Society of St. Francis Xavier, Pilar's
Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050
(Autonomous College affiliated to University of Mumbai)

CURRICULUM STRUCTURE

FINAL YEAR UG: B.E.

MECHANICAL ENGINEERING

REVISION: FRCRCE-3-25

Effective from Academic Year 2026-27

Board of Studies Approval: 05/03/2026

Academic Council Approval: 25/06/2026

Dr. Deepak Bhoir	**Dr. Vasim A. Shaikh**	**Dr. Sapna Prabhu**
Dean Academics	**HOD (Mechanical Engg.)**	**Principal**

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Preamble

Fr. Conceicao Rodrigues College of Engineering an autonomous institute from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations,2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society, and Industries. We commit to ourselves to the effective implementation of UGC Regulations and NEP 2020 in its spirit. Government of Maharashtra has directed Autonomous Colleges to revise their curriculum in line with National Education Policy (NEP) 2020 through Government Resolution dated 4th July 2023. Accordingly, degree options are given to the students admitted from academic year 2024-25 based on UGC circulars and DTE guidelines ref no. 17/DTE/NEP-2020/2024/111 dated 4th June 2024 related to implementation of NEP.

Based on recent recommendations of the GR, we are pleased to offer our holistic curriculum, a "H-Tree Model" of Engineering Education. A unique "H-Tree Model" of Engineering Education Curriculum is carefully designed to systematically develop IQ (Intelligence Quotient), PQ (Physical Quotient), EQ (Emotional Quotient) and SQ (Spiritual Quotient) of a learner. This curriculum aims at the development of an all-rounded personality with holistic approach to education in which learner receives 25% teacher-led learning, 25% peer learning, 25% self-learning and 25% experiential learning. The curriculum model is outcome based that focuses on learning by doing. Curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. It ensures multiple choices to leaner acquiring skills through systematic planning. It has 7 verticals aligned to GR recommendations with strong science, and mathematics foundation and program core, sequel of electives, Multidisciplinary Minor courses, humanities & management courses and sufficient experiential learning through projects and semester-long industry / research internship along with employable skill-based courses. Learner gets an opportunity to acquire skills through NSDC aligned courses during summer vacations. Learner also gets additional option to choose the kind of degree i.e. Built in Multidisciplinary minor or Double Minor in emerging field or Honors with Research.

The Mechanical Engineering curriculum is designed to provide a balanced combination of strong fundamentals and practical skills. The initial years focus on mathematics, basic sciences, computing, and engineering principles to develop analytical thinking and systematic problem-solving ability. Core engineering courses help students understand the working of machines, materials, and energy systems used in real-world applications. Laboratories, workshop practice, and design-based learning ensure that students learn by doing and gain hands-on experience. Elective courses introduce modern technologies and prepare students for evolving industrial requirements. Projects, internships, and experiential activities expose students to real industrial and societal challenges and enhance employability. Overall, the program aims to nurture technical competent, innovative, and responsible engineers ready for careers, entrepreneurship, and higher studies.

Various steps are taken to transform teaching learning process to make learning a joyful experience for students. We believe that this curriculum will raise the bar of academic standards with the active involvement and cooperation from students, academic and administrative units.

INSTITUTE VISION

To be a leading institution in education, transforming students into globally competent professionals with strong ethical values, innovation capabilities, and a commitment to sustainable societal development.

INSTITUTE MISSION

- Develop industry-ready engineers with strong academic foundations, practical skills, and an entrepreneurial mindset capable of addressing industry and societal needs.
- Cultivate a culture of innovation and research to address real-world challenges through interdisciplinary approaches and sustainable practices.
- Foster a vibrant industry–academia ecosystem by actively engaging faculty and students in knowledge exchange, collaborative learning and professional skill development.

DEPARTMENT VISION

To be a leading department transforming young minds into creative and ethical mechanical engineers committed to engineering excellence and societal well-being.

DEPARTMENT MISSION

- Provide quality education that builds strong engineering fundamentals and technical competence, preparing students for professional excellence.
- Nurture innovation, critical thinking, and problem-solving skills through modern engineering tools and multidisciplinary solutions to real-world challenges.
- Promote research and collaboration with industry and professional bodies to develop sustainable, ethical, and socially responsible engineering solutions.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

Graduates will be able to

1. Build successful careers in engineering and allied fields by applying strong technical knowledge and practical skills.
2. Analyze and solve engineering problems using modern tools and emerging technologies.
3. Demonstrate professional ethics and effective communication in multidisciplinary and team-based environments.
4. Pursue lifelong learning through higher education, research and innovation to adapt to evolving industry needs.

PROGRAM SPECIFIC OUTCOMES (PSO)

Students will be able to:

1. Utilize computational tools and analytical methods to design, simulate, and optimize mechanical systems.
2. Apply manufacturing technologies, materials engineering, intelligent robotics and automation solutions to address industrial challenges.

Curriculum Structure for UG Programs at Fr CRCE w.e.f. A.Y. 2026-27

Nomenclature of the courses in the curriculum

BSESC	Basic Science & Engineering Science Courses
PCPEC	Program Core and Program Elective Courses
MDC	Multidisciplinary Courses
SC	Skill Courses
HSSM	Humanities, Social Sciences and Management
EL	Experiential Learning
LLC	Liberal Learning Courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Program Core Courses
PEC -	Program Elective Courses
MDM	Multidisciplinary Minor
OE	Open Elective
VSEC	Vocational and Skill Enhancement Course
VSC	Vocational Skill Courses
SEC	Skill Enhancement Courses
AEC	Ability Enhancement Course
EEMC	Entrepreneurship, Economics and Management Course
IKS	Indian Knowledge System
VEC	Value Education Course
RM	Research Methodologies
CEFP	Community Engagement or Field Project
ELC	Experiential Learning Courses
PRJ	Project
INT	Internship
CC	Cocurricular Courses
DM	Double Minor
HR	Honors with Research

Credit Specification:

- Theory: 1 credit=13 to 15 hrs of teaching
- Lab: 1 Credit=26 to 30 hrs of lab work
- Studio Activities: 1 Credit= 26 to 30 hrs of creative activities
- Workshop Based Activities: 1 Credit=26 to 30 hrs of hands-on activities related to vocation/professional practice/skill based
- Seminar/Group Discussion: 1 Credit=13 to 15 hrs of participation
- Internship: 1 Credit=Per 2 weeks OR 36 to 40 hrs of engagement
- Field Based Learning/Practices: 1 Credit=26 to 30 hrs of learning activities
- Community Engagement Projects: 1 Credit=26 to 30 hrs of contact time along with 13 to 15 hrs of activities preparation, report writing, independent reading etc.

Credit requirements for different options of the Degrees:

Degree/SEM	I	II	III	IV	V	VI	VII	VIII	Total
B. E	18	20	22+4#	23+5#	20	20	20	20	163+9#=172
B.E with Honors/Minors	18	20	22+4#	23+5#	20+4*	20+4*	20+6*	20+4*	163+9#+18*=190

 # Bridge courses
Optional Credits

1. Learners who earn a minimum of total **172 credits** will be awarded "**Bachelor of Engineering**" degree.
2. Learners will have the following options to earn **B. E. in ……(regular) Engineering with Honours/Minor in …….. (specialization)**

Sr. No.	Honors/Minor degree programs	Programs who can offer this Honours Degree Program	Programs who can offer this as Minor Degree program
1	**Internet of Things**	1. **Computer Engineering** 2. **Artificial Intelligence & Data Science** 3. **Electronics and Computer Science** 4. **Mechanical Engineering**	--
2	**Artificial Intelligence and Machine Learning**	1. **Computer Engineering** 2. **Electronics and Computer Science**	**Mechanical Engineering**
3	**Data Science**	1. **Computer Engineering** 2. **Electronics and Computer Science** 3. **Mechanical Engineering**	
4	**Blockchain**	1. **Computer Engineering** 2. **Artificial Intelligence & Data Science** 3. **Electronics and Computer Science**	**Mechanical Engineering**
5	**Cyber Security**	1. **Computer Engineering** 2. **Artificial Intelligence & Data Science** 3. **Electronics and Computer Science**	**Mechanical Engineering**
6	**Robotics**	**Mechanical Engineering**	1. **Computer Engineering** 2. **Artificial Intelligence & Data Science** 3. **Electronics and Computer Science**
7	**3D Printing**	**Mechanical Engineering**	1. **Computer Engineering** 2. **Artificial Intelligence & Data Science** 3. **Electronics and Computer Science**

3. **Honours and Minor Degree Eligibility Criteria for Students:**

i. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:

a. Students with no backlog in semester I, II, and III

b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above

c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above

ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.

iii) However, it is optional for learners to take Honours/Minor degree program.

iv) The Honours/ Minor degree program can be opted only during regular engineering studies

v) The student shall complete the Honours/ Minor degree program in stipulated four semesters only.

