualization Dashboards and Web Alerts** **Objective:** To construct online charts, gauges, and visualization widgets on an IoT platform and set up automated email/SMS alerts via IFTTT triggers. **Outcome:** Create a functional web dashboard for remote monitoring and trigger emergency notifications when a sensor value breaches safety limits.
9	**Device Authentication and Firmware Protection** **Objective:** To study the implementation of basic security practices including strong device passwords, authentication keys, and encrypted payloads. **Outcome:** Build a secure connection script that rejects unauthenticated communication requests and protects the node from physical tampering vulnerabilities.
10	**Secure Firmware Updates and Vulnerability Assessment** **Objective:** To understand the importance of regular firmware updates and analyze common security attack points like the Mirai Botnet framework. **Outcome:**

	Perform a simulated remote secure firmware update (OTA) and identify open vulnerabilities in an unpatched IoT device node.
11	**Local Storage Data Logging** **Objective:** To log sensor data locally on an SPI-based MicroSD card module during network connection or internet dropouts. **Outcome:** Implement a backup storage architecture that prevents data loss when the primary Wi-Fi cloud connection fails.
12	**Bluetooth Low Energy (BLE) Beacon Advertisement** **Objective:** To configure an ESP32 micro-controller as a Bluetooth Low Energy (BLE) beacon to broadcast custom data packets. **Outcome:** Transmit environment parameters over BLE and read them successfully using a mobile phone application.
13	**Ultrasonic Distance Measurement and Buzzer Alert System** **Objective:** To interface an HC-SR04 ultrasonic distance sensor to calculate object proximity and trigger physical audio alerts. **Outcome:** Write an algorithmic loop to map distance values into changing frequency alarm outputs using microcontrollers.
14	**Edge-Based Data Filtering and Threshold Processing** **Objective:** To filter noisy raw sensor data directly at the edge node using a simple moving average filter before transmission. **Outcome:** Reduce network bandwidth usage by transmitting data only when significant parameter variations breach pre-set limits.
15	**CoAP Protocol Request-Response Implementation** **Objective:** To study the lightweight Constrained Application Protocol (CoAP) using a request-response communication model on a local server. **Outcome:** Create a CoAP client node to read resources from an IoT sensor device with low network overhead.

Suggested Course Project Areas

1. Smart Home Automation and Appliance Control System
2. IoT-Based Smart Agriculture and Soil Moisture Monitor
3. Remote Patient Health Telemetry Station (Pulse & Temperature)
4. Smart Weather Station with Cloud Logging (ThingSpeak)
5. IoT Smoke & Gas Leakage Detector with IFTTT Email Alerts
6. Smart Waste Management and Garbage Bin Level Tracker
7. Intruder Detection System with PIR Sensor and MQTT Alerts

Textbooks

1. Internet of Things (IoT), S.K. Kataria & Sons, Dr. Rajiv Chopra, 1st Edition (2022).
2. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, Pethuru Raj and Anupama C. Raman, 1st Edition (2022).
3. Internet of Things, Oxford University Press India, Dr. Surya Durbha and Dr. Jyoti Joglekar, 1st Edition (2019).
4. Internet of Things (IoT): Principles, Paradigms and Applications of IoT, BPB Publications, Dr. Kamlesh Lakhwani, Dr. Hemant Kumar Gianey, Joseph Kofi Wireko, and Kamal Kant Hiran, 1st Edition (2020).

Reference Books

1. Internet of Things A to Z: Technologies and Applications, Wiley-IEEE Press, Qusay F. Hassan, 2nd Edition (2026).
2. The Internet of Things, MIT Press, Samuel Greengard, Revised and Updated Edition (2021).
3. Wireless Networks and Industrial IoT: Applications, Challenges and Enablers, Springer International Publishing, Nurul Huda Mahmood, Nikolaj Marchenko, Mikael Gidlund, and Petar Popovski, 1st Edition (2020).
4. Industry 4.0 and Industrial IoT, Amazon Digital Services, Dr. Ashutosh Kumar Dubey and Prof. (Dr.) S. B. Choraddi, 1st Edition (2023).

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)

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.

Course Code	Course Name	Teaching Scheme (Hrs./ Week)			Credits Assigned			
25ET5MDM02	Data Acquisition and Industrial Monitoring	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:	25FE1BSC02 Applied Physics
	25FE1ESC02 Basic Electrical and Digital Electronics
	25FE1VSEC01: Problem Solving using C Programming
	25ET4MDM02: Sensor Technology

Course Overview:

This course builds upon Sensor Technology and focuses on acquisition, conditioning, processing, visualization and interfacing of sensor data in modern engineering systems. The course is designed for Mechanical, Computer and Information Technology students and emphasizes interdisciplinary applications in Industry 4.0, robotics, automation, smart manufacturing, predictive maintenance and intelligent monitoring systems

Module 1 introduces the fundamentals of measurement systems, instrumentation, and sensor technologies used in engineering applications. It covers the operating principles of conventional and smart sensors, along with their static and dynamic performance characteristics. Students will learn calibration techniques, error analysis methods, and the role of sensors in mechanical, IT, and computer-based systems. The module also provides an introduction to virtual instrumentation for modern measurement and monitoring applications.

Module 2 focuses on the acquisition and conditioning of analog and digital signals for accurate measurement and processing. It covers instrumentation amplifiers, Wheatstone bridge circuits, filtering techniques, and methods for reducing noise and interference. Students will understand how signal conditioning improves data quality and reliability in engineering systems. The module also introduces programmable gain amplifiers used in modern instrumentation applications.

