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

THIRD YEAR UG: B. TECH

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**

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.
- Notional hours include Theory, practical, tutorials and self-learning for each students per week.

Degree/SEM	I	II	III	IV	V	VI	VII	VIII	Total
B. Tech (Multidisciplinary Minor)	20	20	22	22	22	22	20	20	168
B. Tech with Double Minor (Multidisciplinary & Specialization Minor)	20	20	22 +4*	22 +4*	22 +4*	22 +4*	20 +2$	20	186
B. Tech with Honors with Research (Multidisciplinary Minor)	20	20	22 +4*	22 +4*	22 +4*	22 +4*	20 +2$	20	186

*Optional Credits $ optional 2 credits can be earned either in VII or VIII Semester

1. Learners who earn a minimum of total 168 credits will be awarded "B.Tech in Engg. /Tech. with Multidisciplinary Minor (MDM)" degree.

2. Learners will have the following options to earn B. Tech. in Engg. /Tech. degree in

    a) Major Engg./Tech Discipline with Double Minor (Multidisciplinary and Specialization Minor)
    b) Honors with Research and Multidisciplinary Minor

    a) Major Engg./Tech Discipline with Double Minor (Multidisciplinary and Specialization Minor) (additional 18 credits): 168 +18 =186 Min Credits.

    There will be four courses (4 credits each), one in each semester starting from the 3rd semester which will be from emerging areas of specialisation. In 7th or 8th semester students will complete 2 credits seminar/project.

Admission eligibility min CGPA=7.5 after First year

    b) b) B. Tech in Engg./ Tech.- Honors with Research and Multidisciplinary Minor (additional 20 credits by research): 168 +18 =186 Min Credits. (Admission eligibility min CGPA=7.5 after First and should maintain CGPA=7.5 after Third year)

3. Learner can earn the certificate/Diploma/Degree based on his/her exit from the program as follows. College shall explore feasibility to offer NSDC aligned skill-based courses to the learners:

    a) UG Certificate: After a one-year (40 credits to be earned) and 8-credits summer workshop/vocational courses/internship
    b) UG Diploma: After two-years (80 credits to be earned) and 8-credits summer workshop/vocational courses/internship/Project
    c) B. Voc.: After three-years (120 credits to be earned) and 8-credits summer workshop/vocational courses/internship/Project

Salient Features of Curriculum:

- Framed as per Government Resolution dated 4 th July 2023 in line with National Education Policy (NEP) 2020.
- Minimum 168 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, multiple entry-exit, 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 learners.

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SEMESTERWISE CURRICULUM STRUCTURE
UG Mechanical Engineering Program:

SEM-V

Course Code	Course Vertical	Sub-Vertical	Course Name	Notional Hours		Examination Marks (1 Credit=50 Marks)					Credits	
						ISE	MSE	ESE Min	ESE Max	Total	Points	Total
25PCC13ME20	PCPEC	PCC	Fluid Mechanics and Hydraulic Machines	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-	-	50	1	
				SS/SL	2							
25PCC13ME12	PCPEC	PCC	Theory of Machines	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-	-	50	1	
				SS/SL	2							
25PCC13ME14	PCPEC	PCC	CAD/CAM and FEA	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
				SS/SL	3							
25PCC13ME21	PCPEC	PCC	Automation and Control Engineering	TH	2	20	30	20	50	100	2	2
				SS/SL	2							
25PCC13ME13	PCPEC	PCC	Metrology and Quality Engineering	TH	2	20	30	20	50	100	1	2
				SS/SL	2							
25PCC13ME15	PCPEC	PCC	FEA and CFD Laboratory	PR	2	50	-	-	-	50	1	1
25PEC13MEXX	PCPEC	PEC	Program Elective Course-1	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
				SS/SL	3							
25PEC13MEXX	PCPEC	PEC	Program Elective Laboratory	PR	2	50	-	-	-	50	1	1
25OE3X	MDC	OE	1. Health, Wellness and Psychology 2. Emotional and Spiritual Intelligence	TH	2	100	-	-	-	100	2	2
				SS/SL	2							
25MDMXX4	MDC	MDM	MDM Course-4	TH	2	20	30	20	50	100	2	2
				SS/SL	2							
25DMX3	DM	DM	Double Minor Course	TH	2	20	30	20	50	100	2	4*
				TU	2	50	-	-	-	50	2	
25HR04	HR	HR	Honors with Research	SS/SL	4						4	4*
Total					**TH:TU:PR:SL 16:2:8:18=44**				**-**	**1100**	**-**	**22**

SEM-VI

Course Code	Course Vertical	Sub-Vertical	Course Name	Notional Hours		Examination Marks (1 Credit=50 Marks)					Credits	
						ISE	MSE	ESE Min	ESE Max	Total	Points	Total
25PCC13ME22	PCPEC	PCC	Heat Transfer	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
				SS/SL	3							
25PCC13ME17	PCPEC	PCC	Machine Design	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
				SS/SL	3							
25PCC13ME23	PCPEC	PCC	Heat Transfer Laboratory	PR	2	50	-	-	-	50	1	1
25PCC13ME19	PCPEC	PCC	Hydraulics and Pneumatics Laboratory	PR	2	50	-	-	-	50	1	1
25PEC13MEXX 25PEC13MEXX	PCPEC	PEC	Program Elective Course-2	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
				SS/SL	3							
25PEC13ME3X 25PEC13MEXX	PCPEC	PEC	Program Elective Course-3	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-	-	50	1	
				SS/SL	3							
25PEC13MEXX	PCPEC	PEC	Program Elective Laboratory	PR	2	50	-	-	-	50	1	1
25PEC13ME12	PCPEC	PEC	Program Elective Laboratory	PR	2	50	-	-	-	50	1	1
25OE4	MDC	OE	Public Relations and Corporate Communication	TH	2	100	-	-	-	100	2	2
				SS/SL	2							
25MDMXX5	MDC	MDM	MDM Course-5	TH	2	20	30	20	50	100	2	2
				SS/SL	2							
25VSE13ME04	SC	VSEC	Measurement Systems and Quality Engineering Laboratory	PR	2	50	-	-	-	50	1	1
25VSE13ME05	SC	VSEC	CNC Laboratory	PR	2	50	-	-	-	50	1	1
25DMX4	DM	DM	Double Minor Course	TH	2	20	30	20	50	100	2	4*
				TU	2	50	-	-	-	50	2	
25HR05	HR	HR	Honors with Research	SS/SL	4						4	4*
Total					**TH:TU:PR:SL 12:4:12:16=44**				**-**	**1100**	**-**	**22**

Notional Hours = Contact Hours + Self-Learning

List of Program Elective Courses:

Track-1: Manufacturing and Management

SEM-V: ***Any one Theory:***

25PEC13ME12: Costing and Cost Control
25PEC13ME13: Mould and Metal Forming Technology
25PEC13ME14: Additive Manufacturing

Lab:
25PEC13ME15: Additive Manufacturing Laboratory

SEM-VI: ***Any two Theory:***

25PEC13ME16: Tool Engineering
25PEC13ME18: Optimization Techniques
25PEC13ME19: Project Management
25PEC13ME110: Industrial Engineering and Operations Management

Lab:
25PEC13ME111: Manufacturing Systems
25PEC13ME112: Industrial Engineering and Operations Management Laboratory

Track-2: Design and Automation

SEM-V: ***Any one Theory:***

25PEC13ME22: Finite Element Analysis
25PEC13ME23: Dynamics of Machinery

Lab:
25PEC13ME24: Condition Monitoring Laboratory

SEM-VI: ***Any two Theory*****:**

25PEC13ME25: Industrial Robotics
25PEC13ME27: IC Engines
25PEC13ME28: Product Design and Development

Lab:
25PEC13ME29: Robotics and Control Engineering Laboratory
25PEC13ME210: Product Design Laboratory

B. Tech in Mechanical Engineering with Minor Computer Engineering:

Course Code	Computer Engineering Minor Courses	Credits
25MDMXX1	Data Structures and Algorithms	2
25MDMXX2	Database Management System	2
25MDMXX3	Microcontrollers and Applications	2
MDMXX4	AI and Applications	2
MDMXX5	Human Machine Interface	2

B. Tech in Mechanical Engineering with Minor Electronics Engineering:

Course Code	Electronics Engineering Minor Courses	Credits
25MDMXX1	Signals and System	2
25MDMXX2	Digital Electronics	2
25MDMXX3	Microcontrollers and Applications	2
MDMXX4	Linear Integrated Circuits	2
MDMXX5	Industrial Electronics	2

B. Tech in Mechanical Engineering with Minor Business Management:

Course Code	Business Management Minor Courses	Credits
25MDMXX1	Financial Accounting	2
25MDMXX2	Economics for Business	2
25MDMXX3	Business Administration	2
MDMXX4	Human Resource Management	2
MDMXX5	Digital Marketing	2

B. Tech in Mechanical Engineering with Minor Healthcare Management:

Course Code	Healthcare Management Minor Courses	Credits
25MDMXX1	Biomedical Instrumentation & Imaging	2
25MDMXX2	Hospital Administration Fundamentals	2
25MDMXX3	Operations Management for Healthcare Systems	2
MDMXX4	Digital Transformation in HealthCare	2
MDMXX5	Bioinformatics and Computational Biology	2

B. Tech in Mechanical Engineering with Minor Design:

Course Code	Design Minor Courses	Credits
25MDMXX1	Industrial and Product Design	2
25MDMXX2	Communication Design	2
25MDMXX3	Graphic Design and Animation	2
MDMXX4	Interaction Design	2
MDMXX5	Mobility and Vehicle Design	2

Double Minor Degree in 'Emerging Areas' Offered to Mechanical Engineering Students:

1. Name: Internet of Things

1. **DM21:** Sensors and Actuators

2. **DM22:** Fundamentals of IoT
3. **DM23:** Embedded System and RTOS
4. **DM24:** System Design

2. Name: Data Science

1. **DM51:** Statistics for Data Science
2. **DM52:** Data Analytics and Visualisation
3. **DM53:** Game Theory
4. **DM54:** Web and Social Media Analytics

3. Name: Artificial Intelligence and Machine Learning

1. **DM61:** Statistics for Data Science
2. **DM62:** Fundamentals of AI & ML
3. **DM63:** Natural Language Processing
4. **DM64:** Artificial Intelligence for Mechanical Engineering

4. Name: Sustainability

1. **DM41:** Design Thinking for Sustainability
2. **DM42:** Green Computing
3. **DM43:** Emerging Technologies for Sustainability
4. **DM44:** Sustainable Product Design

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
25PCC13ME20	Fluid Mechanics and Hydraulic Machines	L	T	P	SL	L	T	P	Total
		2	--	2	2	2	--	1	3
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Practical	50	--		--		50	

Pre-requisite Course Codes	Thermodynamics	
Course Outcomes	CO1	Explain fluid properties, viscosity, and hydrostatics, including forces on submerged surfaces.
	CO2	Analyse fluid kinematics, flow classification, and flow characteristics using stream and potential functions.
	CO3	Apply Bernoulli's equation and control volume analysis for fluid flow problems.
	CO4	Explain boundary layer concepts and aerofoil theory.
	CO5	Describe turbomachinery principles and analyse hydraulic turbines.
	CO6	Evaluate centrifugal and positive displacement pumps, including efficiency and cavitation.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Basic Concepts:** Significance of fluid mechanics, physical properties of fluid, Newton's law of viscosity, Newtonian and non-Newtonian Fluid	1-4	2
	1.2	**Fluid Statics:** Pascal's law, hydrostatic law, hydrostatic force on submerged surfaces (vertical, inclined & curved). Archimedes principle, buoyancy.	1-4	3
2	2.1	**Fluid Kinematics:** Classification of fluid flow, streamline, path line, streak line, acceleration of fluid particle, differential equation of continuity, rotational flow and vortices, stream function, potential function	1-4	4
3	3.1	**Fluid Dynamics:** Concept of control volume and control surface, Importance of Reynolds Transport theorem (RTT)	1-4	2
		(No numerical). Euler's equation, Expression of Bernoulli's equation.		
	3.2	**Laminar Viscous flow:** Reynolds number, Laminar flow between parallel plates (Plane Poiseuille&Couette flow), Laminar flow in circular pipe (Hagen-Poiseuille flow).	1-4	3
4	4.1	**Boundary Layer Theory:** Concept of formation of boundary layer, boundary layer parameters, boundary layer along a long thin plate and in pipe	1-4	3
5	5.1	Basic Euler's theory of turbo machines and it application to pumps, turbines and compressors	5-6	2
	5.2	**Hydraulic Turbines:** Basic theory, classification of turbines, theory of impulse and reaction turbines, estimation of work done, efficiency, characteristics of turbines	5-6	3

6	**6.1**	**Centrifugal pumps:** Construction, estimation of work done, efficiency, characteristics, determination of operating point, cavitation and NPSH, specific speed of pumps	5-6	2
	6.2	**Positive Displacement pumps:** Types and applications, Head, discharge, work done and efficiency, indicator diagram (no numerical on reciprocating pump).	5-6	2
Total				**26**

Self-Learning Component:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Laboratory:

Sr. No	Experiments to be completed in laboratory	Hrs
PART A: Fluid Mechanics		
1	Stability of Floating Bodies	2
2	Calibration of Venturimeter/ Orifice meter/Nozzle/ Pitot tube	2
3	Verification of Bernoulli's Equation	2
4	Online Virtual/Simulation based Experiment on Fluid Mechanics	2
PART B: Hydraulic Machines		
1	Impact of jet	2
2	Performance Characteristics of Pelton Wheel Turbine (Impulse Turbine)	2
3	Performance Characteristics of Francis Turbine (Reaction Turbine)	2
4	Performance Characteristics of Centrifugal Pump	2
5	Online Virtual/Simulation based Experiment on Fluid Machinery	2
	TOTAL	**18**

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.