4. Courses offered during internship semester shall be in online mode

5. Learner can earn additional credits by enrolling to skill courses offered in summer. College shall explore feasibility to offer NSDC aligned skill based courses to the learners

6. Technical support team for registration of Academic Bank of Credits (ABC), registration of elective/optional courses, registration of online courses, registration for degree options etc. under supervision of Dean Academics.

Salient Features of Curriculum:

- ✓ Framed as per Government Resolution dated 4th July 2023 in line with National Education Policy (NEP) 2020.
- ✓ Minimum 172 choice-based credit structure with options of Degrees earning additional credits
- ✓ Unique 'H-Tree' Model of Curriculum: Hybrid model for holistic development with happy learning environment having bridge connecting verticals providing unique path for each learner for 3-dimensional growth, Life Long Learning, bridge courses, inclusive model indicating equal distribution of central resources
- ✓ More emphasis on laboratory based and experiential learning
- ✓ More weightage to continuous assessment to reduce examination stress
- ✓ Mandatory Semester-long internship, courses with emotional & spiritual learning and skill-based learning aligned with NSDC framework
- ✓ Well balanced curriculum to attain Program Outcomes and skills of 21st century learner

- ✓ Curriculum is designed to create excitement among learners for education through stories, activities, collaboration, hackathon, contest, case studies, creative art etc.
- ✓ Curriculum is designed to make graduates responsible citizens of country with future ready skills to handle challenges of 21st Century

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Structure of Credits to be completed in Final Year (SEM-VII and/or SEM-VIII):

SEM-VII/VIII												
Course Code	Course Vertical	Sub-Vertical	Course Name	Contact Hours		Examination Marks (1 Credit=50 Marks)					Credits	
						ISE	MSE	ESE		Total	Points	Total
								Min	Max			
25PEC14ME1X	PCPEC	PEC	Program Elective Course-4	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
25PEC14ME1X	PCPEC	PEC	Program Elective Course-5	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
25PEC14ME2X	PCPEC	PEC	Program Elective Course-6	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
25PEC14ME2X	PCPEC	PEC	Program Elective Course-7	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
25MDM6X	MDC	MDM	MDM Course-6	TH	2	20	30	20	50	100	2	2
25MDM7X	MDC	MDM	MDM Course-7	TH	2	20	30	20	50	100	2	2
25RMC14ME01	EL	RM	Essentials of Research Methodology	TH	2	20	30	20	50	100	2	2
25RMC14ME02	EL	RM	Intellectual Property Rights	TH	2	20	30	20	50	100	2	2
PRJ1ME01	EL	PR	Major Project	PR	12	300	-	-	-	300	6	6
25SEM14ME01	PCPEC	PEC	Course Seminar		2		As per Rubrics for Seminar				2	2
INT14ME01	EL	INT	Semester long Internship	PR	36-40 hrs		As Per Internship Manual				12	12
HXXXCXXX	HMM/DM	HMM/DM	Honors/Minor Degree Course	TH	Online		As Per SWAYAM				8	8*
HXXXCXXX	HMM/DM	HMM/DM	Honors/Minor Degree Lab (Project)	PR							**2**	**2***
Total					**TH:TU:PR 16:4:12+2=34**				**-**	**1250**	**-**	**40+10***

@MDM should be **Non-technical** courses e.g. Principles of Management
Project or Internship is mutually exclusive in SEM-VII or SEM-VIII
Remaining credits can be acquired in SEM-V to SEM-VIII
Online course 1 Credit=4 Week course from SWAYAM can be taken in SEM V to SEM VIII
Online min 8 week course from SWAYAM can be taken in SEM V to SEM VIII to complete 2 credit course (Combination of two 4-week credit courses shall be allowed with prior approval)
* Online min 12 week course from SWAYAM can be taken in SEM V to SEM VIII to complete 3 credit course

SEM VII/VIII - Program Elective – I/II	SEM VII/VIII - Program Elective – III/IV
25PEC14ME11: Heating, Ventilation, Air Conditioning and Refrigeration	25PEC14ME21: Machinery Diagnostics
25PEC14ME12: Lean Manufacturing	25PEC14ME22: Smart Materials
25PEC14ME13: Design of Material Handling and Power Systems	25PEC14ME23: Finite Element Methods for Engineering Analysis

MDM Course - 6	MDM Course - 7
25MDM61: Disaster Management	25MDM71: Management Information System
25MDM62: Environment Management	25MDM72: Finance Management

Honors Degree Offered to Mechanical Engineering Students from SEM-V to SEM-VIII:

A. Name: **Robotics**

1. SEM-V: 25HRBC501: Industrial Robotics
2. SEM VI: 25HRBC601: Mechatronics & IoT
3. SEM VII: HRBC701: Artificial Intelligence & Data Analysis
4. SEM VII: HRBSBL701: Robotics and Automation Lab
5. SEM VIII: HRBC801: Autonomous Vehicle Systems

B. Name: 3D Printing

1. SEM-V: 25H3DPC501: Introduction to CAD
2. SEM VI: 25H3DPC601: 3D Printing: Introduction & Processes
3. SEM VII: H3DPC701: Applications of 3D Printing
4. SEM VII: H3DPSBL701: Skill Based Lab– Digital Fabrication
5. SEM VIII: H3DPC801: 3D Printing in Medical Technology

C. Name: Data Science

1. SEM-V: 25HDSC501: Mathematics for Data Science
2. SEM VI: 25HDSC601: Statistical Learning for Data Science
3. SEM VII: HDSC701: Data Science for Health and Social Care
4. SEM VII: HDSSBL701: Data Science for Health and Social Care Lab
5. SEM VIII: HDSC801: Text, Web and Social Media Analytics

D. Name: **Internet of Things**

1. SEM-V: 25HIoTC501: IoT Sensor Technologies
2. SEM VI: 25HIoTC601: IoT System Design
3. SEM VII: HIoTC701: Dynamic Paradigm in IoT
4. SEM VII: HIoTSBL701: Interfacing & Programming with IoT Lab (SBL)
5. SEM VIII: HIoTC801: Industrial IoT

Minors Degree Offered to Mechanical Engineering Students from SEM-V to SEM-VIII:

A. Name Artificial Intelligence and Machine Learning

1. SEM-V: 25HAIMLC501: Mathematics for AI & ML
2. SEM VI: 25HAIMLC601: Game Theory using AI & ML
3. SEM VII: HAIMLC701: AI & ML in Healthcare
4. SEM VII: HAIMLSBL701: AI & ML in Healthcare: Lab
5. SEM VIII: HAIMLC801: Text, Web and Social Media Analytics

B. Name: Blockchain

1. SEM-V: 25HBCC501: Bit coin and Crypto currency
2. SEM VI: 25HBCC601: Blockchain Platform
3. SEM VII: HBCC701: Blockchain Development
4. SEM VII: HBCSBL701: Private Blockchain Setup Lab (SBL)
5. SEM VIII: HBCC801: DeFi (Decentralized Finance)

C. Name: Cyber Security

1. SEM-V: 25HCSC501: Ethical Hacking
2. SEM VI: 25HCSC601: Digital Forensic
3. SEM VII: HCSC701: Security Information Management
4. SEM VII: HCSSBL601: Vulnerability Assessment Penetration Testing (VAPT) Lab
5. SEM VIII: HCSC801: Application Security