Module 3 introduces the principles and architecture of data acquisition systems used for collecting and converting real-world signals into digital data. Topics include sampling theory, sample-and-hold circuits, ADCs, DACs, and data logging systems. Students will learn how data is acquired, processed, and stored in modern measurement systems. An overview of industrial SCADA systems is also provided for self-learning.

Module 4 explores the integration of sensors and data acquisition systems with embedded platforms. It covers microcontroller-based acquisition systems and widely used communication protocols such as UART, I2C, SPI, and CAN bus. Students will gain knowledge of reliable data exchange between embedded devices and peripheral systems. The module also introduces the Modbus protocol used in industrial automation.

Module 5 focuses on processing, analyzing, and visualizing sensor-generated data for meaningful interpretation. It includes data preprocessing, statistical analysis, filtering methods, and feature

extraction techniques. Students will learn how to transform raw sensor data into useful information and present it effectively using Python-based visualization tools. The module also provides a foundation for applying machine learning techniques to sensor data.

Module 6 introduces intelligent engineering systems and emerging Industry 4.0 technologies. It covers Cyber-Physical Systems, Digital Twin concepts, predictive maintenance, machine condition monitoring, and smart manufacturing practices. Students will understand how advanced sensing, data analytics, and automation contribute to intelligent industrial operations. The module also explores future trends and emerging intelligent engineering systems through self-learning.

Course Outcomes	After successful completion of the course, the students will be able to	
	CO1	**Define** measurement systems, sensors and signal acquisition principles. **(Remembering)**
	CO2	**Explain** signal conditioning circuits, data acquisition architectures and conversion techniques. **(Understanding)**
	CO3	**Implement** sensor interfacing and communication protocols using embedded platforms. **(Applying)**
	CO4	**Analyze** acquired sensor data using processing and visualization techniques. **(Analysing)**
	CO5	**Evaluate** intelligent monitoring solutions for engineering applications. **(Evaluating)**
	CO6	**Design** integrated sensor-based intelligent systems for real-world applications. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Sensors and Measurement Systems**	05
		After completing this module, students will be able to: • Explain the fundamentals of measurement systems, instrumentation, and sensor technologies. • Differentiate between conventional sensors and smart sensors based on their characteristics and applications. • Analyze the static and dynamic performance characteristics of sensors and measurement systems. • Perform calibration and error analysis for measurement systems and identify their applications in mechanical, IT, and computer-based engineering systems.	
	1.1	Introduction to Measurement Systems and Instrumentation	
	1.2	Review of Sensors and Introduction to Smart Sensors	
	1.3	Study of Static and Dynamic Characteristics of Sensors	
	1.4	Calibration Techniques and Error Analysis in Measurement Systems	
	1.5	Applications in Mechanical, Information Technology and Computer Engineering Systems	
		Self-Learning Topics: Introduction to Virtual instrumentation.	

2	**Signal Acquisition and Conditioning**		05
	After completing this module, students will be able to: • Differentiate between analog and digital signals used in measurement systems. • Analyze the operation of instrumentation amplifiers and Wheatstone bridge circuits. • Design and apply active and passive filters for signal conditioning. • Implement noise reduction and shielding techniques to improve signal quality.		
	2.1	Fundamentals of Analog and Digital Signals	
	2.2	Operation and Applications of Instrumentation Amplifiers	
	2.3	Principles and Applications of Wheatstone Bridge Circuits	
	2.4	Design and Implementation of Active and Passive Filters	
	2.5	Techniques for Noise Reduction and Signal Shielding	
	Self-Learning Topics: Introduction to Programmable Gain Amplifiers.		
3	**Sensor Data Acquisition System**		05
	After completing this module, students will be able to: • Explain the principles of signal sampling and data acquisition. • Compare different types of ADCs and DACs based on their characteristics and applications. • Analyze the role of sample-and-hold circuits in data acquisition systems. • Evaluate the architecture and operation of data loggers and DAQ systems.		
	3.1	Principles of the Sampling Theorem	
	3.2	Working of Sample-and-Hold Circuits in Data Acquisition Systems	
	3.3	Fundamentals and Types of Analog-to-Digital Converters (ADCs)	
	3.4	Fundamentals and Applications of Digital-to-Analog Converters (DACs)	
	3.5	Architecture and Operation of Data Loggers and DAQ Systems	
	Self-Learning Topics: Overview of industrial SCADA system.		
4	**Embedded Interfacing and Communication**		05
	After completing this module, students will be able to: • Develop basic microcontroller-based data acquisition and interfacing systems. • Explain the working principles of UART, I²C, and SPI communication protocols. • Analyze CAN bus communication for industrial and automotive applications. • Select appropriate communication protocols for embedded system applications.		
	4.1	Development of Microcontroller-Based Data Acquisition Systems	
	4.2	Fundamentals of UART Communication Protocol	
	4.3	Fundamentals of I2C Communication Protocol	
	4.4	Fundamentals of SPI Communication Protocol	
	4.5	CAN Bus Fundamentals	
	Self-Learning Topics: Introduction to the Modbus protocol		