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Fluid Mechanics and Hydraulic Machines – R. K. Bansal, Laxmi Publications
2. Fluid Mechanics: Fundamentals and Applications – Yunus A. Çengel, John M. Cimbala, McGraw Hill
3. Hydraulics and Fluid Mechanics – P. N. Modi & S. M. Seth, Standard Book House
4. Introduction to Fluid Mechanics – Fox, McDonald, Pritchard, Wiley Publications
5. Hydraulic Machines – Jagdish Lal, Metropolitan Book Co. Pvt. Ltd.
6. Turbomachinery: Basic Theory and Applications – S. L. Dixon, Elsevier

AICTE Prescribed Textbook:

Fluid Mechanics & Hydraulics Machinery Author Name-Prof. Suman Chakraborty
(https://ekumbh.aicte-india.org/allbook.php#)

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3	2	-	-	-	-	-	-	-	-	-	3	-
CO5	3	2	-	-	-	-	-	-	-	-	-	3	2
CO6	3	2	-	-	-	-	-	-	-	-	-	3	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			
25PCC13ME12	Theory of Machines	L	T	P	SL	L	T	P	Total
		2	--	2	2	2	--	1	3
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Practical	50	--		--		50	

Pre-requisite Course Codes	Engineering Mechanics, Mechanics of Solids	
Course Outcomes	CO1	Demonstrate basic concepts of kinematics and identify various components of common mechanisms.
	CO2	Analyse the velocity and acceleration of various links in motion.
	CO3	Illustrate different types of cams, followers with different motions and develop profiles of cams for engineering applications.
	CO4	Illustrate various types of gears/ their terminology, areas of application analyse various parameters pertaining to spur gears and gear trains.
	CO5	Demonstrate basic concepts pertaining to balancing/vibrations in evaluation of simple machine components.
	CO6	Analyse clutches, brakes and dynamometers for evaluation of braking force and belt drive for power transmission.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Basic Concepts:** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints.	1-2	1
	1.2	**Degree of freedom** (mobility): Kutzbach mobility criterion, Grűbler's criterion & its limitations	1-2	1
	1.3	**Inversions:** Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	1-2	1
2	2.1	**Velocity Analysis of Mechanisms** (mechanisms up to 6 links) Velocity analysis by instantaneous centre of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach)	1-2	2
	2.2	**Acceleration Analysis of Mechanisms** (mechanisms up to 6 links) Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach)	1-2	2
3	3.1	**Cam and Follower Mechanism** Cam and its Classification based on shape, follower movement, and manner of constraint of follower; Followers and its Classification based on shape, movement, and location of line of movement; Cam and follower terminology	1-2	1
	3.2	**Motions of the follower:** SHM, Constant acceleration and deceleration (parabolic), Constant velocity, Cycloidal;	1-2	1
	3.3	**Layout of cam profile** for specified displacement characteristics for cams with translating and oscillating followers	1-2	2

4	**4.1**	**Gears:** Introduction, Types of gears and applications, Gear terminology, Condition for constant velocity ratio−conjugate profiles, profiles used in gears. Interference of involute teeth, methods of preventing interferences through undercutting, length of path of contact and contact ratio, no of teeth to avoid interference	1-2	3
	4.2	**Gear Trains:** Simple, compound, planetary and epicyclic gear trains (with numerical)	1-2	2
5	**5.1**	**Balancing:** Introduction. Rotary masses: several masses in same plane, several masses in different planes. (No numerical problems) Balancing of locomotives− Variation of Tractive Effort, Swaying Couple and Hammer blow, The concept of primary and secondary balancing (No numerical problems)	1-2	3
	5.2	**Vibrations:** Introduction−free vibrations; longitudinal, transverse and torsional vibrations, critical or whirling speed of shaft. Torsional vibrations of two rotor system - torsionally equivalent shaft.	1-2	2
6	**6.1**	**Clutches, Brakes and Dynamometers:** Study and analysis of single plate clutch, multiple plate clutches and cone clutches. Types of brakes. viz. block and shoe brakes, band brake, band and block brakes Types of dynamometers, classification, Prony brake, Rope brake belt transmission dynamometers	1-2	3
	6.2	**Belts:** Introduction, Types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission	1-2	2
			Total	**26**

Practical:

Sr. No.	**PART A (Experiments) (Minimum 5)**	**Hours**
1	Experiments on Gyroscope	10
2	Experiments on Governors- Porter Governor, Hartnell Governor	
3	Determine natural frequency of Simple Pendulum	
4	Determine natural frequency of Compound Pendulum	
5	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system	
6	Determine whirling speed of shaft	
7	Experimental balancing of single and multi-rotor system	
	PART B (Graphical Solutions)	
1	Analysis of Velocity and Acceleration of Mechanisms	3
2	Development of CAM Profile for specific follower motion	3
	PART C (Simulation)	
1	Motion Analysis of Mechanisms using Solidworks	2
2	Vibration analysis of mechanical system using MATLAB/SCILAB/GNU Octave	2
	Total	**20**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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.

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

Text Books:

1. S.S. Ratan, "Theory of Machines", Tata McGraw Hill
2. Ghosh and A.K. Mallik, "Theory of Mechanisms and Machines", East-West Press

Reference Books:

1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, "Theory of Machines and Mechanism", Oxford Higher Education
2. P.L. Ballaney, "Theory of Machines", Khanna Publishers
3. M.A. Mostafa, "Mechanics of Machinery", CRC Press
4. R.L. Norton, "Kinematics and Dynamics of Machinery", McGraw Hill
5. A.G. Erdman, G.N. Sander, and S. Kota, "Mechanism Design: Analysis and Synthesis Vol I", Pearson

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/105/112105268/
2. http://www.nptelvideos.in/2012/12/kinematics-of-machines.html

AICTE Prescribed Textbook:

Theory of Machines and Mechanisms, Prof. G C Mohan Kumar
(https://ekumbh.aicte-india.org/allbook.php#)

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	3	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	2	-	-	-	-	-	-	-	-	3	2
CO5	3	3	-	-	3	-	-	-	-	-	-	3	1
CO6	3	3	-	-	-	-	-	-	-	-	-	3	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			
25PCC13ME14	CAD/CAM and FEA	L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	Basics Mathematics.	
Course Outcomes	CO1	Use of computer graphics in design.
	CO2	Understand Fundamental Concepts geometric transformation.
	CO3	Apply parametric equations for curve and surface generation.
	CO4	Understand the fundamental principles, components, and working of CNC machines.
	CO5	Implement appropriate CNC codes for specific tasks and analyse real-life engineering problems using FEA.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to CAD:** Need and Utility of CAD systems in industry, Fundamentals of computer graphics & hardware, Types of Geometric Modelling, **Raster Graphics:** line and circle algorithm.	1-8	6
2	2.1	**Geometric Transformation:** Homogenous Transformation (2D Translation, scaling, Reflection, Rotation)	1-8	6
	2.2	Window Viewport and Clipping.	1-8	
3	3.1	**Curves And Surfaces:** Cubic spines Bezier curves & B- spines (No Numerical).	1-8	4
	3.2	Product data exchanges formats (STEP, IGES).	1-8	
4	4.1	**CNC Machines:** Fundamental elements of CNC, Benefits of CNC, Computer control concepts, Data processing units. **Basics of control systems:** Motion controller, Interpolation-Linear & Circular, Positioning & contouring control loops, Incremental & Absolute system, DNC & CNC systems and Adaptive control system. **CNC Hardware Basics:** CNC drives, Spindle design, Actuation and Feedback devices.	1-8	4
5	5.1	**CNC Programming(Turning & Machining):** G & M code, Tool length, nose radius & Diameter compensation, Canned cycles, Looping Jumping Subroutines Macros, Parametric programming, Turning & Machining centre programming.	1-8	6
	5.2	**FEA Software**: General Procedure & Application.		
Total				**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 CAD/CAM and FEA 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:

4. Refrigeration and Air Conditioning by S. C. Arora and S. Domkundwar, Dhanpatrai and sons, Delhi
5. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi
6. ISHRAE Air Conditioning Handbook
7. ISHRAE Refrigeration Handbook
8. ASHRAE Handbook of Fundamentals
9. 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)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	-	1	-	-	-	-	-	-	-	-	3	-	-
CO2	2	-	1	-	-	-	-	-	-	-	-	3	-	-
CO3	2	-	1	-	-	-	-	-	-	-	-	3	1	-
CO4	3	-	1	-	3	1	-	-	-	-	-	2	3	-
CO5	3	1	1	1	2	1	-	-	-	-	-	3	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)				Credit Assigned			
		L	T	P	SL	L	T	P	Total
25PCC13ME21	Automation and Control Engineering	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	

Pre-requisite Course Code		
Course Code	CO1	Illustrate the basic concept of Industrial automation in different manufacturing set-ups.
	CO2	Design and Develop Pneumatic Circuits
	CO3	Develop electro-pneumatic and PLC-based automation solutions
	CO4	Design and Develop Hydraulic Circuits
	CO5	Model control systems and analyze their performance
	CO6	Assess system stability using Routh, Root Locus, and basic frequency analysis

Module No.	Topics	Ref.	Hrs.
1	Definition, need, and scope of industrial automation, Types of automation: fixed, programmable, flexible, Levels of Automation, Automation principles and strategies, Basic elements of automated systems: sensors, actuators, controllers, power, interfaces, Benefits and Impact of Automation in Manufacturing and Process Industries. Architecture of Industrial Automation Systems, Case studies: Automation in automotive, packaging, and process industries,	1	4
2	Properties of compressed air, air preparation units (FRL), ISO symbols for pneumatic components, Direction control valves, flow control valves, non-return valves, Cylinders: single-acting, double-acting, Pneumatic Sequencing Method: Cascade method, Shift register method. Proximity Sensors: (optical, inductive, magnetic, pressure switches)	2,3	5
3	Introduction to Electrical actuation of pneumatic components, Relays, solenoids, limit switches, proximity sensors, Sequencing Circuits upto 3 Cylinders PLC: Architecture: I/O modules, power supply, communication, PLC Programming Basics: Ladder Logic (LLD), Timers, Counters, Interlocks, PLC safety: E-stop, fail-safe design Introduction to PLC simulation tools (LogixPro, FACTORY I/O)	4	5
4	Introduction to hydraulic systems, comparison with pneumatics, Hydraulic power unit (HPU) components, Directional, flow, and pressure control valves, Hydraulic actuators: cylinders and motors, Hydraulic accumulators and energy storage, Electro-hydraulics: Servo valves, proportional valves, feedback systems, Applications: presses, clamping, lifting, mobile hydraulics	5	4
5	Introduction to Control System, Open-loop and closed-loop control systems, Mathematical modeling of systems: Mechanical (translational & rotational) & Electrical (RLC) & Electromechanical systems. Response characteristics of components and systems through classical solution.	6,7	4

	Transfer functions and block diagram reduction. Controller actions: P, I, D, PI, PD, PID, Practical examples: temperature, speed, position control		
6	Concept of stability, Routh–Hurwitz Criterion, Root Locus, Introduction to frequency response: Bode plot concept, Gain margin & phase margin	6,7	4
	Total		**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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. Groover, M.P. "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th Edition, Pearson, 2015.
2. Festo Didactic, "Fundamentals of Pneumatics", Festo Training Manual.
3. Andrew Parr, "Pneumatics and Hydraulics: A Technician's and Engineer's Guide", 3rd Edition, Butterworth-Heinemann, 2011.
4. Festo Didactic, "Electro-Pneumatics Basic Level", Festo Training Manual.
5. Eaton (Vickers), "Industrial Hydraulics Manual", Latest Edition, Eaton Hydraulics.
6. Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Pearson, 2010.
7. S. C. Goyal and U. A. Bakshi. "Principles of Control system", 7th Edition, Technical Publications Pune, 2006.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	1	1	-	-	-	-	2	3
CO2	3	2	3	-	2	-	-	-	-	-	-	3	3
CO3	3	3	3	1	3	-	-	-	-	-	-	3	3
CO4	3	2	3	-	2	-	-	-	-	-	-	3	3
CO5	3	3	2	2	3	-	-	-	-	-	-	2	3
CO6	3	3	2	3	2	-	-	-	-	-	-	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			
25PCC13ME13	Metrology and Quality Engineering	L	T	P	SL	L	T	P	Total
		2	--	--	2	2	--	-	2
			Examination Scheme						
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Understand the overall concept of metrology including standards of measurements, limits, fits, tolerances and gauge design.
	CO2	Demonstrate knowledge of comparators, principle of interference and surface texture measurement.
	CO3	Understand the methods to measure screw thread and gear parameters.
	CO4	Understand and implement the concept of quality
	CO5	Identify and use proper quality tools in various manufacturing or service problems.
	CO6	Comprehend and apply quality standards in different situations.

Module No.	Topics	Ref.	Hrs.
1	Introduction to Metrology: Definition and Scope. Accuracy & Precision. Standards and characteristics of measurements. Limits, fits and Tolerances: Basic definitions, Taylor's principle, Hole-basis and shaft-basis systems, Design of Go & No-Go gauges for hole and shaft using tolerance disposition diagram.	1, 2	05
2	Comparators: Understanding of features and operation of mechanical, optical, and pneumatic comparators, advantages, limitations, and field of applications. Principles of interference, concept of flatness, flatness testing, optical flats. Surface texture measurement: Importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Different types of surface roughness measuring instruments and symbols.	1, 2	05
3	Screw Thread measurement: Two wire and three wire methods, floating carriage micrometer. Gear measurement: Gear tooth comparator, measurement using rollers and Parkinson's Tester.	1, 2	02
4	Quality: Definition, Evolution of quality, Dimensions of quality planning, Principles of TQM, setup policy and objectives of quality control, quality of design and quality of conformance, compromise between quality & cost, Costs of quality	3	05
5	Process Data Collection & presentation – Bar Chart, Histogram and Run Charts. Process Variability – variables & process variation (Measures of accuracy & centering, precision or spread, normal distribution and sampling averages). Process Control by Variable – using X bar and R Chart and control charts for standard deviation. Process Control by Attribute - for number of defectives or non- conforming units - np-charts, p-charts, c-charts and u-charts.	4	06

	Process capability, OC curve, acceptance sampling AQL, LTPD, AOQL, producers and consumers risk, sampling plans.		
6	Quality standards: ISO 9001:2000 Quality Management System Standard, ISO 14001:2004 Environmental Management System Standard	5	03
	Total		**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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.