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14ME11	Heating, Ventilation, Air Conditioning, and Refrigeration	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	
		Tutorial	50	--	--		50	

Pre-requisite Course Codes	Thermodynamics and Applied thermodynamics	
Course Outcomes	CO1	Explain the classification, properties, and selection of refrigerants and analyze air refrigeration systems.
	CO2	Analyze vapour compression refrigeration systems and describe vapour refrigeration system.
	CO3	Evaluate thermal comfort conditions and apply psychrometric principles to analyze air-conditioning processes.
	CO4	Design and analyze air distribution systems for efficient airflow and comfort conditioning
	CO5	Explain the working principles of major HVAC&R components used in refrigeration and air-conditioning systems.
	CO6	Elaborate refrigeration and air-conditioning concepts to real-world applications such as cold storage, food processing, etc.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Refrigerants:** Classification, Designation, Selection of refrigerant, Physical and chemical properties of refrigerants, Secondary refrigerants	1-2	1
	1.2	**Air Refrigeration System:** Bell Coleman cycle, Necessity of air cooling, Factors considered for the selection of air refrigeration system, Types of air refrigeration system with schematic and T-S diagram, Numerical based on simple and bootstrap air refrigeration system.	1-2	3
2	2.1	**Vapour Compression Refrigeration System:** Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle, Numerical based on standard vapour compression system by using P-h chart .and refrigerant table	1-2	2
	2.2	**Vapour Absorption Refrigeration System.** Simple and practical, vapour absorption system Refrigerant-adsorbent properties, COP of ideal vapour absorption system, Domestic Electrolux refrigerator, Lithium bromide absorption system	1-2	2
3	3.1	**Thermal Comfort Conditions:** Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design	1-2	2

		Conditions		
	3.2	**Psychrometry of Air Conditioning Processes** Psychrometry properties, relations and processes, Adiabatic air mixing, process Psychrometric chart, RSHF, GSHF, ERSHF, Bypass factor, Apparatus dew points Numerical based on psychrometric chart and Classification of air conditioning system, relations. Cooling load calculations	1-2	3
4	**4.1**	**Duct system** Classification of ducts, duct material, pressure in ducts, Flow through duct, pressure losses in duct, Air flow through simple duct system, Equivalent diameter, Methods of duct system design	1-2	3
	4.2	**AHU and Air conditioning systems** Fan coil unit, Types of fans used air conditioning applications, Filters, supply and return grills, Sensors. Variable air volume system, Control air volume and Variable refrigeration flow system.	1-2	3
5	**5.1**	**HVACR & Components** Working of reciprocating, screw and scroll compressors, working of air cooled, and water cooled and evaporative condensers, Working of DX, Flooded, and Forced feed evaporators, Expansion devices Capillary tube, TXV, EXV.	1-2	4
6	**6.1**	**Application of HVAC&R** Ice plant, Food storage plants, dairy and food processing plants, freeze drying, A/c in textile, Printing pharmaceutical industry and Hospitals, Cold chain Technology, Transport air conditioning, Solar refrigeration.	1-2	3
			Total	**26**

Tutorial:

Sr. No.	Tutorials details	Hours
1	Detailed note on Conventional and newly developed refrigerants	1
2	Numerical on aircraft refrigeration system	1
3	Numerical on VCRS system	1
4	Detailed note on Electrolux and lithium bromide system	1
5	Cooling load calculation of confined space	1
6	Detailed note on Variable refrigeration or variable air volume system	1
7	Detailed working principle and application areas for expansion devices (any 2)	1
8	Elaborate any 2 applications of HVAC system in details	1
	Total	**8**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:
The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:
Assessment shall be based on the tutorials evaluated through continuous assessment of understanding and application of Heating, ventilation, air conditioning and refrigeration principles.

Recommended Books:
Text Books:
1. Refrigeration and Air Conditioning by C.P. Arora, McGraw Hill education (India) (P) limited, New Delhi
2. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi
3. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi

Reference Books:
1. Refrigeration and Air Conditioning by S. C. Arora and S. Domkundwar, Dhanpatrai and sons, Delhi
2. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi
3. ISHRAE Air Conditioning Handbook
4. ISHRAE Refrigeration Handbook
5. ASHRAE Handbook of Fundamentals
6. ASHRAE Handbook of Equipment 10. ASHARE Handbook of System

Links for online NPTEL/SWAYAM courses:
1. https://nptel.ac.in/courses/112107208
2. https://nptel.ac.in/courses/112102248

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2
CO1	3	2	-	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	2	2	3	3	-	-	-	-	-	-	-	-	-	-
CO5	2	3	-	2	-	-	-	-	-	-	-	-	-	-
CO6	2	2	-	2	-	-	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14ME12	Lean Manufacturing	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE	MSE	ESE	Total		
		Theory	20	30	50	100		
		Tutorial	50	--	--	50		

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Apply structured observation techniques to identify shop-floor inefficiencies and root causes.
	CO2	Explain evolution of manufacturing systems and Lean production philosophy.
	CO3	Analyze factory systems including people, process, and Lean culture elements.
	CO4	Evaluate manufacturing processes using 8 waste analysis and recommend Lean improvements.
	CO5	Calculate takt time, analyze cycle time gaps, and improve production flow.
	CO6	Develop material flow maps and interpret shop-floor data for decision making.

Module No.	Topics	Hrs.
1	**Observation Skills :** Difference between seeing vs observing in Gemba, Identifying process inefficiencies, Root cause identification methods, Structured problem observation approaches	4
2	**Evolution of Manufacturing** Craft production → Mass production → Lean production, Ford vs Toyota production philosophies, Development of Lean thinking, Emergence of Kaizen culture in Japanese manufacturing, Manufacturing competitiveness trends	4
3	**Factory Concepts** Factory organization basics, Hard skills + soft skills in manufacturing, Lean workplace culture, Role of people, systems, and processes, Embedding Kaizen in daily operations	4
4	**Understanding Lean Operation** Lean enterprise operations, Waste identification (Muda concept), Process improvement thinking, Lean mindset across organization, Role of Kaizen in continuous improvement cycles.	4
5	**Flow Management** Flow vs batch production,Waste reduction through flow, Material movement principles, Basics of production flow design, Introduction to Kanban for pull-based production and inventory control.	4

6	**Mapping Material Flow** Material flow mapping concepts, Value stream visualization using Value Stream Mapping, understanding process bottlenecks, Introduction to mapping tools, Preparing VMaPQ.	4

Tutorials:

Sr. No.	Details	Hours
1	Observation Skills	2
2	Manufacturing Component Production Planning and Project Report Preparation	2
3	Industrial Case Study Analysis and Manufacturing Decision Making	2
4	Understanding Lean Operation – 8 Wastes Analysis	2
5	Flow Management	2
6	VMapQ Based Assignment (Material Flow Analysis)	2

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

Assessment shall be based on the tutorials evaluated through continuous assessment of understanding and application of Lean Manufacturing principles.