5	**Sensor Data Processing and Visualization**		05
	After completing this module, students will be able to: • Apply preprocessing techniques to improve the quality of sensor data. • Perform statistical analysis and filtering of acquired data. • Extract meaningful features from sensor signals for further analysis. • Create effective data visualizations using Python-based tools.		
	5.1	Data Preprocessing Techniques for Sensor Signals	
	5.2	Statistical Analysis of Acquired Sensor Data	
	5.3	Application of Filtering Techniques for Signal Enhancement	
	5.4	Feature Extraction from Sensor Data	
	5.5	Data Visualization using Python Libraries (Matplotlib, Pandas, Plotly)	
	Self-Learning Topics: Introduction to Machine Learning for sensor data analysis.		
6	**Intelligent Systems and Industry 4.0 Applications**		05
	After completing this module, students will be able to: • Explain the concepts and components of Cyber-Physical Systems and Digital Twins. • Analyze predictive maintenance strategies using sensor data. • Evaluate machine condition monitoring techniques in industrial environments. • Describe the role of smart manufacturing technologies in Industry 4.0 ecosystems.		
	6.1	Fundamentals of Cyber-Physical Systems	
	6.2	Concepts and Applications of Digital Twins	
	6.3	Predictive Maintenance Using Sensor Data	
	6.4	Machine Condition Monitoring in Industrial Environments	
	6.5	Smart Manufacturing Technologies: Motor Condition Monitoring, Smart factory dashboard Predictive maintenance workflow, Digital twin architecture examples	
	Self-Learning Topics: Emerging Trends in Intelligent Engineering Systems.		
		Total	**30**

List of Experiments:

Experiment No.	Title of the Experiment
1	**Sensor Calibration** **Objective:** To understand sensor calibration procedures and evaluate measurement accuracy. **Outcome:** Calibrate a sensor and determine measurement errors and accuracy.
2	**Temperature Sensor Interfacing** **Objective:** To study the interfacing of temperature sensors with a data acquisition system.

	Outcome: Acquire and interpret temperature data using suitable interfacing techniques.
3	**Pressure Sensor Interfacing** **Objective:** To understand pressure measurement and sensor characteristics. **Outcome:** Interface a pressure sensor and acquire pressure data for analysis.
4	**Instrumentation Amplifier Design** **Objective:** To design signal conditioning circuits for low-level sensor signals. **Outcome:** Design and test instrumentation amplifier circuits for sensor applications.
5	**Filter Implementation** **Objective:** To implement filtering techniques for signal conditioning. **Outcome:** Apply analog and digital filters to improve signal quality.
6	**ADC Interfacing** **Objective:** To understand analog-to-digital conversion and data acquisition. **Outcome:** Interface ADC modules and acquire digital sensor data.
7	**DAC Interfacing** **Objective:** To study digital-to-analog conversion techniques. **Outcome:** Generate analog outputs using DAC interfacing methods.
8	**UART Communication** **Objective:** To establish serial communication between embedded devices. **Outcome:** Implement UART communication for reliable data transfer.
9	**I2C Communication** **Objective:** To study multi-device communication using I2C protocol. **Outcome:** Interface sensors and peripherals using I2C communication.
10	**SPI Communication** **Objective:** To understand high-speed serial communication using SPI protocol. **Outcome:** Implement SPI communication between embedded systems.
11	**Data Logger Development** **Objective:** To develop a system for recording and storing sensor data.

	Outcome: Design and implement a basic sensor data logger.
12	**Sensor Data Acquisition using ESP32** **Objective:** To acquire real-time sensor data using ESP32. **Outcome:** Develop an ESP32-based sensor acquisition system.
13	**Sensor Data Visualization using Python** **Objective:** To visualize acquired sensor data using Python tools. **Outcome:** Generate plots and dashboards for sensor data analysis.
14	**Condition Monitoring System** **Objective:** To monitor machine or process conditions using sensor data. **Outcome:** Analyze sensor data for condition monitoring applications.
15	**Mini Project Demonstration** **Objective:** To integrate course concepts into a practical engineering application. **Outcome:** Develop and demonstrate a sensor-based intelligent monitoring system.

Suggested Mini Project Areas:

1. Machine Health Monitoring System
2. Industrial Data Logger
3. Vibration Monitoring System
4. Environmental Monitoring Station
5. Smart Energy Monitoring System
6. Predictive Maintenance Prototype
7. Multi-Sensor Acquisition Platform

Text Books:

1. Ramon Pallas-Areny, Sensors and Signal Conditioning.
2. D.V.S. Murthy, Transducers and Instrumentation.
3. H.S. Kalsi, Electronic Instrumentation.
4. A.K. Sawhney, Electrical and Electronic Measurements.

Reference Books:

1. John G. Webster, Measurement, Instrumentation and Sensors Handbook.
2. Nathan Ida, Sensors, Actuators and their Interfaces.
3. Robert H. Bishop, Mechatronics Handbook.
4. Behzad Razavi, Fundamentals of Microelectronics

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)
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.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25IT5MDM02	Database Management System	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	OR/PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	-	-	25
		Total	150						

Pre-Requisite courses:	25FE1VESC02 - Problem Solving using C programming
	25FE2PCC04 - Data structure and algorithm

Course Overview

The Database Management System (DBMS) course provides a comprehensive understanding of modern data management principles, database design methodologies, and relational database technologies. Students learn to model real-world applications using ER/EER diagrams, design normalized databases, formulate and optimize SQL queries, and understand transaction processing, concurrency control, and recovery mechanisms. The course also introduces database programming using JDBC and exposes learners to emerging schema-less NoSQL databases, enabling them to build efficient, scalable, and reliable data-driven applications

Module 1: Introduction to Database Management Systems

This module introduces the fundamental concepts of database systems, highlighting the limitations of traditional file processing systems and the advantages offered by DBMS. Students gain an understanding of database architectures, different types of databases, and the roles of various database users, forming the foundation for advanced database concepts.

