Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

National Education Policy (NEP)-2020 Compliant Curriculum

SE - Second Year Engineering (2024 Pattern)- Revised

in

Mechanical Engineering

(With effect from Academic Year 2026-27)

Contents

Nomenclature

AEC	Ability Enhancement Courses
AICTE	All India Council for Technical Education
CO	Course Outcome
CEP	Community Engagement Project
CCE	Comprehensive Continuous Evaluation
HSSM	Humanities, Social Science, and Management
MDM	Multidisciplinary Minor
MEC	Mechanical Engineering
MOOC	Massive Open Online Course
NPTEL	National Programme on Technology Enhanced Learning
NEP	National Education Policy
PCC	Program Core Course
PEO	Program Educational Objectives
PSO	Program Specific Objectives
SWAYAM	Study Webs of Active-learning for Young Aspiring Minds
UGC	University Grants Commission
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course
WK	Knowledge and Attitude Profile

Preface by Board of Studies

Dear Students and Teachers,

We, the members of the Board of Studies – Mechanical Engineering, are very happy to present the Second Year Mechanical Engineering syllabus, effective from the Academic Year 2026-27 (2024 Pattern). We are confident that you will find this syllabus both interesting and challenging. The present curriculum will be implemented for Second Year Engineering from the academic year 2026-27, and it will be subsequently extended to the Third and Final Years in the academic years 2027-28 and 2028-29, respectively.

Mechanical Engineering is one of the most sought-after branches among engineering students, which necessitates continuous revision and up gradation of the syllabus. Mechanical Engineering is a dynamic discipline that integrates principles from core engineering fields and supports innovation across manufacturing, design, energy, materials, and automation. This curriculum is designed to provide students with a comprehensive understanding of the fundamentals, emerging technologies, and practical applications in Mechanical Engineering, while also equipping them to meet the demands of a rapidly evolving industry.

The revised syllabus aligns with the vision of NEP-2020, and conforms to the frameworks set by Savitribai Phule Pune University, AICTE New Delhi, UGC, and various accreditation agencies. It takes into account recent technological developments, innovations, and industry needs to ensure students are well-prepared for professional challenges.

Wherever applicable, additional learning resources such as NPTEL and SWAYAM links are provided at the end of each course. Students are encouraged to utilize these platforms for self-learning, engage in online courses, and undertake additional projects to enhance their knowledge and skill set. On successful completion, they are advised to submit their course certifications, which will further support and enrich their academic growth.

This curriculum is the result of collaborative efforts involving academic experts, industry professionals, and alumni to ensure relevance and excellence. It is designed not only to meet current industry expectations but also to prepare students for higher studies, research, and entrepreneurial ventures in the field of Mechanical Engineering.

We hope this curriculum inspires students to become technically competent professionals, responsible citizens, and contributors to the technological and sustainable advancement of society.

Dr. Pradeep A. Patil
Chairman
Board of Studies - Mechanical Engineering

Program Specific Outcomes

PSO1: SPECIFY, DESIGN and **EVALUATE** mechanical components and systems using modelling and analysis software.

PSO2: APPLY knowledge of machines, tools, automation, properties of advanced materials and modern management methods for manufacturing of mechanical components and systems.

PSO3: **APPLY** core aspects of thermal and fluid engineering to determine the performance of mechanical systems including power absorbing and power generating systems.

Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing a graduate to achieve.

PEO1: The graduate will have a successful career in mechanical engineering with strong technical, research & professional skills.

PEO2: The graduate will possess an ability to work in diversified fields along with team work and leadership qualities.