Reference Books:

1. Engineering. Metrology, I.C. Gupta, Dhanpat Rai Publications.
2. Engineering. Metrology, 22nd edition, R. K. Jain, Khanna Publisher, (2022).
3. Statistical quality Control, 2nd edition, Mahajan M., Dhanpat Rai & Sons, Delhi (2015).
4. Quality Control, 3rd edition, D. H. Besterfield, Pearson Education (2012).
5. Understanding and Implementing ISO 9000 and ISO Standards, 2nd edition, David L. Goetsch, Stanley Davis, Prentice Hall.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	2	-	1	-	-	-	-	2	3
CO2			1	1	2	-	1	-	-	-	-	2	3
CO3	-	-	-	-	2	-	1	-	-	-	-	2	3
CO4	-	-	-	-	-	-	-	-	-	-	-	1	2
CO5	-	-	1	-	-	-	-	-	-	-	-	2	3
CO6	-	-	-	-	-	-	-	-	-	-	-	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			
25PCC13ME15	FEA and CFD Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Practical	50	--	--		50	

Pre-requisite Course Codes	Computer Aided Machine Drawing	
Course Outcomes	CO1	Apply static structural analysis techniques to evaluate and interpret the behaviour of structures under various conditions.
	CO2	Apply structural dynamic analysis techniques to evaluate and interpret the response of structures under dynamic loading conditions.
	CO3	Apply thermal analysis techniques to evaluate and interpret heat transfer and temperature distribution in engineering systems.
	CO4	Apply steady flow analysis techniques to evaluate and interpret fluid behaviour in engineering systems under steady conditions.
	CO5	Apply turbulence modelling techniques to analyse and predict fluid flow behaviour in engineering systems.

Sr. No	Topics	Hr
1	Problems for Static structural analysis.	6
2	Problems for Dynamic Structural analysis.	5
3	Problems for Thermal Analysis.	5
4	Problems for Steady flow analysis.	6
5	Problems for Turbulence Modelling.	4
Total		**26**

Course Assessment:

Laboratory Learning:
ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Programming the Finite Element Method, I M Smith, D V Griffiths and Margetts WILEY Publications.
2. The Finite Element Method: Theory, Implementation, and Applications, Larson, Mats G., Bengzon, Fredrik, Springer
3. Introduction to Finite Element Analysis and Design by N. H. Kim, B. V. Sankar, and A. V. Kumar by Wiley publication
4. Finite Element analysis using ANSYS by Paleti Srinivas, Krishna Chaitanya, Rajesh Kumar Detti, PHI Publication.
5. Finite Element Analysis Theory and Application With ANSYS by Saeed Moaveni, Pearson Publication.

6. Introduction to Finite Element Analysis Using MATLAB and Abaqus By Amar Khennane, CRC Press publication

Suggested CO - PO articulation Matrix

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

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	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
25PEC13ME12	Costing and Cost Control	Examination Scheme							
			ISE	MSE		ESE			Total
		Theory	20	30		50			100
		Tutorial	50	--		--			50

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Explain types of costs, cost control fundamentals, and the role of cost engineers.
	CO2	Implement job, batch, process, and activity-based costing in manufacturing
	CO3	Perform break-even analysis, standard costing, and cost estimation techniques.
	CO4	Apply budgeting, marginal costing, value engineering, and lean techniques.
	CO5	Use make-or-buy analysis, inventory costing, and cost-volume-profit analysis.
	CO6	Analyze case studies and apply tools like Tally and Excel for cost management.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Overview of Costing**: Definition, objectives, and importance in manufacturing, Types of Costs: Fixed, variable, direct, indirect, and sunk costs. Cost Control Fundamentals: Principles and significance in engineering projects, Role of Cost Engineers: Key competencies and responsibilities.	1-8	4
2	2.1	**Cost Control vs. Cost Reduction**: Meaning, differences, and importance, Role of Costing in Industrial Engineering: Applications in production planning and control.	1-8	3
	2.2	**Costing Methods in Manufacturing:** Job Costing, Batch Costing, Process Costing, Activity-Based Costing (ABC).	1-8	2
3	3.1	**Cost Estimation Techniques in Production Engineering:** Elements of Cost: Material cost, labor cost, and overheads, Factors affecting cost estimation, Break-even Analysis: Determining the minimum production quantity for profitability, Standard Costing: Concept, advantages, and variance analysis.	1-8	4
4	4.1	**Cost Control Techniques in Industry:** Budgeting and Cost Control: Definition, types of budgets, budgetary control, Marginal Costing: Concept and decision-making applications.	1-8	3

	4.2	**Value Engineering:** Reducing cost without affecting quality and performance. **Waste Reduction and Cost Savings:** Lean manufacturing techniques.	1-8	2
5	**5.1**	**Cost Analysis for Decision Making:** Make-or-Buy Decisions: Cost-based decision-making for outsourcing. Inventory Costing: EOQ, ABC analysis, and JIT in cost reduction. Depreciation and Its Impact on Costing: Different depreciation methods. Cost-Volume-Profit (CVP) Analysis: Understanding cost behavior and profitability.	1-8	4
6	**6.1**	**Industrial Case Studies and Costing Software:** Case Studies on Cost Control in Manufacturing: Real-world industry examples. Introduction to Costing Software: Tally, and Excel for cost management. Future Trends in Costing and Cost Control: Digital transformation in industrial costing.	1-8	4
Total				**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 costing and cost control methods.

Recommended Books:

Text Books:

1. M.L. Mehta & S.P. Gupta – Cost Accounting: Principles and Practice (Sultan Chand & Sons)
2. Charles T. Horngren, Srikant M. Datar, Madhav Rajan – Cost Accounting: A Managerial Emphasis (Pearson)
3. R. Kesavan, C. Elanchezhian, B. Vijaya Ramnath – Engineering Economics and Costing (Laxmi Publications)
4. V.K. Saxena & C.D. Vashist – Advanced Cost and Management Accounting (Sultan Chand & Sons)

Reference Books:

5. Colin Drury – Management and Cost Accounting (Cengage Learning)
6. Jawaharlal & Seema Srivastava – Cost Accounting (McGraw Hill)

7. Bhabatosh Banerjee – Cost Accounting: Theory and Practice (Prentice Hall India)
8. M.N. Arora – A Textbook of Cost and Management Accounting (Vikas Publishing)

AICTE Prescribed Textbook:
Book Name- Estimation, Costing & Valuation Author Name-Dr. Sandeep Panchal
(https://ekumbh.aicte-india.org/allbook.php#)

Suggested CO - PO articulation Matrix

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

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			
		L	T	P	SL	L	T	P	Total
25PEC13ME13	Mould and Metal Forming Technology	2	1	--	3	2	1	-	3
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes		
Course Outcomes	Learner will be able to	
	CO1	Understand the different types of casting Process.
	CO2	Understand the concept of different metal forming process.
	CO3	Approach metal forming processes both analytically and numerically
	CO4	Design metal forming processes
	CO5	Develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.

Module No.	Topics	Ref.	Hrs.
1	**Sand Casting of Metals** Mould materials: Moulding sand; Constituents of moulding sand and its property requirements. Design and manufacture of Patterns and Cores: Pattern allowances, Types of patterns, Core print, Core. Use of Gating system, Pouring basin, Sprue, Runners and Ingates. Use of chills, padding and risering. Melting practices: Cupola, Arc and Induction furnaces. Defects in cast components.	8	5
2	**Introduction to Metal Forming:** Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, effects of temperature, strain rate, microstructure and friction in metal forming-yield criteria and their significance, Classification of Metal Forming Processes, Advantages and Limitations, Stress strain relations in elastic and plastic deformation, concept of flow stresses, Hot and Cold Working Processes.	1-7	4
3	**Rolling:** Introduction and Classification, Types of Rolling Mills, Forces and Geometrical Relationships in Rolling, Calculation of Rolling Load, Defects in Rolled Products.	2-7	4
4	**Forging:** Introduction and Classification, operation and principle of Forging Processes and Equipment, Methods of forging, Open and Close Die Forging Processes, Defects in forged products.	2-7	4
5	**Extrusion:** Introduction and Classification, Extrusion Equipment, Extrusion of components including Seamless Pipes and Tubes. Extrusion of pipes by cold working. **Drawing:**	2-7	5

	Introduction and Classification, Wire Drawing, Rod Drawing, Tube Drawing, Deep Drawing,		
6	**Sheet Metal Forming:** Principle, working and application of the following processes: spinning, stretch forming, plate, V and edge bending, Ironing, Roll Bending, Metal Spinning, explosive forming, Hydro forming, electro hydraulic forming, and magnetic pulse forming.	2-7	4
	Total		**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 mould and metal forming technology.

Recommended Books:

1. Lin D Balint M Pietrzyk, Microstructure Evolution in Metal Forming Processes 1st Edition
2. Amitabha Ghosh and Asok Kumar Mallick, Manufacturing Science, Affiliated East-West Press
3. Christian Brecher and Ozdemir , Advances in Production Technology, Springer Publications
4. P.C.Sharma , A Text Book on Production Engineering, S.Chand Publications
5. P. N. Rao, "Manufacturing Technology", Tata McGraw Hill
6. Aviter, "Fundamental of Metal Working", McGraw Hill Publisher
7. Dieter, "Mechanical Metallurgy"
8. Principles of Metal casting by Mahi Sahoo.

Links for online NPTEL/SWAYAM courses:
https://nptel.ac.in/courses/112/107/112107250/ - Principles of Metal Forming Technology, IIT Roorkee
https://nptel.ac.in/courses/112/106/112106153/ - Forming, IIT Madras

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO3	3	3	-	-	-	-	-	-	-	-	-	2	3
CO4	3	-	3	-	-	-	-	-	-	-	-	3	3
CO5	3	-	3	-	-	-	-	-	-	-	-	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			
		L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
25PEC13ME14	Additive Manufacturing	Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	Basic manufacturing.	
Course Outcomes	CO1	Illustrate understanding of various cost-effective alternatives for manufacturing products and select the feasible additive manufacturing for specific technical application
	CO2	Understand and apply the principles of liquid-based rapid prototyping and tooling processes to build and generate data for additive manufacturing of various objects.
	CO3	Understand and apply the principles of solid-based rapid prototyping systems for efficient additive manufacturing and product development.
	CO4	Understand and apply the principles of powder-based additive manufacturing systems for efficient prototyping and production of complex geometries.
	CO5	Understand and apply reverse engineering techniques in additive manufacturing to reconstruct, modify, and optimize existing designs for manufacturing and prototyping.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to additive manufacturing, its historical development, advantages. Classification of additive manufacturing process, Advantages & Disadvantages, Applications to various fields, Rapid Tooling, Design Consideration.	1-8	6
2	2.1	**Liquid-Based Systems:** Stereolithography (SLA): Photopolymerization process, Working Principle, Material used, Advantages and limitation, Application	1-8	6
	2.2	Solid ground curing: Working Principle, Material used, Advantages and limitation, Application.		
3	3.1	**Solid Based Rapid Prototyping Systems:** LOM (Laminated Object Manufacturing) System: Working Principle, Material used ,Advantages and limitation, Application.	1-8	4
	3.2	FDM (Fused Deposition Modelling) System: Working Principle, Material used, Advantages and limitation, Application.		
4	4.1	**Powder Based Systems:** SLS (Selective Laser Sintering): Working Principle, Material used, Advantages and limitation, Application.	1-8	6
	4.2	(3DP) Three-Dimensional Printing: Working Principle, Material used , Advantages and limitation, Application.		
	4.3	(EBM) Electron Beam Melting: Working Principle, Material used , Advantages and limitation, Application.		
5	5.1	**Reverse Engineering**	1-8	4

		Introduction to Digitizing Methods, Contact type and Non-contact type, Brief introduction to the types of medical imaging. **Virtual reality:** Definition, features of VR, Technologies used in VR, Introduction to Augmented reality **.**		
Total				**26**

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Preprocessing of 3d Print Component.	**01**
2	3D Printing of Component.	**01**
3	Case study on SLA.	**01**
4	Case study on LOM.	**01**
5	Case study on FDM.	**01**
6	Case study on SLS.	**01**
7	Case study on 3DP.	**01**
8	Case study on EBM.	**01**
Total Hours		**08**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 various additive manufacturing techniques.

Recommended Books:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping Principles and Applications",
2. World Publishing Co. Pte. Ltd.
3. Gibson, D.W. Rosen, and B. Stucker, "Additive Manufacturing Technologies Rapid
4. Prototyping to Direct Digital Manufacturing", 2010, Springer Inc.
5. Ali Kamrani, EmadAbouel Nasr, "Rapid Prototyping Theory and Practice", 2006, Springer
6. RafiqNoorani, Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc., 2006,

ISBN 0-471-73001-7
7. James O. Hamblen, and Michael D. Furman, "Rapid Prototyping of Digital Systems", Kluwer Academic Publishers.
8. Kenneth G. Cooper, "Rapid Prototyping Technology Selection and Application", 2001, Marcel Dekker Inc, New York.