Module 2: Data Modeling, Database Design and Normalization

This module focuses on conceptual and logical database design techniques. Students learn to develop ER/EER models, transform them into relational schemas, and apply normalization techniques to eliminate redundancy and maintain data consistency. Real-world case studies help learners understand practical database design considerations.

Module 3: SQL and Relational Algebra

This module develops proficiency in SQL for creating, manipulating, and querying databases. It covers SQL commands, aggregate operations, joins, views, stored procedures, triggers, and introduces relational algebra operations that provide the theoretical basis for relational query processing

Module 4: Transaction Processing, Concurrency and Database Recovery

This module explains the mechanisms that ensure reliable and consistent database operations in multi-user environments. Students study transaction properties, scheduling techniques, concurrency control protocols, deadlock handling, and recovery methods that preserve data integrity during failures.

Module 5: Database Programming

This module introduces database connectivity and application-level database interactions. Students learn to establish database connections, execute queries, manage records, and implement CRUD operations using JDBC and Java, enabling the development of database-driven applications.

Module 6: Introduction to Schema-less Databases

This module provides an overview of NoSQL databases and schema-less data models. Students explore the differences between SQL and NoSQL systems, understand their advantages and limitations, and perform basic operations using MongoDB, preparing them for modern large-scale data management environments.

The Database Management System (DBMS) course provides students with a strong foundation in database concepts, design methodologies, and relational database technologies. It enables learners to model, design, query, and manage databases efficiently using SQL, normalization techniques, and transaction management concepts. The course also introduces database programming with JDBC and modern NoSQL databases to support the development of scalable and data-driven applications

Course Outcome	After successful completion, students will be able to	
	CO1	**Recall** fundamental concepts and architectural details related to database management systems. **(Remembering)**
	CO2	**Explain** the fundamental concepts, steps, and techniques involved in database design, query processing and transaction processing. **(Understanding)**
	CO3	**Apply** SQL commands to define, manipulate, and retrieve data using various database objects for effective information storage and processing. **(Applying)**
	CO4	**Analyze** real-world system requirements to construct and optimize database design for consistency and efficiency. **(Analysing)**
	CO5	**Evaluate** database design and identify appropriate techniques for efficient information management/processing. **(Evaluating)**
	CO6	**Design** and implement a normalized relational database to perform database transaction operations effectively. **(Creating)**

Syllabus

Module No.	Unit No.	Topics	Hours
1		**Introduction to Database Management System**	4
		After completion of the module the student will be able to : • Explain the need for DBMS and its advantages over traditional file systems. • Describe database architectures, types, and user roles. • Differentiate among various database models and application domains.	
	1.1	Introduction to DBMS, Advantages over file system, Database terminology and characteristics.	
	1.2	Database architecture, 3-level architecture, Database types and Database Users.	
		Self-Learning Topic: Case Study based on Amazon Database	
2		**Data Modeling, Database Design and Normalization**	**12**

	After completion of the module the student will be able to : • Develop ER/EER diagrams for real-world applications. • Transform conceptual models into relational schemas. • Apply normalization techniques to minimize redundancy and maintain data integrity.		
	2.1	Data modeling and models, E-R Modeling: Entities, Attributes, Relationships, Cardinality, Participation, ER diagrams, Limitations, Relational Modeling, Converting ER model to Relational model.	
	2.2	Extended Entity Relationship (EER), Generalization, Specialization and Association.	
	2.3	Case studies based on ER model (real life examples e.g. Amazon, Spotify, Swiggy, LinkedIn, IRCTC, etc.)	
	2.4	Database Anomalies, Normalization process, Advantages, Functional dependencies (Full, Partial and Transitive), Normal forms: 1NF, 2NF and 3NF.	
	Self-Learning Topic: BCNF and Normal forms-based problems		
3	**SQL and Relational Algebra**		**11**
	After completion of the module the student will be able to : • Use SQL commands to define, manipulate, and query database objects. • Implement advanced SQL features such as views, procedures, functions, and triggers. • Apply relational algebra operations to formulate and analyze database queries.		
	3.1	SQL basics - datatypes, operators, integrity constraints; SQL commands - DDL, DML, DCL, Aggregate functions, Group By, Order By, Subqueries and SQL JOINs.	
	3.2	Advance SQL – Virtual Tables (Views), Stored Procedures, Functions and Triggers	
	3.3	Relational Algebra: Union, Selection, Projection, Cartesian Product, Joins	
	Self-Learning Topic: SET Operations		
4	**Transactions Processing, Concurrency and Database Recovery**		**11**
	After completion of the module the student will be able to : • Explain transaction properties and scheduling concepts in DBMS. • Analyze concurrency control techniques and deadlock handling mechanisms. • Evaluate database recovery methods to ensure consistency and reliability.		
	4.1	Database transaction, ACID properties, Transaction states diagram, TCL (Commit, Rollback, Savepoints), Schedules, Serializability.	
	4.2	Database recovery mechanism - Lag based, Checkpoints and shadow paging; Deadlock detection and prevention	
	4.3	Concurrency control techniques - Locking, Timestamping and Validation protocol.	