Textbooks and References

1. Flow Management Tools and Methods for Manufacturing / Dr. Abhilash Pathania
2. Simplified lean manufacture: Elements, rules, tools, and implementation / N. Gopala Krishnan
3. Lean supply chain management essentials: a framework for materials managers / Bill Kerber and Brian J Dreckshage
4. Lessons in lean management: 53 ideas to transform services / by Debashis Sarkar.
5. Life on the line in contemporary manufacturing: The workplace experience of lean production and the Japanese model / by Risk Delbridge
6. Lean administration: case studies in leadership and improvement. / Association for Manufacturing Excellence
7. Toyota Production System: Beyond Large-Scale Production / Taiichi Ohno
8. My Life and Work / Henry Ford
9. The Machine That Changed the World / James P. Womack, Daniel T. Jones, and Daniel Roos
10. Learning to See: Value Stream Mapping to Add Value and Eliminate Muda / Mike Rother and John Shook
11. Lean Production Simplified / Pascal Dennis

12. Complete lean enterprise: Value stream mapping for administrative and office processes / by Beau Keyte, Drew Locher"

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO6	3	-	3	-	-	-	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms Level

Remember	**Understand**	**Apply**	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14ME13	Design of Material Handling and Power Systems	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	
		Tutorial	50	--	--		50	

Pre-requisite Course Codes	Engineering Mechanics, Strength of Materials, Machine Design	
Course Outcomes	CO1	Apply the concept of system design.
	CO2	Select appropriate gears for power transmission on the basis of given load and speed
	CO3	Design material handling systems such as hoisting mechanism of EOT crane,
	CO4	Design belt conveyor systems
	CO5	Design engine components such as cylinder, piston, connecting rod and crankshaft

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Methodology and morphology in design; optimum design; and system-oriented approaches to design.	1-7	2
2	2.1	**Design of Transmission Gearbox:** Single-stage and two-stage gearboxes with fixed speed ratios, including the design of spur and helical gears, along with the design principles for bevel gears and worm–worm wheel gear pairs.	1-7,9	6
3	3.1	**Design of Hoisting Mechanism:** Design of a snatch block assembly covering rope selection, sheave, hook, hook bearing, cross piece, sheave axle, and shackle plate; design of the rope drum; and selection of the motor along with the transmission system.	1-7, 10	6
4	4.1	**Design of Belt Conveyors:** Estimation of power requirement, selection of belt, design of the tension take-up unit, and idler pulley.	1-7, 10	4
5	5.1	**Engine Design (Petrol and Diesel):** Design of the cylinder, piston with pin and rings, connecting rod, and crankshaft with bearings.	1-7, 9	6
Total				**26**

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Design of Transmission Gear Box	**02**
2	Design of EOT Crane	**02**
3	Design of Belt Conveyor	**02**
4	Design of IC Engine	**02**
Total Hours		**08**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

Assessment shall be based on the tutorials evaluated through continuous assessment of ability of designing mechanical systems.

Recommended Books:

Text Books:

1. "Machine Design Exercises", S.N.Trikha - New Delhi Khanna Publisher 1978.
2. "Mechanical Engineering Design", Shigley J E and Mischke C R,11th Edition 2019, McGraw Hill, ISBN: 9788184956207.
3. "Design of Machine Elements", Bhandari VB,5th Edition 2020, TMH,ISBN: 9789390177479
4. "Machine Design", Black PH and O Eugene Adams, 3rd Edition, McGraw Hill ISBN 10: 0070055246
5. "Design Data", P.S.G. College of Technology, Coimbatore. ISBN: 978-8192735504
6. "Engineering Design", Dieter G E, McGraw Hill Inc, ISBN: 9781260113297
7. "Mechanical System Design", SP Patil, 2nd Edition., JAICO Publishing House ISBN: 978-8179923153
8. "Gear Design Handbook", Gitin Maitra, 2nd Edition, ISBN: 978-0074602379
9. "Design Data Book- Design of engine parts", Khandare S.S & Kale A.V, 2nd Edition, ISBN: 978-9352654260
10. "Material Handling Equipment", Rudenko,2nd Edition, M.I.R. publishers, Moscow

Reference Books:

11. "Mechanical design analysis", MF Spotts, 3rd Edition, Prentice Hall Inc.
12. "Machine Design-An Integrated Approach", Robert L. Norton,6th Edition, Pearson Education, ISBN: 9780135184233
13. "Material Handling Equipments", N. Rudenko, Peace Publication
14. "Material Handling Equipments", Alexandrov,5th Edition, Mir Publication ISBN: 9780714717456
15. Machine Desgin", Reshetov, Mir Publication 1978.
16. "Machine Design", R.C.Patel, Pandya, Sikh, Vol -I & II,12th Edition, C. Jamnadas& Co.
17. "Design of Machine Elements", 4th Edition, V. M. Faires, ISBN: 978-0023359507

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc22_me62 - Gear And Gear Unit Design: Theory and Practice, IIT Kharagpur

2. https://nptel.ac.in/courses/112/106/112106137/ - Machine Design-II, IIT Madras

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	3	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	-	2	-	2	-	-	-	-	-	2
CO3	3	3	3	-	-	2	-	2	-	-	-	-	-	2
CO4	3	3	3	-	-	2	-	2	-	-	-	-	-	2
CO5	3	3	3	-	-	2	-	2	-	-	-	-	-	2

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25PEC14ME21	Machinery Diagnostics	2	1	--	2	1	--	3
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	
		Tutorial	50	--	--		50	

Pre-requisite Course Codes	Industrial Electronics	
Course Outcomes	CO1	Explain the fundamentals of vibration and condition monitoring in machinery diagnostics.
	CO2	Summarize the principles and settings of data acquisition used in machinery diagnostics.
	CO3	Interpret time and frequency domain responses to recognize faults such as unbalance, misalignment, bent shaft, etc., in rotating machinery
	CO4	Explain advanced signal processing and non-vibration diagnostic techniques used for machinery fault detection
	CO5	Describe fault types, causes and diagnostic indicators in bearings, gearboxes and pumps.
	CO6	Summarize the concepts of fault prognosis, Remaining Useful Life (RUL) and uncertainty in predictive maintenance.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Basics of Vibration signal analysis** Periodic and random motion, Spectral Amplitude Scaling: RMS, Peak and Peak-to-Peak Conversion and Selection, Time and frequency domain analysis, Phase analysis, Orbit analysis, Understanding signal pattern.	1-2	3
	1.2	**Introduction to Vibration based Condition Monitoring** Maintenance Principles, Vibration based fault Prognosis, Goal of Vibration Monitoring, Steps in Vibration Monitoring, Benefits of Vibration based condition monitoring	1-2	2
2	2.1	**DAQ system** Data Acquisition & Signal Processing Classification of signals, Signal analysis, Fast Fourier Transform (FFT)	1-2	3
	2.2	Essential Settings in Data Acquisition System (Plot Formats, Frequency Span and Frequency Resolution, Average Types and Number of Averages, Windowing, Spectrum Scaling), Signal conditioning.	1-2	2
3	3.1	**Machinery Fault Diagnosis I** Natural frequency and resonance tests (Practical approach), Time and Frequency domain analysis to identify unbalance, bent shaft, Misalignment, Soft foot conditions, Mechanical looseness	1-2	3

4	4.1	**Advanced Diagnostic Techniques** Advanced Signal Processing Techniques (Envelope Analysis, Cepstrum Analysis, Time–Frequency Analysis. Non-Vibration Based Techniques (Thermography, oil analysis, motor current signal analysis, Acoustic emission)	1-2	4
5	5.1	**Machinery Fault Diagnosis II** Rolling element bearing, Journal Bearing, Gear Box, Vane defect in pumps. (Aspects to be covered: types of faults, causes of failure, diagnosis techniques and fault indicators)	1-2	7
6	6.1	**Fault Prognosis** Introduction to Fault Prognosis, concept of Remaining Useful Life (RUL), Prognostic Approaches, Uncertainty in Prognosis.	1-2	2
			Total	**26**

Tutorial:

Sr. No.	Tutorials details	Hours
1	Case study on analysis of vibration signals using time waveform, frequency spectrum and phase plots	1
2	Industrial application of vibration-based condition monitoring and maintenance planning: a case study	1
3	Configuration of data acquisition systems: sensors, sampling, windowing and signal conditioning	1
4	Case study on diagnosis of rotating machinery faults (unbalance, misalignment, looseness, soft foot) using spectral patterns	1
5	A study of bearing, gearbox and pump vane defects using vibration signals	1
6	Assessment of journal bearing faults and lubrication issues through oil analysis and thermography: a case study	1
7	Use of advanced diagnostic methods: envelope, cepstrum and time–frequency analysis in bearing/gear box/etc: In any software	1
8	A case study on Application of fault prognosis concepts and Remaining Useful Life (RUL) estimation	1
	Total	**8**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

Assessment shall be based on the tutorials evaluated through continuous assessment of understanding and application of machinery diagnostic methods.