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc24_me138/preview
2. https://onlinecourses.nptel.ac.in/noc22_me74/preview
3. https://onlinecourses.nptel.ac.in/noc22_me130/preview
4. https://onlinecourses.nptel.ac.in/noc25_mm02/preview

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	2	2	–	-	–	–	–	–	3	2
CO2	3	2	2	2	2	–	–	–	–	–	–	3	2
CO3	3	2	3	2	2	–	–	–	–	–	–	3	2
CO4	3	3	3	2	2	–	-	–	–	–	–	3	3
CO5	2	3	2	3	2	–	–	–	–	–	–	2	3
CO6	3	2	3	2	2	–	-	–	–	–	–	3	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
25PEC13ME15	Additive Manufacturing Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Practical	50	--	--		50	

Pre-requisite Course Codes	CAD Modelling.	
Course Outcomes	CO1	Illustrate basic understanding of types of CAD model creation.
	CO2	Apply segmentation techniques in Slicer's Segment Editor module to prepare 3D models for printing.
	CO3	Develop 3D model using available 2D image.
	CO4	Apply various design considerations to enhance the quality and functionality of 3D component printing.
	CO5	Apply additive manufacturing processes to develop a physical 3D mechanical structure.

Sr. No	Topics	Hr
1	Modelling of a component using 3D modelling software	4
2	Segmentation in Slicer's Segment Editor module for the purpose of 3D printing.	6
3	Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source) (Application: Any engineering or medical part.)	6
4	Application of various design considerations in 3D component printing.	4
5	Development of physical 3D mechanical structure using any one of the Additive manufacturing processes	6
Total		**26**

Course Assessment:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi
3. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy
4. Medical Modelling - The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd
5. Biomaterials, artificial organs and tissue engineering, Edited by Larry L. Hench and Julian R. Jones, Woodhead Publishing and Maney Publishing, CRC Press 2005
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2
CO2	3	3	-	-	-	-	-	-	-	-	-	2	2
CO3	3	3	3	-	-	-	-	-	-	-	-	3	2
CO4	3	3	-	-	-	-	-	-	-	-	-	2	3
CO5	3	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			
		L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
25PEC13ME22	Finite Element Analysis	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	Introduction to FEA: Introduction to FEM,	1-8	4
	1.2	Mathematical Modelling of field problems in engineering, Governing Differential equations, primary/secondary variables, boundary condition types-essential/natural etc.		
	1.3	Discrete and Continuous Models.		
	1.4	Definitions of various terms used in FEM like 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	1-8	8
	3.2	Assembly of Matrices- solution of problems in one-dimensional structural analysis, heat transfer (stepped and taper bars, spring-Cart Systems)		
	3.3	Analysis of Plane trusses, Analysis of Beams.		
4	4.1	Two-Dimensional Finite Element Formulations: Introduction, three node triangular element, four node rectangular element.	1-8	4
	4.2	Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular element.		
	5.1	Finite Element Formulation of Dynamics and Numerical Techniques:		

5		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**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 various finite element methods to 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)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	1	-	-	-	-	-	-	3	-
CO2	3	2	1	1	1	-	-	-	-	-	-	3	-
CO3	3	2	1	2	2	-	-	-	-	-	-	3	-
CO4	3	2	1	2	2	-	-	-	-	-	-	3	-
CO5	3	2	1	2	2	-	-	-	-	-	-	3	-
CO6	3	2	1	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			
25PEC13ME23	Dynamics of Machinery	L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
			Examination Scheme						
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	Theory of Machines	
Course Outcomes	CO1	Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems.
	CO2	Illustrate basic of static and dynamic forces.
	CO3	Determine natural frequency of element/system.
	CO4	Determine vibration response of mechanical elements / systems.
	CO5	Design vibration isolation system for a specific application.
	CO6	Demonstrate basic concepts of balancing of forces and couples.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Governors:** Introduction to Centrifugal and Inertia governors, Study and Force analysis of Porter and Hartnell governors including Performance characteristics, Governor effort and power	3-4	4
	1.2	**Gyroscope:** Introduction, Gyroscopic couple and its effect on spinning bodies, naval ships during steering, pitching, rolling and their stabilization.	3-4	1
2	2.1	Static and Dynamic force analysis of Slider crank mechanism (neglecting mass of connecting rod and crank), Turning moment on crank shaft	3-4	2
	2.2	Dynamically equivalent systems to convert rigid body into two mass with and without correction couple (Case study- Connecting rod)	3-4	2
3	3.1	**Basic Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Importance of study of vibrations, Vibration parameters - springs, mass, damper, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis	8-9	1
	3.2	**Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method	8-9	3
4	4.1	**Free Damped Single Degree of Freedom Vibration System:** Introduction to different methods of damping, Study and analysis of 1) Viscous damped system (under damped, critically damped, over damped; Logarithmic decrement) 2)Coulomb's damping (Combined Viscous and Coulomb damping excluded)	8-9	3
	4.2	**Equivalent Single Degree of Freedom Vibration System:** Conversion of multi-springs, multi masses, multi-dampers into a single spring and damper with linear or rotational co-ordinate system	8-9	3

5	**5.1**	**Forced Single Degree of Freedom Vibratory System:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper)	8-9	3
6	**6.1**	**Rotor Dynamics:** Critical speed of single rotor, undamped and damped	3-4	1
	6.2	**Balancing:** Static and Dynamic balancing of multi rotor system (up to four rotors), balancing of reciprocating masses in In-line engines (up to four cylinders), Introduction to V-engines (excluding other radial engines)	3-4	3
Total				**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 dynamics of machinery principles.

Recommended Books:

1. Theory of Machines Thomas Bevan CSB Publishers & Distributors
2. Theory of Machines by Jagdishlal Metropolitan Book New Delhi, Company, Daryaganj, Delhi
3. Theory of Machines by S.S.Ratan Tata McGraw Hill , New Delhi
4. Theory of Machines by P.L.Bellaney Khanna publication, NewDelhi
5. Theory of Machines and Mechanisms by John J Uicker, Gordon R Pennock and Joseph E Shigley, Oxford University Press
6. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
9. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
10. Mechanical Vibraitons by G.K.Grover
11. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
12. Principles of Vibration by Benson H Tongue, 2nd Edition, Oxford University Press
13. Vibration Analysis by P. Srineevasan, TMH
14. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
15. Theory and Practice of Mechanical Vibrations by J S Rao and K Gupta, New Age International
16. Elements of Vibration Analysis by Leonard Meirovitch, McGrav- Hill, New York

Links for online NPTEL/SWAYAM courses:
https://nptel.ac.in/courses/112/101/112101096/ - Dynamics of Machines, IIT Bombay
https://nptel.ac.in/courses/112/107/112107212/ - Introduction to Mechanical Vibration, IIT Roorkee

Suggested CO - PO articulation Matrix

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

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			
25PEC13ME24	Condition Monitoring Laboratory	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Lab	50	--	--		50	

Pre-requisite Course Codes	-	
Course Outcomes	After completing the given assignments and experiments, students will be able to:	
	CO1	Understand the fundamentals of condition monitoring.
	CO2	Explain condition monitoring techniques and equipment.
	CO3	Understand machinery faults using vibration analysis.
	CO4	Apply ISO standards for condition monitoring.
	CO5	Conduct experimental studies on machinery faults.
	CO6	Interpret and document condition monitoring results by FFT analyser.

Module No.	Experiments / Assignments List
1	Assignment on : **Introduction to Condition Monitoring** Overview of condition monitoring and its techniques, Introduction to condition monitoring equipment and software in Lab, Basics of data acquisition and signal processing, Vibration sensors (Accelerometers, Velometers, Displacement sensors), Time-domain and frequency-domain analysis (FFT, RMS, Peak values), Identification of common faults (imbalance, misalignment, bearing defects), Examples of Condition Monitoring in Industries, Case studies based on Maintenance Strategies (Breakdown, Preventive, Predictive and Proactive)
2	Assignment on : Study of ISO Standards for Condition Monitoring (ISO 17359, ISO 10816, ISO 18436)
3	**Experiment (any 4)** on a. Condition Monitoring and Machinery Fault Diagnosis – Good Shaft and Bearing Signature b. Condition Monitoring and Machinery Fault Diagnosis – Unbalancing with varying speed c. Condition Monitoring and Machinery Fault Diagnosis – Misalignment d. Condition Monitoring and Machinery Fault Diagnosis – Bent shaft e. Condition Monitoring and Machinery Fault Diagnosis – Mechanical Looseness f. Condition Monitoring and Machinery Fault Diagnosis – Bearing Defects / Fault g. Condition Monitoring and Machinery Fault Diagnosis – Bent Shaft h. Condition Monitoring and Machinery Fault Diagnosis – Regular-triangle Method for Dynamic Balance i. Condition Monitoring and Machinery Fault Diagnosis – Lissajous Figure j. Condition Monitoring and Machinery Fault Diagnosis – Oil Whirl and Oil Whip of Sliding Bearing

Course Assessment:

Laboratory Learning:
ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

References :

Books:

1. A.R. Mohanty – *Machine Condition Monitoring: Principles and Practices, CRC Press*
2. R. B. Randall – *Vibration-Based Condition Monitoring: Industrial, Aerospace, and Automotive Applications*
3. Allan Davies – *Handbook of Condition Monitoring: Techniques and Methodology*
4. B.K.N. Rao – *Handbook of Condition Monitoring*
5. Clyde M. Creese – *Introduction to Machinery Analysis and Monitoring*
6. Tony L. Schmitz & K. Scott Smith – *Machinery Vibration Analysis*
7. R.A.Collacott – *Mechanical Fault Diagnosis and Conditon Monitoring, Chapman and Hall*

ISO Standards for Condition Monitoring:

1. **ISO 17359** – Guidelines for Condition Monitoring and Diagnostics of Machines
2. **ISO 10816** – Evaluation of Machine Vibration by Measurements on Non-Rotating Parts
3. **ISO 18436** – Requirements for Training and Certification of Condition Monitoring Personnel
4. **ISO 13373** – Guidelines for Vibration Condition Monitoring of Machines

Research Papers & Journals:

1. "Condition Monitoring and Fault Diagnosis: A Review" – *Elsevier, Mechanical Systems and Signal Processing*
2. "Vibration Analysis for Machine Fault Detection" – *IEEE Transactions on Industrial Electronics*
3. "Predictive Maintenance Using Machine Learning and IoT Sensors" – *Journal of Intelligent Manufacturing*
4. "Recent Advances in Rotating Machinery Condition Monitoring" – *International Journal of Prognostics and Health Management*

Laboratory Manuals & Guides:

1. SKF Vibration Analysis Handbook – Industry-standard guide for vibration monitoring.
2. Fluke Infrared Thermography Guide – Practical guide on thermal imaging for condition monitoring.
3. Emerson Condition Monitoring Manual – Industrial approach to vibration-based condition monitoring.

Online Resources & Software:

1. National Instruments – LabVIEW for Vibration Analysis (www.ni.com)
2. SKF Condition Monitoring & Predictive Maintenance (www.skf.com)
3. Emerson Machinery Health Management (www.emerson.com)
4. ReliabilityWeb – Condition Monitoring Articles & Webinars (www.reliabilityweb.com)
5. CBM Connect – Free Courses & Webinars on Condition Monitoring (www.cbmconnect.com)
6. NPTEL : Machinery Fault Diagnosis and Signal Processing - Prof. Amiya Ranjan Mohanty,

IIT Kharagpur (12 Weeks)

7. Condition Monitoring and Maintenance Management (BME-025) - Dr. N. Venkateshwarlu, Indira Gandhi National Open University (8 Weeks)

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2	3
CO3	3	2	-	-	-	-	-	-	-	-	-	3	3
CO4	3	2	-	-	-	-	-	-	-	-	-	1	3
CO5	3	3	3	3	-	-	-	-	-	-	-	3	3
CO6	3	3	3	3	-	-	-	-	-	-	-	3	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			
25OE3X	Health, Wellness and Psychology	L	T	P	SL	L	T	P	Total
		2	-	-	2	2	-	-	2
			Examination Scheme						
			ISE	MSE		ESE			Total
		Theory	100	---		---			100
		Lab	---	---		---			---

Pre-requisite Course Codes		-
Course Outcomes	CO1	Introduce the concept of health, wellness and psychology, and understand its effectiveness in handling stress.
	CO2	Develop human strength and life-enhancement skills through recovery and goal setting.
	CO3	Apply the holistic well-being quotient for personal and professional benefits.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Psychology, Health and Wellness**		
	1.1	Understanding holistic health- Meaning, components of holistic health-components of wellbeing, Psychology of overall health-enhancing behaviors component, Types of health-compromising behaviors, Illness Management and wellness enhancement.	R1	4
	1.2	Nature and source of stress, personal and professional triggers of stress, Effects of stress, coping with stress (minimalistic yet effective exercise habits)	R2	4
2		**Promoting Personal and Professional Wellness: Human Strengths & Life-Enhancement**		
	2.1	Strength: Definition, meaning; Realizing strength; Maximizing Unrealized strength Weakness: Definition, meaning; Identifying and overcoming weakness; Developing hope and optimistic approach.	R2 & R3	4
	2.2	Recovery and Goal Setting: analyzing trends in personality, Approaching Individual differences; Meaning of Goal setting, Types and effectiveness of Goal Setting. Motivation: Meaning, Theory of Needs, 4A's of coping with stress during or after goal setting.	R2	4
	2.3	Eudaimonic Wellness: Meaning and characteristics; concept of defensive coping.	R1, & R4	2
3		**Positive Approach and The Psychology of Living in The Present**		
	3.1	The Psychology of Living in the Present: meaning, self-registering to the flow of positive thoughts and actions; addressing positive and negative emotions; Eliminating daily hassles, creating happiness. Responding to overthinking: Sociocultural factors and self- realization.	R1,R2, &R4	4
	3.2	Resilience: Meaning and Nature; How to build resilience; Self-communication	R3 & R4	4
		and self-care, reframe thoughts; channelize gratitude; practice resilience		

		building: physical and mental exercises.		
		Total		26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: Based on Self-Learning / Formative assessment activities will be conducted during the full semester - 100 Marks

Recommended Books:

1. Emmons, R.A., & McCullough, M.E. (2003). Counting blessings versus burdens: An experimental investigation of gratitude and subjective well-being in daily life. Journal of Personality & Social Psychology, 88, 377-389
2. Carpenter, S. (2012). Awakening to sleep. Monitor on Psychology, 44 (1), 40.
3. Emmons, R. A., & Mishra, A. (2012). Why gratitude enhances well-being: What we know, What We Need to Know.
4. Carr, A. (2004). Positive Psychology: The science of happiness and human strength UK Routledge.