	Self-Learning Topic: DeadLock prevention and detection		
5	**Database programming**		**4**
	After completion of the module the student will be able to : • Establish database connectivity using JDBC. • Perform CRUD operations through database applications. • Develop simple database-driven applications using Java and MySQL.		
	5.1	Database driver and connection string, Cursor, RecordSets, Default query and Parameterized query.	
	5.2	Database programming with JDBC – CRUD Operations with Java and MySQL	
	Self-learning Topics: Domain specific database and UI design		
6	**Introduction to Schema-less Database**		**3**
	After completion of the module the student will be able to : • Compare schema-based and schema-less database systems. • Explain the features, benefits, and limitations of NoSQL databases. • Perform basic data operations using MongoDB and understand its application scenarios.		
	6.1	Schema vs. Schema-less databases. Advantages and disadvantages	
	6.2	Schema-less database (NoSQL) features, SQL vs NoSQL, and MongoDB Basic Operations	
	Self-Learning Topic: Installation and query processing with Cassendra		
		Total	**45**

List of Experiments:

Expt No.	List of Experiments
1	**Draw an ER diagram and convert it into relational schema for a real life problem** **Objective:** To understand conceptual database design by modeling real-world entities, relationships, and constraints using ER diagrams and converting them into relational schemas. **Outcome:** Students will be able to design ER diagrams for real-world applications and transform them into well-structured relational database schemas.
2	**Perform SQL DDL commands with various Constraints** **Objective:** To learn the use of SQL Data Definition Language (DDL) commands and integrity constraints for creating and managing database objects. **Outcome:** Students will be able to create, modify, and manage database structures while enforcing data integrity using appropriate constraints.

3	**Perform SQL DML commands with Where clause and various Operators** **Objective:** To develop proficiency in manipulating database records using SQL DML statements and filtering data using conditions and operators. **Outcome:** Students will be able to insert, update, delete, and retrieve data efficiently by applying suitable filtering conditions and operators.
4	**Execute Aggregate functions, Group By and Subqueries.** **Objective:** To understand advanced query formulation techniques for data summarization, grouping, and nested query execution. **Outcome:** Students will be able to analyze and summarize database information using aggregate functions, grouping mechanisms, and subqueries.
5	**Perform various types of SQL JOINs** **Objective:** To understand methods for retrieving related data from multiple tables using different SQL join operations. **Outcome:** Students will be able to combine and query data from multiple relations using appropriate join techniques.
6	**Create SQL VIEWs and Indexing** **Objective:** To explore database abstraction and query optimization techniques through views and indexing mechanisms. **Outcome:** Students will be able to create virtual tables and implement indexing strategies to enhance database security and query performance.
7	**Create SQL Procedure and Trigger for the given scenario** **Objective:** To understand procedural extensions of SQL and automate database operations using stored procedures and triggers. **Outcome:** Students will be able to design and implement stored procedures and triggers to support business logic and automated database actions.
8	**Perform CRUD operations using JDBC API** **Objective:** To learn database connectivity and application-level interaction using the JDBC API for executing SQL operations. **Outcome:** Students will be able to develop Java-based applications that perform Create, Read, Update, and Delete (CRUD) operations on relational databases.

9	**Simulate transaction control using TCL (Commit, Rollback, Savepoint).** **Objective:** To understand transaction management concepts and control mechanisms that ensure consistency and reliability in database operations. **Outcome:** Students will be able to implement transaction control commands to maintain database integrity during concurrent and multi-step operations.
10	**Perform DCL - New Users, Roles, and Privileges (Revoke and Grant)** **Objective:** To learn database security concepts by managing user access, privileges, and roles using Data Control Language (DCL) commands. **Outcome:** Students will be able to administer database security by creating users, assigning roles, and controlling access permissions effectively.
Self study	**Concurrency simulation**

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)

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.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25CE5MDM02	Android Application Development	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	OR/PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	25	-	-	25
		Total	150						

Pre-Requisite Courses:	25FEAEC01: JAVA Programming

Course Overview:

This course is designed to introduce Mechanical and Electronics Engineering students to the fundamentals of Android application development. Offered by the Department of Computer Engineering, it provides a structured, beginner-friendly pathway to understanding the mobile application ecosystem, development tools, and core programming concepts needed to build functional Android apps.

The course focuses on hands-on learning through six progressively structured modules, starting from environment setup and basic UI design, to data management, background services, and networked applications. Students will gain practical experience through a minimum of twelve laboratory sessions covering real-world development scenarios.

The curriculum is kept intentionally broad to ensure accessibility for students from non-software backgrounds, while still delivering industry-relevant skills. On completing this course, students will be capable of independently developing, testing, and deploying simple Android applications, and will have a strong foundation for further exploration of mobile development in their respective engineering domains.

Module 1 – Introduction to Android

This module builds the foundational knowledge required to begin Android development. Students will explore the history and growth of the Android ecosystem, understand the overall architecture of Android applications, and learn to configure the development environment including Android Studio and the SDK. The module covers project structure, the Android Manifest file, running apps on virtual and physical devices, and the Activity lifecycle. The SOLID design principles are also introduced to encourage good software design habits from the outset.

Module 2 – Android UI Fundamentals

This module focuses on designing and building effective user interfaces using Android's XML-based layout system. Students will work with the most commonly used UI components including TextView, EditText, Button, and ImageView, and will learn to structure screens using LinearLayout, RelativeLayout, and ConstraintLayout. Topics also include handling screen orientation changes, using the action bar, displaying Toast notifications, and applying basic UI design principles to build clean and intuitive interfaces.