PEO3: The graduate will continue to learn and to adapt in a society of constantly evolving technological environment

Program Outcomes

Program Outcomes (POs) are statements that articulate what students are expected to know, understand, and be able to do by the time they graduate from the program. These outcomes are aligned with the overall educational objectives of the program and reflect the skills, knowledge, attitudes, and behaviors acquired by students throughout their academic journey. On successful completion of B.E. in Mechanical Engineering, graduating students/graduates will be able to:

PO No.	Title	Program Outcome Description
PO1	Engineering Knowledge	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.
PO2	Problem Analysis	Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for public health and safety, whole-life cost, net zero carbon, culture, society and environment. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling, recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team Work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

Knowledge and Attitude Profile (WK)

WK No.	Focus Area	Description
WK1	Natural Sciences and Social Sciences	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Mathematics and Data Analysis	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	Engineering Fundamentals	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering Specialist Knowledge	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Engineering Design and Environmental Considerations	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Engineering Practice (Technology)	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Role of Engineering in Society	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Research and Critical Thinking	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics and Inclusive Behavior	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability, etc., with mutual respect.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPC V4.0) - (August 2024) Page 55-56

General Rules and Guidelines

Term	Definition
Course Outcomes (COs)	Course Outcomes are narrower statements that describe what students are expected to know and be able to do at the end of each course. These relate to the skills, knowledge, and behavior that students acquire throughout the course.
Assessment	Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of **Program Educational Objectives (PEOs)** and **Program Outcomes (POs)**.
Evaluation	Evaluation is one or more processes, performed by the **Evaluation Team**, to interpret the data and evidence gathered through assessment practices. It determines how well PEOs or POs are being achieved, and informs decisions for improvement.

Assessment and Evaluation:

Assessment and Evaluation shall be conducted in two parts:
1. Comprehensive Continuous Evaluation (CCE)
2. End-Semester Examination (ESE)

Component	Description	Marks
Comprehensive Continuous Evaluation (CCE)	Conducted at institute level, covering all Units of the syllabus. The design and mark allocation follow the Continuous Assessment Sheet structure.	20 or 40
End-Semester Examination (ESE)	Conducted at university level, typically covering the entire syllabus through summative examination.	60

A) Comprehensive Continuous Evaluation (CCE) : It can be conducted via Mode 1 or Mode 2

Mode 1:

To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 40 marks with the specified parameters, the allocation of marks and the structure can be as per continuous assessment sheet;

Savitribai Phule Pune University

Board of Studies (Mechanical and Automobile Engineering)

[CCE] Comprehensive Continous Evaluation [40 Marks Distribution]

Class: SE A — **Subject: Fluid Mechanics**

Exam Seat No.	Roll No.	Name of Student	Unit 1		Unit 2		Unit 3		Unit 4		Unit 5		Cumulative Sum			40 Marks Distribution			Marks obtained out
			Field Activity	Quiz	Field Activity	Quiz	Field Activity	Quiz	Field Activity	Quiz	Field Activity	Quiz	Field Activity	Quiz	Internal Test	Field Activity	Quiz	Internal Test	
			A	B	C	D	E	F	G	H	I	J	SUM(A+C+E+G+I)	SUM(B+D+F+H+J)					
			10	10	10	10	10	10	10	10	10	10	50	50	100	20	10	10	40
S9970160753	2020	AMOGH SHINDE	8	8	8	8	8	8	8	8	8	8	40	40	40	20	8	4	32

[CCE] Comprehensive Continous Evaluation [20 Marks Distribution]

Exam Seat No.	Roll No.	Name of Student	Unit 1		Unit 2		Unit 3		Unit 4				Cumulative Sum			20 Marks Distribution			Marks obtained out
			Field Activity	Quiz	Field Activity	Quiz	Field Activity	Quiz	Field Activity	Quiz			Field Activity	Quiz	Internal Test	Field Activity	Quiz	Internal Test	
			A	B	C	D	E	F	G	H			SUM(A+C+E+G+I)	SUM(B+D+F+H+J)					
			10	10	10	10	10	10	10	10			50	50	100	10	5	5	20
S9970160753	2020	AMOGH SHINDE	8	8	8	8	8	8	8	8			32	32	40	6.4	3.2	2	11.6

Figure 1 Template Comprehensive Continuous Evaluation (CCE), Click here for excel Template

Field Activities / Home Assignments

Field activities and home assignments are essential components of experiential learning. Under this head, course projects, industrial visits, and guest lectures are to be incorporated. For each unit, one such activity should be designed and executed to reinforce theoretical learning through practical exposure.