Suggested CO - PO articulation Matrix

Course Outcomes	**Programme Outcomes (POs)**											**Programme Specific Outcomes* (PSOs)**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	2	-	-	-	2	-	1	-	1	-	-	-
CO2	-	2	2	-	-	2	-	2	3	2	2	-	-
CO3	-	3	2	1	-	3	1	2	3	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			
25OE3X	Emotional and Spiritual Intelligence	L	T	P	SL	L	T	P	Total
		2	-	-	2	2	-	-	2
		Examination Scheme							
			ISE	MSE		ESE			Total
		Theory	100	---		---			100
		Lab	---	---		---			---

Pre-requisite Course Codes		
Course Outcomes	CO1	Introduce the concept of emotional intelligence, its models, components and measures of emotional intelligence
	CO2	Understand the significance of emotional intelligence in self-growth and building effective relationships, Understand the professional impact of emotional intelligence
	CO3	Develop a wide range of work and life skills.
	CO4	Display spiritual intelligence in different roles.
	CO5	Apply the spiritual quotient for corporate benefits.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamentals of Emotional Intelligence**		
	1.1	Emotion- Meaning, characteristics of emotion, components of emotion- cognitive component, physiological component, Behavioural component. Types of emotions, exposing the myths about emotion, physiological or bodily changes accompanying emotions, how emotions affect our thinking and actions	R1	3
	1.2	Nature and Significance of EI, Models of emotional intelligence: Ability, Trait and Mixed, Building blocks of emotional intelligence: self-awareness, self- management, social awareness, and relationship management	R2	3
2		**Personal and Social Competence**		
	2.1	Self-Awareness: Observing and recognizing one's own feelings, Knowing one's strengths and areas of development Self-Management: Managing emotions, anxiety, fear, and anger	R2	3
	2.2	Social Awareness: Others' Perspectives, Empathy and Compassion Relationship Management: Effective communication Collaboration, Teamwork, and Conflict management (professional impact)	R2	3
	2.3	Strategies to develop and enhance emotional intelligence and using them effectively in professional life	R1	2
3		**Background and Approach: Spiritual Intelligence and Karma Yoga**		
	3.1	Spiritual Intelligence- Definition, need, state of presence, psychological element, Intuitive intelligence. Foundation of Spiritual Intelligence Types of spiritual actions Models- SQ and SI-Growth model Yoga of Action and Spirituality: Professionalism	R6,R8	3

	3.2	Types of spiritual actions	R5, R7	3
		Models- SQ and SI-Growth model Readiness for spiritual intelligence: self-leadership, synthesize high performance, spiritual awareness, neuropsychology, and state of conscious identity.		
4		**Opposite Polarity in SI and Overall Impact on Personality**		4
	4.1	Twin poles of attention- subject and the object pole Benefits of Spiritual Intelligence- personal, social and corporate Dimensions of Spiritual Intelligence- SI and Self Esteem, SI and Restoration of confidence SI and clarity of thoughts and speech, Personality moulding and SI.	R8	
5	**5.1**	**Spiritual Ecology and Environmental Grassroots Activism**		
		Spiritual Stewardship and Ecology: Case studies based on making a difference in ecology through environmental grassroots activism	R4	2
Total				**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: Based on Self-Learning / Formative assessment activities will be conducted during the full semester - 100 Marks

Recommended Books:

1. Bar-On, R., & Parker, J.D.A.(Eds.) (2000). The handbook of emotional intelligence, San Francisco, California: Jossey Bros.
2. Goleman, D. (2005). Emotional Intelligence. New York: Bantam Book.
3. Sternberg, R. J. (Ed.). (2000). Handbook of intelligence. Cambridge University Press.
4. Thich Nhat Hanh, V. S. (2016). *Spiritual Ecology: The Cry of the Earth.* Golden Sufi Center.
5. Vivekananda, S. (2015). *The Complete Book of Yoga.* Solar Books.
6. Yogananda, P. (1946). *Autobiography of a Yogi.* Thomas Press Ltd.
7. Krishnaswami, O. (2006). *Karma Yoga: Yoga of Action.* Dev Publishers.
8. Buzan, T. (2001). *Power of Spiritual Intelligence: 10 Ways to Tap into Your Spiritual Genius.* Thorsons.

Suggested CO - PO articulation Matrix

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

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			
		L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
25PCC13ME22	Heat Transfer	Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	Thermodynamics	
Course Outcomes	CO1	Apply the principles of conduction heat transfer to analyze heat flow through plane walls, cylinders, and spheres.
	CO2	Evaluate heat transfer from extended surfaces and analyze unsteady-state heat transfer using lumped heat capacity methods.
	CO3	Analyze free and forced convection processes and boundary layer development in internal and external flows.
	CO4	Determine the performance of heat exchangers using LMTD, effectiveness–NTU methods, and correction factors.
	CO5	Explain boiling and condensation mechanisms and distinguish between different boiling regimes and condensation modes.
	CO6	Apply radiation heat transfer laws to evaluate heat exchange between black and non-black bodies, including radiation shields.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Fundamentals of heat transfer** Mechanism of conduction, Convection and radiation heat transfer and it's Governing laws.	1-2	1
	1.2	**Conduction through wall, sphere and cylinder** Generalized heat conduction equation in rectangular, cylindrical and spherical coordinates (only equations for cylindrical and spherical coordinates, no derivation). Steady state heat conduction through plane wall, composite wall, composite cylinder, composite sphere. Critical radius of insulation in cylinder and sphere.	1-2	4
2	2.1	**Heat transfer from Extended Surfaces:** Types of extended surfaces and its significance. Governing differential equation for fin (Finite, Infinite, and Insulated tips) and its solution. Fin efficiency and effectiveness.	1-2	2
	2.2	**Unsteady state heat transfer:** Lumped heat capacity Analysis. Applications of unsteady state heat transfer, Thermal time constant	1-2	2
3	3.1	**Convection:** Free and Forced convection. **External Flow**: Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate. **Internal Flow**: Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes.	1-2	4
4	4.1	**Heat Exchangers:** Types of heat exchangers, Overall heat	1-2	5

4		transfer coefficient, LMTD, Effectiveness, Effectiveness – Number of Transfer Unit (ε- NTU) method, Correction factor for multi pass (up to 2 passes on shell and tube side) and cross flow heat exchanger.		
5		**Boiling and Condensation:** Introduction to Different boiling regimes, Film condensation, Drop wise Condensation.	1-2	2
6		**Radiation:** Basics laws of radiation and heat exchange between two bodies. Absorptivity, Reflectivity and Transmissivity. Concept of a Black body. The Stefan-Boltzmann Law, Shape Factor Algebra and Salient Features of the Shape Factor. **Heat Exchange Between Non-black Bodies:** Infinite parallel planes, Infinite long concentric cylinders. Radiation Shields.	1-2	6
Total				**26**

Tutorial:

Sr. No.	Tutorials details	Hours
1	Detailed note on mode of heat transfer (Conduction, convection, radiation) with specific detailed application of each mode.	1
2	Numerical on composite wall, cylinder and sphere.	1
3	Numerical on extended surfaces	1
4	Numerical on convection heat transfer (flow through pipe and over plate)	1
5	Numerical on heat exchanger (LMTD and NTU methods) (This should include design of heat exchanger)	1
6	Detailed note on boiling and condensation process with specific application.	1
7	Numerical on infinite long plate in radiation heat exchange.	1
8	Numerical on shields in radiation heat exchange	1
	Total	**8**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 hat transfer principles.

Recommended Books:

Text Books:

1. Fundamentals of Heat and Mass Transfer by F.P. Incropera and D P deWitt, Wiley India 3rd Edition
2. Introduction to thermodynamics and Heat transfer by YunusACengel 2ndEdition, McGraw Hill
3. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy, 2nd Edition, PEARSON. 7. Heat Transfer by J P Holman, Mcgraw Hill

Reference Books:

1. Introduction to Heat Transfer, Som S. K , PHI Publication
2. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/101/112101097/ Heat and Mass Transfer, IIT Bombay
2. https://nptel.ac.in/courses/112/105/112105248/ Heat Exchangers: Fundamentals and Design Analysis, IIT Kharagpur

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	2	-
CO2	3	3	3	3	-	-	-	-	-	-	-	2	-
CO3	3	3	3	3	-	-	-	-	-	-	-	2	-
CO4	3	3	3	3	-	-	-	-	-	-	-	2	-
CO5	2	2	2	2	-	-	-	-	-	-	-	2	-
CO6	3	3	3	3	-	-	-	-	-	-	-	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			
		L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
25PCC13ME17	Machine Design	Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	Engineering Mechanics, Mechanics of Solids	
Course Outcomes	CO1	Use design data book/standard codes to standardize the designed dimensions
	CO2	Design operational joints, welded and bolted joints subjected to static loads.
	CO3	Design shaft, keys and couplings under various conditions.
	CO4	Design helical and leaf springs and pressure vessels.
	CO5	Select bearings for a given applications from the manufacturers catalogue.
	CO6	Select and/or design belts and flywheel for given applications

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Mechanical Engineering Design, Steps involved in design, types of design, Material properties and their uses in design, Manufacturing consideration in design, Modes of failures	1-6	1
	1.2	Factor of safety, Design stresses, Theories of failures (Selection in the process of designing)	1-6	1
	1.3	Design of Operational Joints: Socket and Spigot Cotter joint, Knuckle joint	1-6	4
2	2.1	Design of welded joints: Types & classification of welded joints, applications. Familiarization of AWS code. Strength of welded joints-Transverse & parallel fillet welds. Welded joints subjected to torsion. Circular fillet welds and adjacent fillet welds. Design of welded joints subjected to eccentric loading.	1-6	2
	2.2	Design of bolted joints: stresses in bolts, joints for leak proof fluid tight applications (like cylinder-to-cylinder cover fastening in an IC engine), bolts of uniform strength, Design of bolted joints subjected to eccentric loading	1-6	2
3	3.1	Design of Shaft: power transmitting, power distribution shafts, Module (excluding crank shaft) under static and fatigue criteria.	1-6	2
	3.2	Keys: Types of Keys and their selection based on shafting condition.	1-6	1
	3.3	Couplings: Classification of coupling, Design of Flange couplings, Bush pin type flexible couplings	1-6	3
4	4.1	Design of Springs: Classification and applications, design of helical compression and tension springs (only circular cross-section)	1-6	2
	4.2	Design of Pressure Vessels: Design concepts of thick Stresses in thick cylinders. Determination of wall thickness, hoop and radial stresses, nature of hoop and radial stress distribution on cylinder walls.	1-6	2
5	5.1	Rolling Contact Bearings: Types of bearing and designation, selection of rolling contact bearings based on constant / variable load & speed	1-6	2

		conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing)		
6	**6.1**	Design and selection of Flat Belts with pulley construction.	1-6	2
	6.2	Design of Flywheel – Introduction, Fluctuation of energy and speed, turning moment diagram, estimating inertia of flywheel for reciprocating prime movers and machines, Weight of the flywheel	1-6	2
Total				**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Design of Cotter Joint	01
2	Design of Knuckle Joint	01
3	Design of Bolted and Welded Joints	01
4	Design of Couplings	01
5	Design of Shafts	01
6	Design of Springs and Pressure Vessels	01
7	Design of Bearings	01
8	Design of Belts and Flywheels	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 machine design principles.

Recommended Books:

Text Books:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design by Pandya & Shah, Charotar Publishing

4. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
5. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas& Co
6. Recommended Data Book – PSG

Reference Books:

1. Machine Design by Reshetov, Mir Publication
2. Machine Design by Black Adams, McGraw Hill
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
5. Design of Machine Elements by V.M.Faires
6. Design of Machine Elements by Spotts.

Links for online NPTEL/SWAYAM courses:
https://archive.nptel.ac.in/courses/112/105/112105125/

AICTE Prescribed Textbook:
Design of Machine Elements, Dr. A Kumaravel, M. Kathirselvam
(https://ekumbh.aicte-india.org/allbook.php#)

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	-	-	-	-	-	-	-	-	2	-
CO2	3	2	3	-	-	-	-	-	-	-	-	2	-
CO3	3	2	3	-	-	-	-	-	-	-	-	2	-
CO4	3	2	3	-	-	-	-	-	-	-	-	2	-
CO5	3	2	3	-	-	-	-	-	-	-	-	2	-
CO6	3	2	3	-	-	-	-	-	-	-	-	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
25PCC12ME23	Heat Transfer Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Practical	50	--	--		50	

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Apply the principles of conduction to determine thermal conductivity of metals, insulating materials, and composite slabs.
	CO2	Evaluate convective heat transfer coefficients under natural (free) and forced convection conditions over flat surfaces and through tubes.
	CO3	Analyze the performance of heat exchangers by determining overall heat transfer coefficient and effectiveness for parallel and counter flow configurations
	CO4	Determine radiative heat transfer characteristics by measuring emissivity of surfaces.
	CO5	Investigate boiling heat transfer phenomena by evaluating critical heat flux and associated heat transfer coefficients.
	CO6	Interpret experimental data, estimate thermal resistances, plot temperature distributions, and compare results with theoretical correlations.