Module 3 – Activities, Intents & Fragments

This module explores the structural building blocks of Android applications. Students will develop a thorough understanding of the Activity lifecycle and learn to navigate between screens using explicit and implicit Intents. Intent filters and data passing between activities are covered in detail. The module also introduces Fragments, their lifecycle, management, and use in building flexible multi-screen applications, giving students the skills needed to construct well-structured, navigable apps.

Module 4 – Data Storage

This module equips students with the techniques needed to persist data within Android applications. Topics include SharedPreferences for storing small key-value data, reading and writing to internal device storage, and creating and managing a SQLite relational database through direct SQL operations and the higher-level Room Persistence Library. Students will implement basic Create, Read, Update, and Delete (CRUD) operations and understand when to apply each storage mechanism based on the nature and volume of the data.

Module 5 – Android Services & Notifications

This module introduces the mechanisms Android provides for running operations in the background and communicating with the user. Students will learn about the Service lifecycle, implement Broadcast Receivers to respond to system and app-level events, and use NotificationManager to deliver alerts and updates. The module also covers scheduling tasks with AlarmManager, sending emails via Intent, and managing user alerts, skills essential for building responsive and professionally polished applications.

Module 6 – Networking & Multimedia

This module introduces students to connecting Android applications to the internet and handling rich media content. Topics include making HTTP requests to web servers, parsing JSON responses, and using the Retrofit library for efficient API consumption. Students will also explore Android's Media APIs to integrate audio and video playback into their apps. The module concludes with an overview of the AndroidX libraries and an introduction to RESTful web service integration, preparing students for building data-driven, connected applications.

Course Outcomes (COs)	**After successful completion of the course, the students will be able to**	
	CO1	**Understand** the Android ecosystem, architecture, and set up a development environment to build and run basic Android applications. **(Remembering)**
	CO2	**Design** and **implement** user interfaces using XML layouts and standard UI components including TextView, EditText, Button, and ImageView. **(Understanding)**
	CO3	**Apply** Activity lifecycle concepts, use explicit and implicit Intents, and build multi-screen applications using Fragments. **(Applying)**
	CO4	**Implement** data storage mechanisms using Shared Preferences, internal file storage, and SQLite database for data persistence. **(Analyzing)**
	CO5	**Understand** and **apply** Android services, broadcast receivers, notification services, and alarm management in applications. **(Evaluating)**
	CO6	**Integrate** networking features to consume web services, parse JSON data, and use multimedia APIs for audio/video playback. **(Creating)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Android**	6
		After completing this module, students will be able to: • Understand Android ecosystem and evolution • Explain Android architecture and components	

	• Set up Android development environment • Apply SOLID principles in development		
	1.1	**Android Ecosystem Overview:** Devices, OS layers, Play Store ecosystem, Open-source nature	
	1.2	**History & Versions:** Evolution timeline, major releases, feature improvements, API levels	
	1.3	**Development Setup:** Android Studio installation, SDK configuration, Emulator setup, Running Hello World	
	1.4	**Project Structure & Architecture:** Manifest file, Project folders, AAC components, Activity lifecycle basics	
	Self-Learning Topic: Explore latest Android version features; Compare Android with other mobile OS; Install Android Studio and document steps		
2	**Android UI Fundamental**		**8**
	After completing this module, students will be able to: • Design UI using XML layouts • Use common UI components • Handle screen orientation • Implement user interaction feedback		
	2.1	**XML Layout Design:** Layout structure, View hierarchy, Attributes, UI rendering	
	2.2	**UI Components:** TextView, EditText, Button, ImageView properties and usage	
	2.3	**Layout Types:** Linear Layout, Relative Layout, Constraint Layout, Use cases	
	2.4	**UI Interaction:** Orientation changes, Action bar, Toast messages, Basic notifications	
	Self-Learning Topic: Design sample mobile app screens; Create responsive layouts		
3	**Activities, Intents & Fragments**		**6**
	After completion of the module the student will be able to : • Understand activity lifecycle • Use intents for communication • Implement fragments • Design multi-screen apps		
	3.1	**Activity Lifecycle:** States, transitions, callbacks, lifecycle management	
	3.2	**Intents:** Explicit, implicit, intent filters, data passing.	
	3.3	**Application Flow:** Multi-screen navigation, back stack, UI transitions	

	3.4	**Fragment Communication:** Passing data between fragments, fragment-to-activity interaction, ViewModel usage basics	
	Self-Learning Topic: Implement fragment-based UI		
4	**Data Storage**		**6**
	After completion of the module the student will be able to : • Store and retrieve data • Use lightweight storage methods • Perform database operations • Implement persistence techniques.		
	4.1	**Shared Preferences:** Key-value storage, reading/writing data, use cases	
	4.2	**Internal Storage:** File handling, read/write operations, security aspects	
	4.3	**SQLite Database:** Database creation, CRUD operations, queries	
	4.4	**Room Library:** ORM concepts, advantages, entity and DAO basics	
	Self-Learning Topic: Develop small data storage app; Compare SQLite and Room		
5	**Android Services & Notifications**		**6**
	After completion of the module the student will be able to : • Understand background processing • Use services and receivers • Implement notifications • Handle user alerts		
	5.1	**Android Services:** Types, lifecycle, background execution, use cases	
	5.2	**Broadcast Receivers:** Event handling, system broadcasts, custom broadcasts.	
	5.3	**Notifications:** Notification manager, alerts, alarm services, user interaction	
	5.4	**Intent-based Communication:** Sending emails, implicit intents, external apps interaction	
	Self-learning Topics: Explore background task handling		
6	**Networking & Multimedia Basics**		**4**
	After completion of the module the student will be able to : • Consume web services • Handle JSON data • Use networking libraries • Work with multimedia APIs		
	6.1	**Networking Basics:** HTTP methods, API calls, connectivity handling	
	6.2	**JSON Processing:** Parsing techniques, data mapping, error handling	