1. **Course Projects**

   Course Projects should be framed based on real-world problems relevant to the subject. Each course project must be communicated through one of the following modes. It is recommended to complete all the communication modes across different course projects:

- **Poster Presentation**
- **PowerPoint Presentation**
- **Model Making**
- **Field or Survey Report with Oral Presentation** (e.g., case study)
- **Submission of Digital Content (e.g. Video Summary)**

To evaluate these field activities, **assessment rubrics** should be designed. The rubrics should include criteria such as clarity, innovation, subject relevance, presentation skills, and technical content.

Note: Part of work of any co-curricular activities (relevant to subject contents) like national level project competitions, club activities, paper presentations, startup activities can be accepted as a course projects.

2. **Industrial Visit**

   An industrial visit should be planned in alignment with the subject's scope and should particularly address advancements in the respective field. The purpose is to provide students exposure to actual engineering practices and systems.

Assessment of industrial visits should be carried out using any of the following tools:

- Quiz (based on the visit)
- Interactive video or oral discussion
- Submission of a detailed visit report

3. **Guest Lectures**

   Guest lectures should be relevant to the course and highlight advanced topics or recent trends in the field. Subject experts from academia or industry may be invited.

Assessment methods for guest lectures may include:

- Quiz conducted post-lecture
- Attendance monitoring
- Evaluation of attentiveness and participation

Rubrics can be developed, if possible, to objectively assess student involvement in guest lectures.

4. **Quiz**

Unit-wise quizzes should be planned and can be conducted either **online** (via LMS, Google Forms) or **offline**. Each quiz should include a **pool of 20 questions**, from which **students are required to attempt any 10**. The quizzes should be diversified across the following question types:

- Simple Multiple Choice Questions (MCQs)

- Numerical MCQs
- Image-based Questions
- Match the Following
- Fill in the Blanks
- Drag and Drop (using images or words)

This variety ensures the assessment caters to different cognitive skills and learning styles.

5. Internal Tests

Two major internal tests should be conducted as follows:

1. **Midterm Examination**: This should cover **Unit I and Unit II**, and should include questions targeting **Bloom's Taxonomy Levels 2, 3, and 4** (UNDERSTAND, APPLY, and ANALYZE).
2. **End term Examination**: This should cover the **remaining units** and should also include questions mapped to **BL Levels 2, 3, and 4**.

Mode 2:

Theory Examination: The theory examination shall be conducted in two different parts Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE). Comprehensive Continuous Evaluation (CCE) :

1. CCE of 40 marks based on all the Units of course syllabus to be scheduled and conducted at institute level.

2. To design a Comprehensive Continuous Evaluation scheme for a theory subject of 40 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr. No.	Parameters	Marks	Coverage of Units
1	Unit Test	16 Marks	Unit 1 & Unit 2 (8 Marks/Unit)
2	Assignments/Case Study	16 Marks	Unit 3 & Unit 4 (8 Marks/Unit)
3	Seminar Presentation/ Open Book Test/ Quiz	08 Marks	Unit 5

6. CCE of 20 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a CCE scheme for a theory subject of 20 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr. No.	Parameters	Marks	Coverage of Units
1	Unit Test	10 Marks	Unit 1 & Unit 2 (5 Marks/Unit)
2	Seminar Presentation/ Open Book Test/ Assignments/ Case Studies	10 Marks	Unit 3 & Unit 4 (5 Marks/Unit)

- **Unit Test–**

  Format: Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, and Create).

  Implementation: Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.