Recommended Books:

Text Books:

1. R.B. Randall, "Vibration-based Condition Monitoring", Wiley2021, ISBN: 978-1-119-47755-6
2. A.R. Mohanty, "Machine Condition Monitoring: Principles and Practices", CRC Press 2017, ISBN: 978113874825
3. R.A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring",1st Edition, Chapman and Hall, ISBN: 978-94-009-5723-7

Reference Books:

4. J.S. Rao, "Vibratory Condition Monitoring of Machine", Narosa Publishing House
5. Principles of Vibration Analysis with Applications in Automotive Engineering" by Peter H. Sydenham & Colin S. Milsom

Links for online NPTEL/SWAYAM courses:
https://nptel.ac.in/courses/112105232

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	2	-	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	2	3	-	3	-	-	-	-	-	-	-	-	-	-
CO4	2	2	-	3	-	-	-	-	-	-	-	-	-	-
CO5	2	3	-	2	-	-	-	-	-	-	-	-	-	-
CO6	2	2	-	2	-	-	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14ME22	Smart Materials	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	
		Tutorial	50	--	--		50	

Pre-requisite Course Codes		
Course Outcomes	CO1	Classify and select different types of smart materials
	CO2	Comprehend Important Concepts and principles of Smart Materials
	CO3	Synthesis, sensing and actuation of Piezoelectric Materials, Magneto strictive Materials, Shape Memory Alloys, Electroactive Polymers
	CO4	Synthesis, sensing and actuation of Ferrofluids and Magneto rheological Fluids, Soft Matter, Carbon Nanotubes and Carbon nanostructures, Thermoelectric Materials
	CO5	Classify and select Smart Materials for Energy Applications: Materials used for energy storage
	CO6	Classify and select Composite Materials, Nano Composite Materials

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to Smart Materials:** Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, Nanocomposite materials	1, 2,	4
2	2.1	**Important Concepts of Smart Materials:** artificial skins, artificial muscles, biomimetic materials, Inch worm devices	3	3
3	3.1	**Overview of the following materials:** 1. Piezoelectric Materials, 2. Magneto strictive Materials 3. Shape Memory Alloys, 4. Electroactive Polymers	4, 5, 6, 7,	5
4	4.1	Overview of the following materials: 1. Ferrofluids and Magneto Rheological Fluids 2. Soft Matter and its applications 3. Carbon Nanotubes and Carbon nanostructures 4. Thermoelectric Materials and Peltier devices	8	5
5	5.1	**Smart Materials for Energy Applications:** Materials used for energy storage, Hydrogen Storage Materials, Energy harvesting, Energy scavenging from vibrations	9, 10	4

6	6.1	**Manufacturing techniques for smart materials:** Micromanufacturing, Lithography, LIGA process, Generative manufacturing processes such as Stereolithography, Selective Laser Sintering, Selective Powder Binding, Laminated Object Manufacturing, Solid Ground Curing, Fused Deposition Modelling, Ballistic Particle Manufacturing.		5
				26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

Assessment shall be based on the tutorials evaluated through continuous assessment of understanding of smart materials for various engineering applications.

Recommended Books:

1. M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman & Hall, London; New York, 1992 (ISBN: 0412370107)
2. Mel Scwartz, "Encyclopedia of Smart Materials Vol. I and II", John Wiley & Sons
3. A.V. Srinivasan, "Smart Structures: Analysis and Design", Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267)
4. G. Gautschi, "Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers", Springer, Berlin; New York, 2002 (ISBN:3540422595)
5. K. Uchino, "Piezoelectric Actuators and Ultrasonic Motors", Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)
6. G. Engdahl, "Handbook of Giant Magneto strictive Materials", Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X)
7. K. Otsuka and C.M. Wayman, "Shape Memory Materials", Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X)
8. Eric Udd, "Fibre Optic Sensors: An Introduction for Engineers and Scientists", John Wiley & Sons, New York, 1991 (ISBN: 0471830070)
9. André Preumont, "Vibration Control of Active Structures: An Introduction", 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966)
10. S Priya and D J Inman, "Energy Harvesting Technologies", Springer-Verlag (2008) ISBN: 978-0-387-76463-4
11. Gibson, I., Rosen, D. W., & Stucker, B. (2015). Additive manufacturing technologies: 3D printing, rapid prototyping, and direct digital manufacturing (2nd ed.). Springer. ISBN 978-1-4939-2112-6.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes * (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	Apply	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14ME23	Finite Element Methods for Engineering Analysis	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	
		Tutorial	50	--	--		50	

Pre-requisite Course Codes	Basic CAD, Design, Mathematics.	
Course Outcomes	CO1	Solve differential equations using weighted residual methods.
	CO2	Develop the finite element equations to model engineering problems governed by second order differential equations.
	CO3	Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements.
	CO4	Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements.
	CO5	Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system and explain introductory CFD concepts and solution procedure.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Overview of FEA.	1-8	4
	1.2	Mathematical Modelling of field problems in engineering, Governing Differential equations, primary/secondary variables, boundary conditions types-essential/natural etc.		
	1.3	Discrete and Continuous Models.		
	1.4	Various principal & Methods used in FEM: element, order of the element, internal and external node/s, degree of freedom.		
2	2.1	Approximate solution of differential equations, residual (Galerkin, Subdomain method, Rayleigh-Ritz method).	1-8	6
	2.2	Minimization of a functional, Principle of minimum total potential, Formulation of 'stiffness matrix', assembly concepts to develop system equation.		
3	3.1	One Dimensional Problems: One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors		
	3.2	Assembly of Matrices- solution of problems in one-dimensional structural analysis (stepped and taper bars, spring-Cart Systems, Plane trusses, Beams), heat transfer	1-8	8

4	**4.1**	**Two Dimensional Finite Element Formulations:** Introduction, three node triangular element, four node rectangular element.		
	4.2	Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular element.	1-8	4
5	**5.1**	**Finite Element Formulation of Dynamics and Numerical Techniques:** Free vibration problems of rod and beam, Lumped and consistent mass matrices.	1-8	4
	5.2	Introduction to CFD: What is CFD?, Scope and Application of CFD, Basic Steps in CFD.		
			Total	**26**

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Numerical on Galerkin method.	**01**
2	Numerical on Subdomain method.	**01**
3	Numerical on Rayleigh-Ritz method.	**01**
4	Numerical on Stepped Bar/ spring-Cart Systems	**01**
5	Analysis of Plane trusses	**01**
6	Analysis of Beams.	**01**
7	Numerical on Natural frequency of axial vibration of bar.	**01**
8	Numerical on Natural frequency of transverse vibration of bar.	**01**
Total Hours		**08**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

Assessment shall be based on the tutorials evaluated through continuous assessment of understanding and application of finite element methods for various engineering scenarios.

Recommended Books:

1. Textbook of Finite Element Analysis by Seshu P, Prentice Hall of India

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

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/104/112104193/
https://nptel.ac.in/courses/105/106/105106051/
https://nptel.ac.in/courses/112/104/112104115/
https://nptel.ac.in/courses/112/103/112103295/
https://nptel.ac.in/courses/112/106/112106135/
https://nptel.ac.in/courses/112/106/112106130/
https://nptel.ac.in/courses/105/105/105105041/

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	-	-	-	-	-	-	-	2	-	-
CO2	3	2	1	1	1	-	-	-	-	-	-	-	2	-	-
CO3	3	2	1	2	2	-	-	-	-	-	-	-	2	-	-
CO4	3	2	1	2	2	-	-	-	-	-	-	-	2	-	-
CO5	3	2	1	2	2	-	-	-	-	-	-	-	2	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25MDM61	Disaster Management	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Analyze disaster risk, vulnerability, and hazard assessment frameworks
	CO2	Explain types, causes, and impacts of natural and anthropogenic disasters
	CO3	Apply national and international disaster management policies and institutional mechanisms.
	CO4	Evaluate institutional frameworks in disaster management
	CO5	Measure the importance of Financing Relief and Risk mapping

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Disaster Management**	1,2	5
	1.1	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters		
	1.2	Climate change and disaster linkages, global warming, Sea level rise and Ozone layer depletion		
2		**Natural and Manmade disasters**	2,3,4	6
	2.1	Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge		
	2.2	Manmade disaster: Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization		
3		**Disaster Management, Policy and Administration**	3,4	4
	3.1	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.		
	3.2	Policy and administration: Importance and principles of disaster management policies, command and co- ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the process.		
4		**Institutional Framework for Disaster Management in India**	5,6	**7**
	4.1	Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.		