	6.3	**Retrofit Library:** Setup, API integration, advantages	
	6.4	**Multimedia:** Audio/video playback, media APIs, AndroidX libraries overview	
	Self-Learning Topic: Create API-based app; Integrate media playback		
		Total	**36**

List of experiments:

Activity No.	Title of the Experiment
1	**To set up Android Studio and create a basic Android application.** **Objective:** • Install Android Studio and configure emulator • Create and run a Hello World application • Understand project structure and Manifest file • View log statements using Logcat **Outcome:** Students will be able to set up Android environment and execute a basic application successfully.
2	**To develop a basic interactive UI application using layouts and button events.** **Objective:** • Display Toast message on button click • Explore Linear Layout, Relative Layout, Constraint Layout • Handle basic UI interactions **Outcome:** Students will be able to create interactive UI applications with event handling.
3	**To design a user input form and transfer data between activities.** **Objective:** • Create form with multiple input fields • Collect user details (name, email, etc.) • Pass data using Explicit Intent **Outcome:** Students will be able to design forms and implement activity-to-activity communication.
4	**To implement implicit intents and intent filters in Android.** **Objective:** • Open web pages using implicit intents • Launch Google Maps using location intent • Implement intent filters for activity access **Outcome:** Students will be able to use system-level apps through implicit intents.

5	**To implement various input controls and picker dialogs.** **Objective:** • Use Spinner for dropdown selection • Implement AlertDialog with actions • Use DatePicker and TimePicker dialogs **Outcome:** Students will be able to integrate advanced input components in Android apps.
6	**To implement menus, selection controls, and navigation.** **Objective:** • Create Options/Overflow menu • Handle menu item selection • Use Radio Buttons for choices • Implement Up navigation in App Bar **Outcome:** Students will be able to design structured navigation and selection interfaces.
7	**To apply themes, styles, and custom drawable resources in Android.** **Objective:** • Create custom themes and styles • Apply reusable UI styling • Use drawable resources in UI design **Outcome:** Students will be able to enhance UI consistency using themes and styles.
8	**To implement user preferences using Shared Preferences and settings screen.** **Objective:** • Create Settings screen using Preference Fragment Compat • Store and retrieve user preferences • Apply preferences at runtime **Outcome:** Students will be able to manage user settings and persistent preferences.
9	**To develop a CRUD-based Notes application using SQLite database.** **Objective:** • Perform insert, update, delete, and read operations • Store notes in SQLite database • Display data using RecyclerView **Outcome:** Students will be able to implement database-driven applications with CRUD operations
10	**To perform background processing using AsyncTask or WorkManager.** **Objective:** • Create background tasks • Update UI after task completion • Understand threading concepts **Outcome:** Students will be able to execute background operations in Android applications.

Text books:

1. Wei Meng Lee – Beginning Android 4 Application Development, Wrox Publication.

Reference Books:

1. Joseph Annuzzi, Lauren Darcey, Shane Conder – Advanced Android Application Development, 4th Edition, Pearson.
2. John Horton – Android Programming for Beginners, 3rd Edition, Packt Publication.
3. Pradeep Kothari – Android Application Development Black Book, DreamTech.

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)
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 experiments.

The Bombay Salesian Society's

Don Bosco Institute of Technology, Mumbai

(An Autonomous Institute affiliated to University of Mumbai)

CURRICULUM STRUCTURE
Honor & Minor Course

Semester V

(As Per NEP 2020)

Scheme: DB25-V1

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

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME5HON01	Energy Scenario & Management	L	P	T	L	P	T	Total
		4	-	-	4	-	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	OR/PR	Total
		Theory	20	30	50	-	-	-	100
		Lab/Tut	-	-	-	-	-	-	-
		Total	100						

Pre-Requisite Courses:	25FE1ESC02 : Basic Electrical and Digital Electronics
	25ME3PCC04 : Thermodynamics
	25ME4PCC03 : Thermal Systems

Course Overview:

Module 1 covers global and National Energy Scenario and Impact of Energy consumption on environment

Module 2 covers Fundamentals parameters of Thermal and Electrical energy and its equivalence.

Module 3 emphasizes on the study EC act, role of energy agencies, BEE & Energy Manager, schemes and norms for industries

Module 4 introduces the Methodology and details of Energy Audit

Module 5 identifies and selects Instrument for Energy Audits

Module 6 helps in studying methods of Energy Economics and Financial Evaluation

Course Outcomes	After successful completion, the students will be able to	
	CO1	**Identify** the global and national energy scenario, conventional and renewable energy resources, and fundamental concepts of sustainability and environmental impact. **(Remembering)**
	CO2	**Explain** global energy scenario, energy resources, statutory regulations and sustainability concepts. **(Understand)**
	CO3	**Apply** thermal and electrical energy fundamentals to evaluate energy use and efficiency. **(Apply)**
	CO4	**Analyze** industrial energy consumption and identify energy conservation opportunities through benchmarking, statutory guidelines, and standard energy audit methodologies. **(Analyze)**
	CO5	**Evaluate** energy conservation projects using engineering economics and financial analysis techniques **(Evaluate)**
	CO6	**Create** structure of energy audit report. **(Create)**

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Energy Scenario & Environment Impact**	10
		Learning Outcomes: • Explain global and Indian energy scenarios. • Differentiate various conventional and renewable energy resources.	