- **Sample Question Distribution**–
  1. Remembering (2 Marks): Define key terms related to [Topic from Units 1 and 2].
  2. Understanding (2 Marks): Explain the principle of [Concept] in [Context].
  3. Applying (2 Marks): Demonstrate how [Concept] can be used in [Scenario]
  4. Analyzing (3 Marks): Compare & contrast [Two related concepts] from Units 1 and 2
  5. Evaluating (3 Marks): Evaluate the effectiveness of [Theory/Model] in [Situation].
- **Seminar Presentation:–**

  Format: Oral presentation on a topic from Unit 5, followed by a Q&A session.–

  Deliverables: Presentation slides, a summary report in 2 to 3 pages, and performance during the presentation

  Implementation: Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.

- **Open Book Test:–**

  Format: Analytical and application-based questions to assess depth of understanding.–

  Implementation: Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5

- **Quiz :**–

  Format: Quizzes can help your students practice existing knowledge while stimulating in terest in learning about new topic in that course. You can set your quizzes to be completed individually or in small groups.

  Implementation: Online tools and software can be used create quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false etc

- **Example Timeline for conducting CCE:–**
  1. Weeks 1-4 : Cover Units 1 and 2

2. Week 5 : Conduct Unit Test (12 marks)
3. Weeks 6-8 : Cover Units 3 and 4
4. Week 9 : Distribute and collect Assignments / Case Study (12 marks)
5. Weeks 10-12 : Cover Unit 5
6. Week 13 : Conduct Seminar Presentations or Open Book Test or Quiz (6 marks)

• Evaluation and Feedback:–

1. Unit Test: Evaluate promptly and provide constructive feedback on strengths and areas for improvement.
2. Assignments / Case Study: Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.
3. Seminar Presentation: Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.
4. Open Book Test: Evaluate based on the depth of analysis and application of concepts. Provide feedback on critical thinking and problem-solving skills.

B) <u>End-Semester Examination (ESE)</u>

Detailed Scheme for 60 Marks: Unit-Wise Allocation (12 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

Detailed Scheme for 40 Marks: Unit-Wise Allocation (10 Marks per Unit) : Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation

Question Paper Design: The following structure is to be followed for designing an ESE for a **theory subject of 60 marks** covering **all 5 units** of the syllabus, with **questions set as per Bloom's Taxonomy** guidelines and **12 marks allocated per unit**.

2. Balanced Coverage

Ensure balanced coverage of all units with questions that assess different **cognitive levels of Bloom's Taxonomy**:

a) **Remembering**: Basic recall of facts and concepts.
b) **Understanding**: Explanation of ideas or concepts.
c) **Applying**: Use of information in new situations.
d) **Analyzing**: Drawing connections among ideas.

Curriculum Structure - Semester III

NEP 2020 Compliant Curriculum Structure

Second Year Engineering (2024 Pattern) Revised– Mechanical Engineering

Level 5.0															
Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			Theory	Practical	Tutorial	CCE*	End-Sem	Term work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
Semester III															
PCC201MEC	Major Course-1	Solid Mechanics	3			40	60	-	-	-	100	3			3
PCC202MEC	Major Course-2	Engineering Thermodynamics	3			40	60	-	-	-	100	3			3
PCC203MEC	Major Course-3	Engineering Materials & Metallurgy	3			40	60	-	-	-	100	3			3
PCC204MEC	Major Course-3A	Material Testing and characterization Lab		2					50		50			1	1
MDM221MEC	Multidisciplinary Course-1	Engineering Mathematics-III	3			40	60				100	3			3
MDM222MEC	Multidisciplinary Course-1A	Electrical/ Electronics And Computer Interfacing Technology Lab		2					50		50			1	1
	Open Elective	Open Elective-I	2			20	30	-	-	-	50	2			2
VSE231MEC	Vocational and Skill Enhancement Course	Workshop Practices		2					25		25			1	1
HSSM232MEC	Entrepreneurship/ Management course	Entrepreneurship Development and Innovation	1			25					25	1			1
VEC233MEC	Value Education Course	Universal Human Values	2			20	30				50	2			2
CEP241MEC	Community Engagement Project	Community Engagement Project		4				25		25	50			2	2
		Total	**17**	**10**		**225**	**300**	**25**	**125**	**25**	**700**	**17**		**5**	**22**