	4.2	Methods and measures to avoid disasters, Management of casualties. set up of emergency facilities, importance of effective Communication amongst different agencies in such situations		
	4.3	Use of Internet and software for effective disaster Management. Applications of GIS, Remote sensing and GPS in this regard		
5		**Financing Relief Measures and Risk mapping**	5.6.7	4
	5.1	Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters International relief aid agencies and their role in extreme events.		
	5.2	Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis	1,3,7	
Total				**26**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by
3. Centre for land warfare studies, New Delhi, 2011.
4. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann, Elsevier Publications.
5. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
6. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
7. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat
8. Publications
9. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	3	-	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25MDM62	Environmental Management	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain major global environmental issues, ecological concepts, biodiversity loss, and Sustainable Development Goals (SDGs).
	CO2	Interpret environmental laws, regulatory frameworks, and governance mechanisms in India and globally.
	CO3	Analyse environmental impact assessment procedures and corporate environmental responsibilities.
	CO4	Apply Environmental Management Systems (EMS), ISO 14001 standards, and environmental auditing principles.
	CO5	Evaluate the role of digital tools (AI, GIS, IoT, blockchain, carbon credits) in modern environmental management.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Environmental Management**		7
	1.1	Global Environmental concerns: - Global Warming, Acid Rain, Ozone Depletion, Chemical smog, Hazardous Wastes.	1,2	
	1.2	Endangered life-species, Loss of Biodiversity, Ecology and Ecological successions and its types, Population as a global problem.	3,4,5	
	1.3	Significance of UN 17 Sustainable Development Goals (SDGs), Natural Circular economy frameworks	2	
2		**Environmental Laws and Governing Policies**		6
	2.1	Environmental policy frameworks, Major environmental laws in India (Salient Features of: - Air Act, Water Act, EPA, Forest & Wildlife Acts), Regulatory agencies and enforcement,	1,2	
	2.2	Central and State Pollution control boards—Powers and Functions. International conventions and protocols	1,2	
3		**Environmental Impact Analysis**		5
	3.1	Role and functions of Government as a planning and regulating agency, Environment Quality Management and Corporate Environmental Responsibility	4,5	
	3.2	Objectives of environmental impact Analysis, Impact prediction, evaluation and mitigation measures, Environmental clearance	4,5	
4		**Environmental Management**		4
	4.1	Environmental Management Systems (EMS) and ISO 14001, Implementation steps and certification processes	6,7	

	4.2	Environmental auditing: purpose & process, Waste audits and pollution prevention assessment, Role of EMS in corporate sustainability	6,7	
5		**Digital Tools & Emerging Technologies in Environmental Management**		4
	5.1	AI and machine learning in pollution prediction, GIS & Remote sensing applications,	1,3,7	
	5.2	IoT-based environmental monitoring, Smart cities and environmental dashboards, Blockchain in carbon trading, Role of Carbon credits in solving environmental problem.	1,3,7	
			Total	**26**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha - Oxford University Press
2. Environmental Studies: From Crisis to Cure by R. Rajagopalan - Oxford University Press
3. A Textbook of Environmental Studies by D.K. Asthana - S. Chand Publishing
4. A Text Book of Environmental Studies by Dr. G.R. Chatwal & Dr. Harish Sharma - Himalaya Publishing House
5. Perspectives in Environmental Studies –Anubha Kaushik, C P Kaushik Third Edition, New age International Publishers
6. Environmental Studies- Benny Joseph, Second Edition the McGraw Hill Puiblishers
1. 7.A Textbook of Environmental Studies, Deeksha Dave, S S Katewa, Second Edition Cengage Publishers,

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	2	-	-	-	-	3	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	3	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	3	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	3	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	3	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	Understand	**Apply**	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25MDM71	Management Information Systems	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE	Total		
		Theory	20	30	50	100		

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Examine the impact of information systems in transforming Businesses.
	CO2	Analyse the ethical, social, and security considerations in the management and governance of information systems.
	CO3	Evaluate the major tools, technologies, and data management approaches used to support business intelligence and managerial decision-making.
	CO4	Assess the influence of social media platforms on business strategy, marketing practices, and customer engagement.
	CO5	Compare and critique the methodologies involved in the development and implementation of information systems within business organizations.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Foundations of Information Systems (IS): Computer Based Information Systems, Components of IS: People, Process, Technology, Data, Role of IS in organizational efficiency. Organizational Strategy and Competitive Advantages using IS	[1],[2]	4
	1.2	Digital Transformation and Platform Economy: Digital transformation strategy, Platform-based business models and digital ecosystems, Case discussions: Platform enterprises		
2	2.1	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management	[1]	7
	2.2	Business Intelligence (BI): Managers and Decision Making, Descriptive, predictive and prescriptive analytics, Data visualization and data storytelling BI for Data analysis and Presenting Results.		
	2.3	Artificial Intelligence in Business: AI-powered Decision Support Systems, Generative AI in enterprises, Intelligent automation and robotic process automation (RPA), AI-driven personalization and forecasting		
3	3.1	Information Security and Risk Management: Threats to Information Systems, Security controls and cyber resilience, Zero-trust security model.	[1],[3]	6
	3.2	Ethical and Social Implications: Ethical issues in information systems, Algorithmic bias and explainable AI, Responsible AI principles, Societal impacts of automation and digital platforms		

	3.3	Social Computing (SC): Web 2.0 and 3.0, SC in business, shopping, Marketing, Operational and Analytic CRM, E-business, E-commerce & M-commerce		
4	4.1	Enterprise Systems: Transaction Processing Systems (TPS), Functional Area Information Systems, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Analytics	[1]	3
	4.2	Cloud Computing and Emerging Technologies: Cloud computing models: IaaS, PaaS, SaaS, Blockchain applications in business, Digital twins and automation.	[1],[3]	3
5	5.1	System Development, Agile Methods and Organizational Implementation: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models	[1],[3]	3
Total				**26**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

[1] Kelly Rainer, Brad Prince, Management Information Systems, Wiley
[2] K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed.,Prentice Hall, 2007.
[3] Tom Taulli, Artificial Intelligence Basics: A Non-Technical Introduction.
[4] Lindsay Herbert: Digital Transformation: Build Your Organization's Future for the Innovation Age
[5] Thomas Erl, Ricardo Puttini & Zaigham Mahmood: Cloud Computing: Concepts, Technology & Architecture

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes * (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2
CO1	3	-	-	2	-		-	-	-	-	-	2	-	-
CO2	3	-	-	2	-	2	-	2	-	-	-	2	-	-
CO3	3	-	-	-	1	-	-	-	-	-	-	2	-	-
CO4	3	-	-	2	-	2	-	2	-	-	-	2	-	-
CO5	3	-	-	2	-	-	-	-	-	-	1	2	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	Apply	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25MDM72	Finance Management	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE	Total		
		Theory	20	30	50	100		

Pre-requisite Course Codes	--	
Course Outcomes	At the End of the course students will be able to :	
	CO1	Understand Indian finance system and corporate finance
	CO2	Take investment, finance as well as dividend decisions

Module No.	Unit No.	Topics	CO	Ref.	Hrs.
1.	1.1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.	1	1, 2, 4, 5	4
	1.2	**Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets Capital Market, Money Market and Foreign Currency Market. **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions, Commercial Banks, Investment-Merchant Banks and Stock Exchanges	1	1	
2.	2.1	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two- security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	2	1	4
	2.2	**Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting	2	1	
3.	3.1	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance Investment Decision, Financing Decision, and Dividend Decision.	2	1	6
	3.2	**Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis	2	1	