Sr. No.	Experiments	Hours
1	Measurement of thermal conductivity of metal rod	2
2	Measurement of heat transfer coefficient for flow over flat surface in free	2
3	Measurement of heat transfer coefficient for flow over flat surface in forced convection.	2
4	Measurement of heat transfer coefficient for flow through tubes in free convection	2
5	Measurement of heat transfer coefficient for flow through tubes in forced convection	2
6	Measurement of emissivity of Grey surface	2
7	Measurement thermal conductivity of the insulating material and plot the radial temperature distribution in the cylinder	2
8	Measure the thermal resistance and total thermal conductivity of composite slab.	2
9	Measurement of overall heat transfer coefficient and effectiveness of a double pipe heat exchanger under conditions of parallel flow and counter flow.	2
10	Measurement of critical heat flux of a nichrome wire and its heat transfer coefficient	2
	Total	**20**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Reference Books:

1. Fundamentals of Heat and Mass Transfer" – Frank P. Incropera & David P. DeWitt1, Publisher: John Wiley & Sons
2. Principles of Heat Transfer" – F. Kreith, Publisher: McGraw-Hill Education
3. Heat and Mass Transfer: A Practical Approach" – E. Radhakrishnan, Publisher: McGraw-Hill Education.
4. Convective Heat and Mass Transfer, Authors: Kays, Crawford, Weigand, Publisher: McGraw-Hill Education

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	-	-	-	-	-	-	-	-	-	3	-
CO5	3	3	-	-	-	-	-	-	-	-	-	3	-
CO6	3	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)			Credit Assigned			
		L	T	P	L	T	P	Total
25PCC13ME19	Hydraulics and Pneumatics Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Practical	50	--	--		50	

Pre-requisite Course Code	-	
Course Code	CO1	Design and Develop Pneumatic Circuits
	CO2	Design and Develop Hydraulic Circuits
	CO3	Design and Develop Electro-Pneumatic Circuits
	CO4	Design and Develop PLC Circuits

Sr. No.	Experiments Details	Hours
1	Basic Single Cylinder Pneumatic circuits	4
2	Basic Single Cylinder Hydraulic Circuits	4
3	Flow Control and Combination Valves Pneumatic Circuits	6
4	Multiple Cylinder circuit Simulation	4
5	Basic Electro-pneumatic Circuits	4
6	Basic PLC Circuits	4
	Total	**26**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Reference Books :

1. Festo Didactic – "Fundamentals of Pneumatics", Festo, Official Training Manual Festo Manual for Electro- Pneumatics.
2. Festo Didactic – "Electro-Pneumatics Basic Level", Festo, Official Training Manual
3. Bolton, W. – "Pneumatic and Hydraulic Systems", Butterworth-Heinemann
4. John W. Webb & Ronald A. Reis – "Programmable Logic Controllers: Principles and Applications"

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	2	-	-	-	-	-	-	3	2
CO2	3	2	2	-	2	-	-	-	-	-	-	3	2
CO3	3	2	2	2	2	-	-	-	-	-	-	3	3
CO4	3	2	2	2	2	-	-	-	-	-	1	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			
		L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	-	3
25PEC13ME16	Tool Engineering	Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes		Basic Manufacturing Processes, Advanced Manufacturing Processes, Machine Shop Practice
Course Outcomes	After completion of this course, students will be able to:	
	CO1	Understand the basics and importance of tool engineering in manufacturing industries.
	CO2	Identify different types of tools and heat treatment for tool materials
	CO3	Analyze the geometry, materials, and coatings of single-point and multi-point cutting tools.
	CO4	Design jigs and fixtures for holding, locating, and guiding workpieces in machining
	CO5	Classify different types of press tools such as shearing, bending, and forming dies and develop strip layouts
	CO6	Understand recent trends in tool engineering for eco-friendly and sustainable solutions

Module No.	Topics	Hrs.
1	**Introduction to Tool Engineering** • Definition, scope, and importance • Types of tools and classifications • Basic tool materials and their properties • Tool Force Measurements using Tool Dynamometers	04
2	**Cutting Tool Design** • Single-point cutting tools: tool geometry, tool angles, materials • Multi-point cutting tools: drills, milling cutters, broaches • Tool life, wear, failure analysis and tool reconditioning • Tool life estimation (Taylor's tool life equation) • Cost analysis in cutting tool design • Case studies on tool performance improvement	05
3	**Jigs and Fixtures** • Definition, purpose, and importance • Principles of location and clamping • Types of jigs (plate, channel, box, indexing jigs) • Types of fixtures (milling, grinding, turning, welding)	04
4	**Press Tools and Die Design** • Types of press tools (shearing, bending, drawing, forming) • Die components and materials • Progressive, compound, and combination dies • Strip layout and die design calculations	05

5	**Heat Treatment and Coating Technology of Cutting Tools** • Heat treatment processes: hardening, tempering, annealing • Coating techniques (PVD, CVD, nitriding etc.)	04
6	**Recent Trends in Tool Engineering** • CAD/CAM in tool design • Additive manufacturing for tool making • Sustainable tool engineering practices	04
	Total	**26**

Tutorial:

Module 1: Introduction to Tool Engineering
Define tool engineering and classify cutting tools, Compare HSS vs Carbide (2 properties + applications), Sketch tool dynamometer and name force components, Simple numerical on cutting force *(given data)*

Module 2: Cutting Tool Design
Sketch and label single-point cutting tool geometry, Design tool angles for turning mild steel *(conceptual)*, Numerical on Taylor's tool life equation**,** Short note: Tool wear types

Module 3: Jigs and Fixtures
Explain 3-2-1 principle with neat sketch, Design a simple drilling jig (locators & clamps only), Short note: Jig vs Fixture (any two points)

Module 4: Press Tools and Die Design
Classify press tools (any four), Sketch progressive or compound die, Numerical: Cutting force or press tonnage *(simple)*

Module 5: Heat Treatment & Coating of Tools
Explain hardening and tempering, Compare PVD vs CVD (any two points), Short note: Effect of coating on tool life

Module 6: Recent Trends in Tool Engineering
Role of CAD/CAM in tool design, Additive manufacturing applications in tools, Short note: Sustainable tool engineering

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 tool engineering principles.

References:

1. "Fundamentals of Tool Design" – *ASTME*
2. "Tool Engineering" – *G.R. Nagpal*
3. "A Textbook of Production Engineering" – *P.C. Sharma*
4. "Manufacturing Science" – *Amitabha Ghosh & A.K. Mallik*
5. "Metal Cutting Principles" – *M.C. Shaw*
6. "Cutting Tool Design" – *Arthur L. McClure*
7. "Jigs and Fixture Design" – *Edward G. Hoffman*
8. "Fundamentals of Tool Engineering Design" – *Donald F. Eary & Edward A. Reed*
9. "Die Design Fundamentals" – *Vukota Boljanovic*
10. "Injection Mould Design" – *R.G.W. Pye*
11. "Tool Engineering Handbook" – *S. Kuppuswamy*
12. CIRP Journal of Manufacturing Science and Technology
13. ASME Journal of Manufacturing Science and Engineering
14. NPTEL (IIT Lectures) – Free lectures on tool design and manufacturing.
15. MIT OpenCourseWare – Covers mechanical and tool engineering concepts.

Suggested CO - PO articulation Matrix

Course Outcomes	**Programme Outcomes (POs)**											**Programme Specific Outcomes* (PSOs)**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3
CO4	3	-	3	-	-	-	-	-	-	-	-	-	3
CO5	3	-	-	-	-	-	-	-	-	-	-	-	3
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			
25PCC13ME18	Optimization Techniques	L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	Statistical Techniques and Partial Differential Equations	
Course Outcomes	CO1	Identify the types of optimization problems and apply optimality criteria.
	CO2	Formulate the problem as Linear Programming problem and analyse the sensitivity of a decision variable.
	CO3	Apply integer programming and discrete event simulation techniques/stochastic simulation technique for problem solving in various domains.
	CO4	Apply multi-objective decision-making methods for problem in manufacturing environment and other domain.
	CO5	Apply multi criterion decision making methods for problem in manufacturing environment and other domain.
	CO6	Apply Design of Experiments method for Optimization.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Basic Concepts: Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization	1-4	1
	1.2	Linear Programming Problem: Formulation, Graphical Method, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis.	1-4	6
2	2.1	Integer Programming Model: Gomory's cutting plane method, Branch & Bound Technique	1-4	4
	2.2	Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique	1-4	2
3	3.1	Multi Objective Decision making (MODM) Methods: Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming.	1-4	4
	3.2	Introduction to Non-traditional optimization Techniques such as Genetic Algorithm, particle swarm, simulated annealing and Techniques based on Neural network & Fuzziness (Only concepts)	3-6	2
4	4.1	Multi Criterion Decision-making (MCDM) Methods: Introduction to multi criterion optimization Simple Additive Weighting (SAW) Method Weighted Product Method (WPM) Analytic Network Process (ANP) Analytic Hierarchy Process (AHP) Method	1-4	3
5	5.1	Robust Design Methods: DOE and Taguchi techniques Full Factorial Design: The basics of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation Fractional Factorial Design: The one-half	5	4

		fraction and one-quarter of the 2k design, The general 2k-p fractional factorial design		
Total				**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Linear Programming and sensitivity analysis	**02**
2	Integer Programming	**02**
3	Monte Carlo Simulation	**01**
4	MODM methods for problem solving	**01**
5	MCDM methods for problem solving	**01**
6	DOE and ANOVA	**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 various optimization techniques.

Recommended Books:

Text Books:

1. S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
2. Malik, A. K., Yadav, S. K., & Yadav, S. R. "Optimization Techniques" IK International Publishing.
3. Taha, H. A., "Operations research: an introduction" Pearson Education India.
4. Gupta, P. K., & Hira, D. S. "Operations research" S Chand & Company.
5. Douglas C. Montgomery, "Design and analysis of experiments" (John Wiley & Sons Inc.)

Reference Books:

1. Pablo Pedregal, "Introduction to Optimization", Springer
2. Ranjan Ganguli, "Engineering Optimization - A Modern Approach" Universities Press
3. R V Rao, "Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making" (Springer Publication).
4. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House
5. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
6. Ritter, H., Martinetz, T., &Schulten, K., Addison, "Neural Computation and Self-Organizing

Maps"-Wesley Publishing Company
7. Saravanan R,"Manufacturing Optimization through Intelligent Techniques", Taylor & Francis (CRC Press)-2006.

Links for online NPTEL/SWAYAM courses:
https://nptel.ac.in/courses/112/101/112101298/ - Optimization from Fundamentals, IIT Bombay

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	-	1	1	-	-	-	-	-	-	-	-
CO2	1	2	-	2	2	-	-	-	-	2	-	2	-
CO3	1	2	-	2	2	-	-	-	-	2	-	2	-
CO4	-	2	-	2	2	-	-	-	-	3	-	2	-
CO5	-	2	-	2	2	-	-	-	-	3	-	2	-
CO6	2	2	2	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			
25PEC13ME19	Project Management	L	T	P	SL	L	T	P	Total
		2	1	--	3	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 selection criteria and select an appropriate project from different options.
	CO2	Write work break down structure for a project and develop a schedule based on it.
	CO3	Identify opportunities and threats to the project and decide an approach to deal with them strategically
	CO4	Use Earned value technique and determine & predict status of the project.
	CO5	Capture lessons learned during project phases and document them for future reference.

Module No.	Topics	Ref	Hrs.
1	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures	1-5	04
2	**Initiating Projects:** How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	1-5	04
3	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	1-5	05
4	**Planning Projects:** Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan **Risk Management in projects:** Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment,		04
5	**Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings	1-5	05

	Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit **Project Contracting** Project procurement management, contracting and outsourcing,		
6	**Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects **Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	1-5	04
	Total		**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 project management principles.

Recommended Books:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	2	2	-	-	-	-	2	-	2	-	-	2
CO2	1	3	2	-	-	-	-	-	-	2	-	-	2
CO3	-	-	-	2	-	2	-	-	-	2	-	-	2
CO4	-	-	-	2	-	-	-	-	-	3	-	-	2
CO5	-	-	2	-	-	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			
25PEC13ME110	Industrial Engineering and Operations Management	L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	-	3
		Examination Scheme							
			ISE1	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Analyze implications of Industrial Engineering in industries
	CO2	Demonstrate the Work space design and Performance merit rating
	CO3	Understand the material flow and importance of layout optimization
	CO4	Understand importance of Inventory and leveraging the benefit to company.
	CO5	Understanding material requirement through dependent and independent demand and meeting the deadline
	CO6	Understanding value creation and secondary value addition.

Module No.	Topics	Ref	Hrs.
1	Evolution & Industrial Engineering in the modern world, **Production and Productivity:** factors influencing productivity, Productivity Improvement tools **&** Quality Improvement tools and techniques (5s, Poka-Yoke, Kaizen, Kanban & QFD, FMEA, SMED)	1-4	04
2	**Work System Design:** Factors affecting human performance, physical workload and energy expenditure. Workspace design for standing and seated workers, Arrangements of components within a physical space. **Job Evaluation and Wage Plan***:* job evaluation procedure, merit rating (performance appraisal), method of merit rating, wage and wage incentive plans	1-4	04
3	**Facility Location:** The need for location decision, Procedure for making location decisions, Factors affecting location decisions, Methods of evaluating location decisions. **Facility Layout / Plant Layout:** Types of Layout, Significance and Factors influencing layout choices, Principles of Plant layout, Concepts of Group Technology and Cellular Manufacturing, Computerized Layout Techniques.	1-4	04
4	**Inventory Management:** Classification and Functions of Inventory, The EOQ Model, P & Q System, ABC & VED analysis.	1-4	05
5	Material requirement Planning (MRP) and Material Resource Planning (MRP II), Dependent Demand and Independent Demand with an example.	1-4	05
6	Value Engineering and Value Analysis: Distinction between value engineering & value analysis and their Significance. Steps in value engineering & analysis, function analysis system techniques- FAST diagram with Case studies	1-4	04
	Total		**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 industrial engineering and operations management principles.