***CCE: Comprehensive Continuous Evaluation**

Note: Students can opt for Open Electives offered by different faculties such as Arts, Science, Commerce, Management, Humanities, or Inter-Disciplinary Studies.

- Example – Open Elective I: Students may choose courses like *Financial Accounting, Digital Finance*, or *Digital Marketing* from the Commerce and Management faculty.

Curriculum Structure - Semester IV

NEP 2020 Compliant Curriculum Structure

Second Year Engineering (2024 Pattern) Revised– Mechanical Engineering

Level 5.0															
Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			Theory	Practical	Tutorial	CCE*	End-Sem	Term work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
Semester IV															
PCC251MEC	Major Course-4	Fluid Mechanics	3			40	60	-	-	-	100	3			3
PCC252MEC	Major Course-5	Manufacturing Processes-I	3			40	60	-	-	-	100	3			3
PCC253MEC	Major Course-6	Applied Thermodynamics	3			40	60	-	-	-	100	3			3
PCC254MEC	Major Course-6A	Thermo- Fluid Engineering Lab I		2					50		50			2	2
MDM271MEC	Multidisciplinary Course-II	Artificial Intelligence and Machine Learning	2			50					50	2			2
	Open Elective	Open Elective-II	2			20	30	-	-	-	50	2			2
VSE281MEC	Vocational and Skill Enhancement Course	Solid Modeling and Drafting		2					50		50			1	1
VSE282MEC	Vocational and Skill Enhancement Course	Data Science & AIML		2					50		50			1	1
AEC283MEC	Ability Enhancement Course	Modern Indian Language: 02		2	1			50			50		1	1	2
HSSM284MEC	Entrepreneurship/ Management course	Engineering Economics and Financial Management	2			50					50	1			1
VEC285MEC	Value Education Course	Environmental Science and Sustainable Development	2			20	30				50	2			2
		Total	**17**	**8**	**1**	**260**	**240**	**50**	**150**	**0**	**700**	**16**	**1**	**5**	**22**

Note: Students can opt for Open Electives offered by different faculties such as Arts, Science, Commerce, Management, Humanities, or Inter-Disciplinary Studies.

- Elective II: Courses like *Project Management*, *Business Analytics*, or *Financial Management* can be opted from Inter-Disciplinary Studies, Commerce, and Management faculties, respectively.

***CCE: Comprehensive Continuous Evaluation**

Important Note: Min.1 to Max.2 hrs. per batch of (20-25 students) to be assigned for ***CCE** and to be considered in teaching load of concerned faculty. (Only applicable for Mode -1)

Savitribai Phule Pune University, Pune

Maharashtra, India

SE - Mechanical Engineering (2024 Pattern) Revised

Semester III Courses

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC–201–MEC: Solid Mechanics

Teaching Scheme		Credit	Examination Scheme	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End-Semester**	**60 Marks**

Prerequisite Courses, if any:

- Engineering Mathematics, Engineering Mechanics, Engineering Physics

Course Objectives:

1. To ACQUIRE basic knowledge of stress, strain due to various types of loading.
2. To DRAW Shear Force and Bending Moment Diagram for transverse loading.
3. To DETERMINE Bending and Shear stress.
4. To DETERMINE the Torsional shear stress for shaft and Buckling of column.
5. To APPLY the concept of Principal Stresses and Theories of Failure.

Course Outcomes:

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

CO1. INVESTIGATE various types of stresses and strain developed on determinate and indeterminate members.