4.	4.1	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion - Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value (NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	2	1	6
	4.2	**Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities	1	1	
5.	5.1	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short-Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	1	1	4
		Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure.	1		
6.	6.1	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches - Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	2	1	2
Total					**26**

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers:

McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	Analyze	Evaluate	Create

Society of St. Francis Xavier, Pilar's
Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050
(Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25RMC14ME01	Essentials of Research Methodology	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	

Pre-requisite Course Codes	-	
Course Outcomes	CO1	Explain the basic concepts and types of research
	CO2	Formulate research problems and research design.
	CO3	Apply statistical tools including ANOVA and basic DOE.
	CO4	Interpret multivariate data analysis concepts at introductory level.
	CO5	Analyze ethical issues in research and publication.
	CO6	Prepare structured research report and presentation.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	**Introduction to Research** Meaning and objectives of research. Characteristics of research. Research process. Types of research – Basic, Applied, Exploratory, Descriptive, Experimental. Research problem identification and formulation. Concept of hypothesis, variables and research gap.	1,2	4
2	2	**Research Design & Sampling** Research design types. Measurement & scaling (Nominal, Ordinal, Interval, Ratio). Sampling techniques – Probability & Non-probability sampling. Questionnaire design basics (Marketing research perspective). Literature review methods and referencing styles.	1,2,	4
3	3	**Statistical Analysis & ANOVA** Probability distributions – Normal, Binomial, Poisson (Conceptual). Estimation and hypothesis testing. Z-test, t-test ANOVA – One way ANOVA, Two way ANOVA Type I and II error.	1,	5
4	4	**Design of Experiments (DOE)** Full factorial design Interaction effects. Introduction to Taguchi method. Applications in Engineering & Manufacturing..	4	4
5	5	**Introduction to Multivariate Data Analysis** Need for multivariate techniques. Multiple regression (concept). Factor analysis (basic idea). Cluster analysis (conceptual overview). Applications in Engineering and Marketing research.	3	4
6	6	**Research and Publication Ethics** Research integrity and scientific conduct. Falsification – Fabrication – Plagiarism Plagiarism – types and detection tools. Authorship ethics and conflicts of interest. Predatory journals. Indexing databases – Scopus, Web of Science. Research metrics – Impact Factor, h-index. Structure of journal paper and conference.	1,2, 6	5

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

References

1. Kothari, C.R., *Research Methodology – Methods and Techniques*.
2. Malhotra, Naresh K., *Marketing Research – An Applied Orientation*.
3. Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., *Multivariate Data Analysis*.
4. Montgomery, D.C., *Design and Analysis of Experiments*.
5. Dawson, Catherine, *Practical Research Methods*.
6. UGC – Research & Publication Ethics Guidelines

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO2
CO1	-	1		1	1	-	-	1	-	1	-	1	-	-
CO2	-	3	2	2	2	-	-	-	-	2	-	1	-	-
CO3	-	2	2	3	2	-	-	-	-	-	-	-	1	-
CO4	-	2	2	3	3	-	-	-	-	-	-	-	1	-
CO5	-	-	-	-	-	2	1	3	-	-	-	-	-	-
CO6	-	1	-	-	-	-	-	-	1	3	-	-	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	**Analyze**	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25RMC14ME02	Intellectual Property Rights	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	20	30	50		100	

Pre-requisite Course Codes	-	
Course Outcomes	CO1	Explain the basic concepts and need of Intellectual Property Rights.
	CO2	Differentiate between patents, trademarks, copyrights and other IP forms.
	CO3	Interpret national and international IPR laws and conventions.
	CO4	Apply procedures for filing patents, trademarks, and copyrights.
	CO5	Analyze infringement issues and legal remedies.
	CO6	Evaluate the role of IPR in innovation, research, and industrial growth.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	**Introduction to Intellectual Property** Concept and meaning of Intellectual Property. Nature and characteristics of IPR. Importance of IPR in knowledge economy. Types of Intellectual Property. Need for IPR in Engineering and Research.	1,2, 3,5, 6	4
2	2	**Patents** Meaning and objectives of patents. Patentable subject matter. Patentability criteria – novelty, inventive step, industrial applicability. Non-patentable inventions. Patent specification and claims. Patent filing procedure in India. Rights of patentee and infringement.	1,2, 3,5, 6	4
3	3	**Trademarks, Copyrights and Industrial Design** Trademark: Definition, types, registration process, infringement. Copyright: Subject matter, ownership, duration, infringement. Industrial Design: Meaning, registration procedure, rights and protection.	1,2, 3,5, 6	6
4	4	**Geographical Indications, Trade Secrets and Semiconductor IC Layout Design** GI:Concept, registration, protection. Trade Secrets: Meaning, protection strategies. Semiconductor Integrated Circuit Layout Design protection.	1,2, 3,5, 6	4
5	5	**International Treaties and Agreements** TRIPS Agreement. WIPO conventions. Paris Convention and Berne Convention. Patent Cooperation Treaty (PCT). Role of WTO in IPR regulation	4	4

6	6	**IPR Management and Case Studies** Technology transfer and licensing. IPR in academic institutions and research organizations. Patent search and documentation. Case studies on infringement and litigation. IPR strategy for startups and MSMEs.	1,2, 3,5, 6	4

Course Assessment

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

References

1. P. Narayanan, Intellectual Property Law, Eastern Law House.
2. W.R. Cornish, Intellectual Property: Patents, Copyright, Trademarks and Allied Rights.
3. B.L. Wadhera, Law Relating to Intellectual Property.
4. WIPO Publication on Intellectual Property Handbook.
5. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property.
6. Bare Acts: Indian Patent Act 1970, Trademark Act 1999, Copyright Act 1957.

Suggested CO - PO articulation Matrix

Course Outcomes	**Programme Outcomes (POs)**												**Programme Specific Outcomes* (PSOs)**	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	-	-	-	-	-	-	1	1	-	-	-	-	-	-
CO2	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	1	-	2	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms

Remember	**Understand**	**Apply**	**Analyze**	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
PRJ14ME01	Capstone Project	--	--	12	--		--	6	6
		Examination Scheme							
			ISE			ESE		Total	
		Theory	--			--		--	
		Lab	300			--		300	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Identify and define real-world engineering problems through literature review and data analysis.
	CO2	Analyze existing literature to determine problem scope, research gaps, and feasibility of identified real world problem.
	CO3	Design and implement engineering solutions using appropriate techniques and modern tools.
	CO4	Evaluate the prototype/working model using appropriate validation metrics, considering societal, environmental, and sustainability aspects.
	CO5	Demonstrate effective written and oral communication, teamwork, and leadership skills.
	CO6	Exhibit professional ethics, and commitment to lifelong learning in engineering practice.

Project Guidelines

1. Project Topic Selection and Allocation

1.1 Project Orientation

- Project orientation shall be begin at the end of Semester VI.
- Students shall be informed about available domains and domain experts for guidance.
- Students should be encouraged to refer to problem statements from Digital India Portal, Smart India Hackathon (SIH), INPASS patent database and other hackathon portals.

1.2 Topic Finalization Criteria

Projects should satisfy the following criteria:

- **Novelty:**
  Topics should be product-based, application-based, or research-based and preferably address gaps in existing systems.
- **Relevance:**
  Should align with current industrial trends and specialization area. Also address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact.

- **Technology:**
  Use of modern tools and latest technologies is encouraged.
- **Originality:**
  Work should not repeat projects carried out in the last three years.
- **Literature Review:**
  Students must refer to recent papers (preferably within last 3 years) from reputed sources such as IEEE, Elsevier, ACM, Springer, etc.
- Students may take inspiration from existing ideas but must evolve them uniquely to suit their project requirements.
- Student's projects may be undertaken in research institutes, industries, or business establishments.

1.3 Group Formation

- Project must be carried out in a group of **minimum 2 and maximum 4 students**.