Reference Books:

1. Production and Operations analysis by Steven Nahmia , McGraw-Hill / Irwin publication
2. Facilities Planning 4th Edition by James A. Tompkins, John Wiley and Sons Inc.
3. Elements Of Production Planning And Control by Eilon, Samuel, New York: Macmillan
4. Production Planning and Control by Prof. Jhamb L.C. by Everest Publishing House
5. Production (Operations) Management by Prof. Jhamb L.C. by Everest Publishing House
6. Inventory Management Prof. Jhamb L.C. by Everest Publishing House
7. Operations Management- an Integrated Approach 5th Edition by R. Dan Reid, Wiley
8. Production and Operations Management by R. Panneer selvam, Prentice-Hall Of India
9. Operations Management for Competitive Advantage by Richard B. Chase, MGH
10. Orlicky's Material Requirements Planning, by Carol Ptak, McGraw Hill.
11. Enterprise resource planning: concepts and practice by Vinod kumar Garg PHI Learning
12. Lean Thinking: Banish Waste and Create Wealth in Your Corporation, by James P. Womack, Free Press
13. Toyota Production System: An Integrated Approach to Just-In-Time, by Yasuhiro Monden ,CRC PRESS

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	2	1	-	-	3
CO2	-	2	-	-	-	-	2	-	2	-	2	2	3
CO3	-	2	2	-	-	-	-	-	-	-	-	2	3
CO4	-	2	1	-	-	-	-	-	-	-	2	-	3
CO5	-	1	-	1	-	-	-	-	-	-	2	-	3
CO6	-	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			
		L	T	P	L	T	P	Total
25PEC13ME110	Manufacturing Systems Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Lab	50	--	--		50	

Pre-requisite Course Codes	None	
Course Outcomes		Learners will be able to
	CO1	Explain role of computers and information technology in manufacturing systems.
	CO2	Develop an FMS (Flexible Manufacturing System) layout for given simple part family, using group technology concepts to and make proper grouping as per their attributes.
	CO3	Recognize use of robotics, programmable logic controllers, microcontrollers and recent advances in the field of manufacturing.

Sr. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Hrs.
1	--	**Presentation on "How it's made":** Faculty will assign any one part from Annexure-I. (Each student will have different part in a batch). Student will download movies/content and will present with the concept "How it's made". Note: Each student will make his/her folder having the name as <batch number_Enrollment number> and will save his/her downloaded content.	04
2	II	**GT codes:** Faculty will ask each student to bring at least one component having mechanical features and having more than 5-6 machining operations. Each student will also prepare the drawing and process plan (As per attached Annexure-II).Then the data will be interchanged by batch students. Collection of parts and making drawing and process plans will be as home assignment. Faculty will assign this task in very first period of practice. Students would: a. Prepare drawing of part brought by the student. b. Prepare process plan as per Annexure-II for the part brought by student. c. Interchange part drawings and process plans. (No photo copies are allowed. Each student in a batch will have total drawings and process plans equal to number of students in a batch who have brought parts. This may be also given as home assignment). d. Prepare feature matrix. e. Select GT coding system and assign GT code to each part.	04
3	III	**FMS layout:** Students would: a. Develop part family (May be 3-6 parts) from all parts.(Taken in Ex. No. 2 above.) This is to be carried out logically from feature matrix. b. Assume quantities of each part of part family developed in a. above. c. Assume additional data for following:	06

		i. Number of shifts and working hours in each shift. ii. Average number of working days in a month. iii. Utilisation factor of FMS unit. d. Prepare process time matrix. (Suggested format is attached as per Annexure-III). e. Determine type and number of work stations. f. Perform necessary calculations and prepare conceptual FMS layout.	
4	IV	**Demonstration:** Students would: a. Demonstrate working of following: i. Robot-anyone. ii. Sensors-each one from force & torque type, velocity and acceleration type, proximity type, position type and vision type. iii. PLC-anyone. iv. MC-anyone. v. Control system-anyone. b. Sketch following. i. Configuration sketch of robot demonstrated. ii. Working sketch of sensors demonstrated. iii. Block diagrams of PLC and MC demonstrated. iv. Circuit diagram of control system demonstrated.	06
5	All	**Mini project (In the group of 4-6 students):** Students would: a. Prepare at least one from the following (as approved by the faculty): i. Prepare simple circuit using application of sensor. ii. Prepare simple robot using available kit. iii. Prepare ladder diagram for any one real life PLC application. iv. Build and operate the functionality of basic or advance logic gates. b. Prepare report which includes sketches, specifications, observation tables, parameters, truth tables, applications, etc. (as applicable). c. Present the project.	06
		Total	**26**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Reference Books:

1. P. Radhakrishnan and S. Subramanyan, *CAD/CAM/CIM*. New Age International.
2. Bedworth, D., Wolfe, T., & Anderson, P. (n.d.). *Computer integrated manufacturing and design*. McGraw-Hill International Publication.
3. *Mechatronics*. (n.d.). HMT.
4. Critchlow, A. J. (n.d.). *Introduction to robotics*. McMillan Publication.
5. Koran, Y. (n.d.). *Robotics for engineers*. McGraw-Hill International Publication.
6. Rao, P., Tiwari, K., & Kundra, T. (n.d.). *Computer aided manufacturing*. Tata McGraw-Hill Publication.

7. Singh, S. (n.d.). *Computer aided design and manufacturing*. KP.
8. Vajpayee, S. K. (n.d.). *Computer integrated manufacturing*. PHI.
9. Groover, M. P. (n.d.). *Automation, production and computer integrated manufacturing*. PHI.
10. Bradley, D., & Others. (n.d.). *Mechatronics*. Chapman and Hall.
11. Burns, W. C., Jr., & Worthington, J. E. (n.d.). *Practical robotics*. PHI.
12. Mehta, V. K. (n.d.). *Basic electronics*. S. Chand Publication, New Delhi.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	2	-	-	-	-	-	-	2	2
CO2	2	2	2	2	2	-	-	-	-	2	-	2	2
CO3	-	-	2	-	2	-	-	-	-	-	-	2	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			
25PEC13ME112	Industrial Engineering and Operations Management Laboratory	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Lab	50	--	--		50	

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Demonstrate to Calculate standard time for all the operations.
	CO2	Apply work measurement technique to analyze the time components involved machining operation of given job using stop watch
	CO3	Prepare chart of Sequence of operation for manufacturing of simple job.
	CO4	Prepare supply chain management chart for online purchase of goods/products.

Module No.	No.	Experiments List	Expts. No.
Group A	1	Experiment for Merit rating and Job Evaluation using pack of cards	2 expts. Out of 4
	2	Study Experiment using pin board	
	3	Study Experiment using two Handed process Chart	
	4	Study experiment on Multiple Activity Chart (Or) Man Machine Chart	
Group B	1	Analyze the motions involved in machining operation of the given job	1 expts. Out of 3
	2	Apply work measurement technique to analyze the time components involved in machining operation of given job using stop watch	
	3	Calculate standard time for all the operations involved in step turning process, or any other process.	
Group C	1	Prepare supply chain chart in day-to-day situation like supply of cold drink/tooth paste/any grocery item.	2 expts. Out of 3
	2	Prepare Supply Chain Management Chart For Online Purchase Of Goods/Products.	
	3	Prepare detailed process plan for manufacturing of simple job.	
		Total	**5 expts.**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Reference Books:

1. Production and Operations analysis by Steven Nahmia , McGraw-Hill / Irwin publication
2. Facilities Planning 4th Edition by James A. Tompkins, John Wiley and Sons Inc.
3. Elements Of Production Planning And Control by Eilon, Samuel, New York: Macmillan
4. Production Planning and Control by Prof. Jhamb L.C. by Everest Publishing House
5. Production (Operations) Management by Prof. Jhamb L.C. by Everest Publishing House
6. Inventory Management Prof. Jhamb L.C. by Everest Publishing House
7. Operations Management- an Integrated Approach 5th Edition by R. Dan Reid, Wiley
8. Production and Operations Management by R. Panneer selvam, Prentice-Hall Of India
9. Operations Management for Competitive Advantage by Richard B. Chase, MGH
10. Orlicky's Material Requirements Planning, by Carol Ptak, McGraw Hill.
11. Enterprise resource planning: concepts and practice by Vinod kumar Garg PHI Learning

Suggested CO - PO articulation Matrix

Course Outcomes	**Programme Outcomes (POs)**											**Programme Specific Outcomes* (PSOs)**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	-	-	-	-	-	-	-	-	2	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3	3
CO3	3	3	3	-	-	-	-	-	-	-	-	-	3
CO4	3	3	3	-	-	-	-	-	-	-	-	-	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)				Credit Assigned			
25PEC13ME25	Industrial Robotics	L	T	P	SL	L	T	P	TOTAL
		2	1	--	3	2	1	--	3
		Examination Scheme							
			ISE	MSE		ESE			Total
		Theory	20	30		50			100
		Tutorial	50	--		--			50

Pre-requisite Course Code		
Course Code	CO1	Understand the basic anatomy of a Robot System
	CO2	Understand working of various sensors and Robot Peripherals
	CO3	Understand the working of Machine Vision
	CO4	Understanding Robot Direct and Inverse Kinematics
	CO5	Demonstrate an understanding of robot intelligence and task planning
	CO6	Understand the Applications of Industrial Robotics arm

Module No.	Topics	Ref.	Hrs.
1	**Introduction to Automation**: Automation, Robotic system & Anatomy, Classification and Future Prospects. Drives Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators and Power Transmission system.	1	2
2	**Robot & its Peripherals End Effecters**: Type of mechanical and other grippers, Tool as end effecter. Sensors: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Vision systems and Equipment	1,2	4
3	**Machine vision :** Introduction, Low level & High-level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Object Description & recognition, interpretation and Applications.	2	5
4	**Robot Kinematics :** Forward, reverse & Homogeneous Transformations, Manipulator Path control and Robot Dynamics. Introduction to wheeled and legged robots including humanoids	1	5
5	**Robot Intelligence & Task Planning :** Introduction, State space search, Problem reduction, use of predictive logic, Means Ends Analysis, Problem solving, Robot learning and Robot task planning.	1	5
6	**Robot Application in manufacturing**: Material transfer, machine loading & unloading, processing operation, Assembly & inspectors, robotic Cell design & control, social issues & Economics of Robotics.	1	5
		TOTAL	26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

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, application and analysis of industrial robotics principles.

Recommended Books :

1. Industrial Robotics, Technology, Programming & Applications, Grover, Weiss, Nagel, Ordey, Mc Graw Hill.
2. Robotics: Control, Sensing, Vision & Intelligence, Fu, Gonzalex, Lee, Mc Graw Hill.
3. Robotic technology & Flexible Automation, S R Deb. TMH.
4. Robotics for Engineers, Yoram Koren , Mc Graw hill.
5. Fundamentals of Robotics, Larry Health.

Suggested CO - PO articulation Matrix

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

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

Blooms level

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

Society of St. Francis Xavier, Pilar's
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
25PEC13ME27	IC Engines	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	Understand basic IC engine types, components, and operating cycles.
	CO2	Explain essential SI engine fuel, ignition systems, and combustion behavior.
	CO3	Explain basic CI engine fuel injection and combustion characteristics.
	CO4	Understand lubrication, cooling, and basic boosting systems.
	CO5	Interpret basic engine performance parameters and emission-control methods.
	CO6	Understand key alternative fuels and basic electronic engine control systems.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction & Classification: Types of IC engines, Basic components & materials (brief), 2-stroke & 4-stroke operation, Comparative study of SI vs CI engines (short)	1-7	2
	1.2	Basic Cycles & Timing: Ideal vs actual cycles (overview only), Fuel–air cycles (concept only; no analysis), Valve timing diagram (SI or CI—only one required)	1-7	2
2	2.1	Fuel Supply System: Mixture requirements, Simple carburetor (concept only; no circuits), MPFI & GDI (overview only)	1-7	2
	2.2	Ignition System: Battery & magneto systems, Spark plug (construction only), Ignition advance (basic idea). SI Combustion: Flame propagation, Detonation, Combustion chamber types	1-7	3
3	3.1	Fuel Injection: Solid injection system, CRDI (overview only), Injection pumps & injectors	1-7	2
	3.2	CI Combustion: Stages of combustion, Delay period, Diesel knocking, CI combustion chambers	1-7	2
4	4.1	Lubrication: Lubricant properties, SAE rating, Lubrication systems (splash/pressure—brief)	1-7	2
	4.2	Cooling: Need for cooling, Air-cooled vs water-cooled Supercharging/Turbocharging: Types (simple classification) , Basic turbocharger arrangement	1-7	2

5	**5.1**	Performance Parameters: Brake Power, Indicated Power, Friction Power, Mechanical, brake thermal, volumetric efficiency, BSFC (concept), Performance curves (qualitative).	1-7	3
	5.2	Emissions & Control: NOx, HC, CO, PM formation (basic), Catalytic converter, EGR, Bharat/Euro norms,	1-7	2
6	**6.1**	Alternative Fuels: LPG, CNG, Hydrogen, Biodiesel (properties + suitability), Basic engine modifications	1-7	3
	6.2	ECM (block diagram only), Basic sensors: TPS, IAT, ECT, CKP, MAP, O_2 sensor (functions only), Electronic spark control,	1-7	2

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Operation in Four stroke and Two-stroke IC engines and their comparative study	**01**
2	S.I. Engines Fuel Supply System, Ignition System, Combustion	**01**
3	Compression Ignition Engines	**01**
4	Engine lubrication, Engine Cooling, Supercharging.	**01**
5	Engine Testing and Performance Measurement (Only Study)	**01**
6	Alternative Fuels	**01**
7	Basics of Electronic Engine Controls:	**01**
8	Activity based study.	**01**
Total Hours		**08**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

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 various IC engines and related principles.