	• Evaluate the impact of energy utilization on sustainability and climate change		
	1.1	**Global and National Energy Scenario:** Global and India's energy demand and supply scenario, Conventional energy sources, Non-conventional energy sources, India's energy mix and energy security, Energy demand sectors, Petroleum refining process, Challenges in India. Potential of Renewable Energy.	
	1.2	**Environment Impact:** Environmental impacts of energy utilization, Climate change and Global Warming, Paris Agreement, Sustainable Development Goals (SDGs), Carbon Credit.	
	Self-Learning Topic: Potential of Hydrogen fuel In India.		
2	**Fundamentals of Energy**		**10**
	Learning Outcomes: • Explain thermal and electrical energy parameters. • Calculate equivalent thermal and electrical energy. • Evaluate energy conversion efficiency of engineering systems.		
	2.1	**Thermal energy**: Forms of thermal energy, Units and conversion, Heat and work, Sensible heat, Latent heat, Specific heat, Calorific value of fuels, Fuel properties.	
	2.2	**Electrical energy:** Voltage, Current, Resistance, Power, Energy, Active, Reactive and Apparent Power, Power Factor, Harmonics, Maximum Demand, Load Factor, Diversity Factor, Demand Factor.	
	2.3	**Energy Equivalence:** Conversion between electrical and thermal energy, Material and Energy balance, Efficiency, COP, Specific Energy Consumption	
	Self-Learning Topic: Estimate energy consumption of building		
3	**Policies & Process**		**10**
	Learning Outcomes: • Explain statutory provisions related to energy conservation. • Describe the role of BEE, Energy Manager and Energy Auditor. • Evaluate industrial energy performance using suitable performance indicators.		
	3.1	Energy Conservation Act 2001 and latest amendments, Objectives of EC Act, Bureau of Energy Efficiency (BEE), Designated Consumers, Certified Energy Manager, Auditor, AEE, Perform Achieve Trade (PAT) Scheme, Energy Saving Certificates (ESCerts), Industrial Energy Performance Indicators, Benchmarking, SEC, Key Performance Indicators (KPI), case study of DC.	
	Self-Learning Topic: ISO 50001 Energy Management System		
4	**Methodology of Energy Audit:**		**10**
		Learning Outcomes: • Explain the methodology of conducting an energy audit. • Analyze utility data to identify energy conservation opportunities.	
	4.1	Need of Energy Audit, Types of Energy Audit, Preliminary Audit, Detailed Energy Audit, Walk-through Survey, Data Collection, Energy Flow Diagram, Mass and Energy Balance, Utility Bill Analysis, Data Validation, Baseline Development. Case study for process industries.	
	Self-Learning Topic: Sankey Diagram		
	Instruments for Energy Audits		**10**
5		Learning Outcomes: • Identify instrument used for energy Audits. • Select instruments for energy measurements.	

		• Analyze utility data to identify energy conservation opportunities	
	5.1	**Measurements :** Power Analyzer, Clamp Meter, Lux Meter, Ultrasonic Flow Meter, Pitot Tube, Thermal Camera, Infrared Thermometer, Flue Gas Analyzer, Anemometer, Tachometer, Air flow measurement, Pressure Gauge, Data Logger. Identification of Energy Conservation Measures (ECMs), Report Preparation.	
	Self-Learning Topic: Harmonic analyzer		
6	**Costing and Analysis**		**10**
		Learning Outcomes: • Calculate energy costs for engineering systems. • Evaluate financial feasibility of energy conservation projects. • Select economically viable energy conservation measures.	
	6.1	Energy Costing, Electricity Tariff, Fuel Cost Analysis, Demand Charges, Time-of-Day Tariff, Cost Benefit Analysis, Life Cycle Costing, Simple Payback Period, Return on Investment, Net Present Value, Internal Rate of Return, Discounted Cash Flow, Sensitivity Analysis.	
	Self-Learning Topic: Economics of Solar energy system		
		TOTAL	**60**

Text Books:

1. Guide Books for Energy Managers and Energy Auditors**, Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India, Latest Edition.**
2. Energy Management Handbook**, Wayne C. Turner and Steve Doty, CRC Press, 9th Edition.**
3. Energy Management Principles**, Craig B. Smith, Elsevier, 3rd Edition.**
4. Handbook of Energy Audits**, Albert Thumann and William J. Younger, CRC Press, 10th Edition.**

Reference Books:

1. **Energy Efficiency Manual**, Donald R. Wulfinghoff, Energy Institute Press, Latest Edition.
2. **Industrial Energy Conservation Manuals**, Bureau of Energy Efficiency (BEE), Ministry of Power, Latest Edition.
3. **Cleaner Production and Energy Efficiency**, UNEP Publications, Latest Edition.
4. **ASHRAE Handbook – HVAC Applications**, ASHRAE, Latest Edition.
5. **ECBC User Guide**, Bureau of Energy Efficiency, Government of India, Latest Edition.

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.
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	• 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 (2 hours) • Total Marks: 50