1.4 Approval Process

- Proposal presentations shall be scheduled domain-wise.
- Evaluation shall be carried out by faculty experts in the respective domain.
- Final approval shall be granted by the Head of Department, internal domain wise faculty members, and project coordinators.
- Guide allocation shall be done after topic approval.

2. Monitoring and Progress Tracking

- Students are required to meet their assigned guide regularly, discuss their progress, and submit a weekly progress report (log book) to the internal guide for review and monitoring.
- Internal guide shall:
  - Monitor technical progress
  - Maintain attendance records
  - Evaluate contribution of each student
- Progress reports shall be considered as continuous assessment.

3. Project Implementation Framework

The Capstone Project is structured into two sequential stages: Phase I, conducted during the 7th semester, and Phase II, completed in the 8th semester.

Phase I: Research & Methodology (Semester VII)

Target Outcomes: CO1, CO2, CO3

Phase I focuses on the foundational stages of the engineering lifecycle. Students will conduct a comprehensive literature review, identify critical research gaps, and assess the feasibility of a real-world problem. Emphasis is placed on designing engineering solutions through the application of modern tools and appropriate technical methodologies.

- **In-Semester Evaluation (ISE):** 150 Marks

  ISE-stage1- Literature review and Methodology (50M)

  ISE- stage 2- Design and Implementation (50M)

  End-Semester Evaluation (ESE): 50 Marks

Phase II: Implementation & Professional Practice (Semester VIII)

Target Outcomes: CO4, CO5, CO6

Phase II transitions into the execution and validation of the project. This stage involves evaluating the prototype or working model against performance benchmarks. Furthermore, students must demonstrate proficiency in technical communication, collaborative teamwork, and leadership. The phase concludes with a focus on professional ethics and a commitment to continuous lifelong learning.

- **In-Semester Evaluation (ISE):** 150 Marks

  ISE- stage 1 - Full demonstration of Project and Draft of Publication/Patent (50M)

  ISE- stage 2 - Black book and Evidence of outcome (50M)

  End-Semester Evaluation (ESE): 50 Marks

Evaluation Components:

1. Weekly Log Report
2. Project Work Contribution
3. Completeness of Work
4. Mid-term Presentations (ISE- (100 Marks) With well-defined rubrics)
5. The End Semester Examination (ESE) shall be conducted in the presence of both an internal and an external examiner. The ESE shall be evaluated based on the demonstration of the project, quality of the final report, and submission of a technical paper to a reputed journal or an international conference/ Publication of patent.

Evaluation shall be based on department-defined rubrics.

Final certification of Project Work ensures satisfactory performance in the above components.

4. Project Report Format

At the end of the semester, each group must submit:

- **Hard Copy (Black Book)**
- **Soft Copy** including:
  - Report

- Source Code
- Executable
- Required utilities/software
- User Manual
- Documentation
- Submission on GitHub

The Report Shall Contain:

1. Abstract
2. Introduction
3. Literature Survey / Existing System
4. Limitations / Research Gap
5. Problem Statement and Objectives
6. Proposed System
7. Analysis / Framework / Algorithm
8. Design Details
9. Methodology
10. Experimental Setup
11. Database / Input Details
12. Performance Evaluation Parameters (Validation)
13. Software and Hardware Setup
14. Results and Discussion
15. Conclusion and Future Scope
16. Timeline Chart (Project Management Tools)
17. Implementation details
18. References
19. Appendix (Publications / Certifications if any)

5. Desirable Activities

Students should be encouraged to:

- Complete relevant certification courses aligned with project domain.
- Participate in project competitions and hackathons.
- Publish at least one technical paper in a reputed journal/Present work at National / International Conferences.
- Submission of GitHub repository

6. Suggested Quality Evaluation Parameters:

- Quality and relevance of problem selected
- Clarity of problem definition and feasibility
- Relevance to specialization / industrial trends
- Address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact
- Originality and innovation
- Use of modern tools
- Quality of analysis and design

- Implementation completeness
- Validation of results
- Impact on society/environment and business value
- Quality of written and oral presentation
- Individual contribution and teamwork
- Participation in hackthons and project competitions

SUGGESTED CO - PO articulation Matrix

Laboratory Outcomes	**Programme Outcomes (POs)**												**Programme Specific Outcomes* (PSOs)**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	1	1	1	-	-	-	-	-	3	3
CO2	3	3	1	-	2	1	1	-	-	-	-	-	3	3
CO3	3	3	3	1	3	1	1	1	1	1	1	2	3	3
CO4	1	3	1	1	3	-	3	3	2	-	1	2	3	3
CO5	-	-	-	-	-	-	-	1	3	3	-	2	-	-
CO6	-	-	-	-	-	-	-	3	-	-	-	3	-	-

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create√**

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25SEM14ME01	Course Seminar	L	T	P	L	T	P	Total
		--	--	--	--	--	2	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Theory	--	--	--		--	
		Lab	100	--	--		100	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Identify a real-world engineering advancements across diverse domains.
	CO2	Analyze research literature and technical data to determine problem scope and feasibility.
	CO3	Demonstrate awareness of advanced engineering developments and emerging technologies.
	CO4	Exhibit professional ethics, independent learning ability, and commitment to lifelong learning.
	CO5	Present structured technical reports with effective written and oral communication skills.

1. Seminar Guidelines

1.1 Topic Finalization Criteria

The selected seminar topic must satisfy the following criteria:

- **Novelty:** The topic should address emerging trends, innovative ideas, or recent technological advancements.
- **Relevance:** The selected topic should align with current industrial trends, address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact, and be closely related to the student's area of specialization.
- **Technology Orientation:** Usage of modern tools, platforms, frameworks, and latest technologies is encouraged.
- **Literature Review:**
  - Students must refer to recent research papers (preferably within the last 3 years).
  - References should be from reputed sources such as IEEE, Elsevier, ACM, Springer, etc.
  - A maximum number of quality research papers should be reviewed and critically analyzed.

1.2 Group Formation

- The seminar shall be carried out as an **individual (single student) activity** to encourage independent research and learning.

1.3 Approval Process

- Topic presentations shall be conducted domain-wise.
- Evaluation shall be carried out by faculty experts in the respective domain.
- Final approval shall be granted by the Head of Department and panel wise domain internal faculty members.
- Guide allocation shall be done after formal topic approval.

2. Internal Assessment (ISE – I & II)

2.1 Evaluation Components

- Fortnightly Log Report (Progress Monitoring)
- Mid-term Presentation (ISE-I & ISE-II) as per department-defined rubrics for 50 marks each
- Completeness and Quality of Work

3. Suggested Quality Evaluation Parameters

Evaluation shall be based on the following:

- Quality and relevance of topic selected
- Clarity of problem definition and feasibility
- Relevance to specialization and industrial trends
- Address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact
- Use of modern tools and technologies
- Quality of analysis
- Societal and environmental impact
- Quality of written report
- Effectiveness of oral presentation

4. Seminar Report Structure

The seminar report must include the following sections:

1. Abstract
2. Introduction
3. Literature Survey / Existing System
4. Comparative study of different technical papers
5. Analysis / Framework / Algorithm of the study
6. Design Details studied
7. Methodologies used in the study
8. Proposal for the new concept/solution/algorithm etc.
9. Conclusion
10. References (in standard citation format)
11. Appendix (Publications / Certifications / Additional Documents if any)

5. Desirable Academic Enrichment Activities

Students are encouraged to:

- Complete relevant certification courses aligned with their seminar domain.
- Present their seminar findings to junior students to promote awareness of emerging technologies.
- Publish e-content related to their seminar topic on the department's official YouTube channel.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12	PSO1	PSO2
CO1	3	2	1	-	2	1	1	-	-	1	-	2	3	3
CO2	3	3	2	-	2	2	2	-	-	1	-	2	3	3
CO3	3	2	1	-	2	2	2	-	-	1	-	3	3	3
CO4	1	-	-	-	-	-	-	3	2	2	-	3	1	1
CO5	1	-	-	-	1	-	-	1	2	3	-	2	1	1

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	**Understand**	**Apply**	**Analyse** √	Evaluate	Create