Recommended Books:

Textbooks

1. Internal Combustion Engines – V. Ganesan, Tata McGraw-Hill
2. Internal Combustion Engines – Mathur & Sharma, Dhanpat Rai Publications
3. Internal Combustion Engines – Heywood J.B., McGraw-Hill
4. Automotive Mechanics – Crouse & Anglin, Tata McGraw-Hill
5. Automotive Engines – S. Srinivasan, TMH
6. Internal Combustion Engines – R.K. Rajput, Laxmi Publications
7. Automobile Engineering – Kirpal Singh (Vol. 1 & 2), Standard Publishers

Reference Books

8. Engine Combustion: Pressure & Emission Fundamentals – John Heywood
9. Gas Turbine and IC Engines – V. Ganesan
10. Bosch Automotive Handbook – Bosch, Wiley

AICTE Prescribed Textbook:

Internal Combustion Engines, Mathur & Sharma, Dhanpat Rai

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	-	-	-	-	-	-	-	-	-	3	-
CO5	3	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			
25PEC13ME28	Product Design and Development	L	T	P	SL	L	T	P	Total
		2	1	--	3	2	1	--	3
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	
		Tutorial	50	--		--		50	

Pre-requisite Course Codes	Machine Design	
Course Outcomes	CO1	Describe the process of product design & development.
	CO2	Employ engineering, scientific, and mathematical principles to develop and execute a design project from a concept to a finished product.
	CO3	Apply the principles of DFMA and other DFX principles in product design.
	CO4	Analyze products based on ergonomics and aesthetic aspects.
	CO5	Apply value engineering and software solutions in product design.
	CO6	Illustrate various modern approaches like concurrent engineering, product life cycle management, robust design, rapid prototyping / rapid tooling.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction:** Definition of product design, Various phases in product development and Design, The Design Process, Considerations in product design	1-3	2
	1.2	**Planning for products**: Establishing markets - market segments - relevance of market research.	1-3	1
	1.4	**Materials:** Overview of materials including new generation materials, Tailor made material concepts, Material selection process.	1-3	1
2	2.1	**Identifying customer needs:** Voice of Customer (VoC), Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, Quality Function Deployment (QFD), House of Quality (HoQ), Product design specification, Development of product design with specifications using QFD, Relevant case studies.	1-3	2
3	3.1	**The design processes:** Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model **Conceptual Design:** Market research, Generation, Selection and Embodiment of concept, Product Architecture, Customer centric product designing	1-3	2
	3.2	**Creativity:** Role of creativity in problem solving, Vertical and lateral thinking, Brain storming, Synectics, Group working dynamics, Adaptation to changing scenarios in economics, social, cultural and technological fronts, Anticipation of new needs and aspirations.		1

4	**4.1**	**Product Ergonomics:** Anthropometry, Environmental conditions, thermal, noise, vibration, displays, illusions, Psycho and psychological aspects in design, Man-machine information exchange.	1-3	2
	4.2	**Product Aesthetics:** Visual awareness, Form elements in context of product design, Concepts of size, shape and texture, Introduction to colour and colour as an element in design, Colour classifications and dimensions of colour, Colour combinations and colour dynamics, Interaction / communication of colours, Psychological aspects of colours, generation of products forms with analogies from nature.	1-3	1
	4.3	**Product Graphics:** Graphics composition and layout, Use of grids in graphics composition, Study of product graphics and textures.	1-3	1
5	**5.1**	**Design for Manufacturing:** Guidelines and Methodology, Producibility requirements, Accuracy and Precision requirements, Strength considerations in Design: Criteria and objectives, Designing for uniform strength, Designing for stiffness and rigidity, Practical ideas for material saving in design - ribs, corrugations, rim shapes, bosses, laminates, etc.	1-3	2
	5.2	Design for forged and Cast components, Design for Sheet Metal processed components, powder metallurgical components, Expanded metals and wire forms	1-3	2
	5.3	**Design for Assembly (DFA):** DFA Index, Analysis of assembly requirements, Standardization, Ease of Assembly and disassembly, Design for bolted, welded and riveted components, Design for hinge and snap fit assemblies, maintenance, consideration of handling and safety, Modular concepts.	1-3	2
	5.4	**Other DFX Principles:** Designs for Maintainability, Safety, Reliability, Sustainable Design	1-3	1
6	**6.1**	**Value Engineering:** Product value and its importance, Value analysis job plan, Steps to problem solving and value analysis, Value analysis tests, Value Engineering idea generation check list, Material and process selection in value engineering, Cost reduction, case studies and exercises.	1-3	1
	6.2	**Software solutions:** Software for drafting, modeling, assembly, detailing, CAM interfacing, Rapid tooling/rapid prototyping, etc.	1-3	1
	6.3	**Modern Applications:** Concurrent Engineering, Robust Design, Additive Manufacturing/Rapid Prototyping, Product Life Cycle Management techniques and application areas.	1-3	4
Total				**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Tutorial:

Sr. No.	Tutorial Details	Hours
1	House of quality	01
2	Concept Generation and Selection	02

3	Industrial Design	02
4	Value Engineering / Robust Design / Modern Approaches	02
5	DFX Principles	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 various product design and development principles.

Recommended Books:

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development," 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
2. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN 9788177588217.
3. Product Design and Manufacturing - R.C. Gupta, A.K. Chitale PHI, 2011

Reference Books:

1. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
2. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

Links for online NPTEL/SWAYAM courses:

1. Product Design and Manufacturing by Prof. J. Ramkumar, Prof. Amandeep Singh | IIT Kanpur https://onlinecourses.nptel.ac.in/noc21_me66/preview
2. Product Design and Development by Prof. Inderdeep Singh, IIT Roorkee https://onlinecourses.nptel.ac.in/noc21_me83/preview

Suggested CO - PO articulation Matrix

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

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

Blooms level

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

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25PEC13ME29	Robotics and Control Engineering Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Practical	50	--	--		50	

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Design and Develop Kinematic of an Industrial Robotic arm
	CO2	Develop machine vision based image processing techniques
	CO3	Develop Solution for Trajectory planning in robots
	CO4	Be able to check system stability by Root Locus or Bode Plot

Experiment No.	Experiments	Ref	Hrs.
1	Edge detection	1	04
2	segmentation using image processing	1	05
3	Programming the robots to solve direct and inverse kinematics problems	1	05
4	Trajectory planning for Robots	1	04
5	Checking Stability of a system using Root Locus	3,4,5	04
6	Checking stability of a system using Bode Plot	3,4,6	04
	Total		**26**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Reference Books:

1. *"Introduction to Robotics: Mechanics and Control"* – John J. Craig
2. *"IoT: Building Arduino-Based Projects"* – Peter Waher
3. Katsuhiko Ogata, *"Modern Control Engineering"*, 5th Edition, Pearson, 2010.
4. Rao V. Dukkipati, *"Analysis and Design of Control Systems using MATLAB"*, New Age International, 2006.
5. MATLAB Documentation, *"Root Locus Analysis using rlocus()"*,
6. MATLAB Documentation, *"Bode Plot Analysis using bode()"*

Suggested CO - PO articulation Matrix

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

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

Blooms level

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

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC13ME210	Product Design Laboratory	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Lab	50	--	--		50	

Pre-requisite Course Codes		Product Design and Development
Course Outcomes	CO1	Identify the need for developing products
	CO2	Select suitable PD&D processes
	CO3	Apply the creativity & industrial design methods to design & develop the chosen product
	CO4	Work collaboratively in a team to complete a PD&D project.
	CO5	Effectively communicate the results of projects and other assignments in written and oral format.

Module No.	Topics	Hours
	(All the following design exercises are to be treated as course project on product redevelopment to be completed by a group of 4 to 5 students. The results are to be documented and presented.)	
1	Identification of Customer Needs	4
2	Conversion of Voice of Customer into Voice of Company	4
3	Concept Generation and Selection	4
4	Industrial Design Aspects	4
5	DFMA and other DFX Considerations	4
6	Development of the Model of redesigned Product and Analysis (if any)	4
Total Hours		**24**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development," 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
2. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN 9788177588217.
3. Product Design and Manufacturing - R.C. Gupta, A.K. Chitale PHI, 2011

Reference Books:

1. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
2. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

Suggested CO - PO articulation Matrix

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

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			
		L	T	P	SL	L	T	P	Total
25OE4	Public Relations and Corporate Communication	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	100	--		--		100	

Pre-requisite Course Codes	SLRW Skills	
Course Outcomes	CO1	Develop professional communication skills through training and practice
	CO2	Draft professional documents with precision
	CO3	Develop effective communication strategies for diverse, cultural and global business environment

Sr. No	Unit	Module	Ref.	Hrs
1		Career Advancement Skills	R-1,3	8
	1.1	Resume Writing & Cover Letter for Employment		
	1.2	Group Discussion		
	1.3	Impressive Grooming		
	1.4	Communication Simulation		
	1.5	Interview Techniques		
2		Synergy Communication	R-4	8
	2.1	Presentation Skills		
	2.2	Report Writing- Importance, Objective, types…		
	2.3	Meetings and Documentation: Notice, Agenda, Minutes		
3		Cross-Cultural Communication	R-2,4	5
	3.1	Cultural awareness		
	3.2	Language barriers		
	3.3	Global communication strategies		
4		Corporate Identity and Branding	R-5	5
	4.1	Corporate image and reputation		
	4.2	Branding strategies		
	4.3	Visual identity		
	4.4	Messaging and tone		
Total				26

Self Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: Based on Self-Learning / Formative assessment activities will be conducted during the full semester - 100 Marks

Sr. No.	List of Assignments	COs
a	Resume/ Cover Letter: prepare resume and draft a customized cover letter for internship or a specific job role.	CO1
b	GD Practices: Participate in structured group discussions on current and general topics.	C01
c	Mock Interview HR Question: Undergo simulated HR interviews.	C01
d	Team Building Activity: Role play, Engage in interactive group tasks and problem-solving activities.	CO1
e	Notice & Agenda and Minutes of the Meeting: practice by organizing a mock meeting and documenting the proceedings accurately	CO2
f	Report and PPT Making: Prepare formal reports on assigned topics following proper structure and formatting guidelines and design PowerPoint presentations	CO3
g	Corporate Identity and Branding: Role play and Case studies	CO4

Recommended Textbooks:

1) Dr. K.Alex, Soft Skills- Know Yourself & know the World, S.Chand
2) John Hayes, Interpersonal Skills at Work, McGraw Hill Education
3) Ankur Malhotra,Campus Placement: A Comprehensive Guide, McGraw Hill Education
4) Meenakshi Raman,Sangeeta Sharma, Communication Skills, Oxford, India
5) Courtland L. Bovee, Business Communication Today, Pearson

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	--	--	–	–	–	1	–	1	–	1	–	3	2
CO2	–	1	2	–	–	1	–	2	3	2	2	2	3
CO3	–	2	2	--	–	--	2	3	2	2	1	1	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			
		L	T	P	L	T	P	Total
25VSE13ME04	Measurement Systems and Quality Engineering Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE			Total
		Practical	50	--	--			50

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Able to measure displacement by sensors like LVDT, Potentiometers.
	CO2	Able to measure pressure /strain by gauges or sensors
	CO3	Able to perform measurement of vibration.
	CO4	Perform flatness testing using principle of interference.
	CO5	Able to design and Develop plan for Acceptance Sampling

Sr. No.	Experiments/Assignment Details	Hours
1	Experiments on measurement of displacement by sensors like LVDT, Potentiometers etc.	3
2	Experiments on measurement of pressure by gauges or sensors like vacuum Gauges, pressure gauge, piezoelectric sensors, strain gauge sensors etc.	3
3	Experiments on measurement of vibration by accelerometers or any suitable method	2
4	Experiments on measurement of gear parameters using Gear tooth Vernier calliper / Parkinson gear tester	4
5	Identification of surface flatness defects using principle of interferometry by optical flats and monochromatic light.	4
6	Design and Develop plan for Acceptance Sampling (Assignment)	4
	Total	**20**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Reference Books:

1. Engineering. Metrology, I.C. Gupta, Dhanpat Rai Publications.
2. Engineering. Metrology, 22nd edition, R. K. Jain, Khanna Publisher, (2022).
3. Statistical quality Control, 2nd edition, Mahajan M., Dhanpat Rai & Sons, Delhi (2015).
4. Quality Control, 3rd edition, D. H. Besterfield, Pearson Education (2012).
5. Understanding and Implementing ISO 9000 and ISO Standards, 2nd edition, David L. Goetsch, Stanley Davis, Prentice Hall.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	2	-	-	-	-	-	-	-	2
CO2	-	-	-	-	2	-	-	-	-	-	-	-	2
CO3	-	-	-	-	2	-	-	-	-	-	-	-	2
CO4	-	-	-	-	2	-	-	-	-	-	-	-	2
CO5	-	-	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			
		L	T	P	L	T	P	Total
25VSE13ME05	CNC Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE	MSE	ESE		Total	
		Practical	50	--	--		50	

Pre-requisite Course Codes	CAD Modelling.	
Course Outcomes	CO1	Develop and execute part programming for CNC Turning Trainer to fabricate components
	CO2	Develop and execute part programming for CNC Milling Trainer to fabricate components
	CO3	Demonstrate CAM Tool path and prepare NC- G code.
	CO4	Analyze and document the design features, preprocessing in CAM software, and capabilities of a commercial CNC machining center.

Sr. No	Topics	Hr
1	Part programming and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.) (One job in a group of 4-5 students)	6
2	Part programming and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.) (One job in a group of 4-5 students)	6
3	Tool-path generation by translation of part geometry from computer aided design (CAD) to computer aided manufacturing (CAM) systems.	6
4	Post processing of Code generated via CAM system.	5
5	Case Study: Report on a visit conducted to any Commercial CNC Machining Centre explaining the Design features, pre-processing in CAM software and its capabilities.	4
Total		**26**

Course Assessment:

Laboratory Learning:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
2. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
3. CNC Programming for Machining, Kaushik Kumar, ChikeshRanjan, J. Paulo Davim, Springer Publication.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	-	-	-	-	3
CO2	3	3	3	-	3	-	-	-	-	-	-	-	3
CO3	3	3	3	-	3	-	-	-	-	-	-	-	3
CO4	3	3	3	-	3	-	-	-	-	-	-	-	3

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

Blooms level

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