CO2. CALCULATE Shear force and bending moment for various types of transverse loading and support.

CO3. COMPUTE the bending stresses and shear stresses on a beam.

CO4. DETERMINE torsional shear stress in shaft and buckling on the column.

CO5. APPLY the concept of principal stresses and theories of failure to determine stresses on a 2-D element

Course Contents

Unit I	Simple Stresses & Strains	(08 Hours)

Simple Stress & Strain: Introduction to types of loads (Static, Dynamic & Impact Loading) and various types of stresses with applications, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, Stress-strain diagram for ductile and brittle materials, factor of safety, Stresses and strains in determinate and indeterminate beam, homogeneous and composite bars under concentrated loads, self-weight (only theory part), Thermal stresses in plane and composite members.

Real World Assignment

Activities on effect of various types of loads, stresses with applications, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity

Activity I: - Measure Young's modulus of elastic material.

Activity II:-Measure Poisson's ratio of a unidirectional stretched material.

Activity III: - Determining negative Poisson's ratio and study its various applications

Exemplars / Practical Applications

Stresses in shaft, wires, beams, pressure vessels etc. In structural domain like truss; fabrication of the material, In aerospace and automobile: sandwich core implementation for light structure with high strength; In mechanical engineering: automotive component characterization.

Unit II	Shear Force & Bending Moment Diagrams	(07 Hours)

SFD & BMD: Introduction to SFD, BMD with application, SFD & BMD for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load, couple and combined loading, Relationship between rate of loading, shear force and bending moment, Concept of zero shear force, Maximum bending moment, point of contra-flexure.

Real World Assignment

Activities on SFD & BMD with considering practical applications

Activity I :- Comparison of Shear Force and Bending Moment for various types of loads.

Activity II:- Graphical representation of Shear Force and Bending Moment of a Vehicle Chassis and Axle

Activity III:- Comparison of Shear Force and Bending Moment for various types of supports

Exemplars / Practical Applications

Design of shaft, chassis, axle, wind turbine blade, towers, bridges etc.

Unit III	**Bending & Shear Stresses**	**(07 Hours)**

Bending Stress on a Beam: Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, derivation of flexural formula, Moment of inertia of common cross section (Circular, Hollow circular, Rectangular, I & T), Bending stress distribution along the same cross-section

Shear Stress on a Beam: Introduction to transverse shear stress on a beam with application, shear stress distribution diagram along the Circular, Hollow circular, Rectangular, I & T cross-section

Real World Assignment

1. Activities on slope & deflection on a beam: Introduction to slope & deflection on a beam with application, slope,
2. Deflection and Radius of Curvature, Macaulay's Method, Slope and Deflection for all standard beams

Activity I:- Evaluation of slope and deflection for beam under various load as well as supports.

Activity II:-Verification of deflection of beam using flexural formula and dial gauge.

Activity III:- Visualize beam deflection using suitable software for various load and support.

Exemplars / Practical Applications

1. Propeller shaft, earthmovers, railway tracks section analysis, cranes support design, beam Bending, tower cranes etc

Unit IV	**Torsion & Buckling**	**(07 Hours)**

Torsion of circular shafts: Introduction to torsion on a shaft with application, Basic torsion formulae and assumption in torsion theory, Torsion in stepped and composite shafts, Torque transmission on strength and rigidity basis, Torsional Resilience

Buckling of columns: Introduction to buckling of column with its application, Different column conditions and critical, safe load determination by Euler's theory. Limitations of Euler's Theory.

Real World Assignment

1. Activities on torsion on thin-walled tubes: Introduction of Torsion on Thin-Walled Tubes Shaft and its application.

   Activity I:-Analyse the torsion in thin-walled tubes by applying twisting moment.

   Activity II:- Measure the effects of bending and shear on shaft by applying twisting moment

   Activity III:- Measure buckling of column under different end conditions.

Exemplars / Practical Applications

1. **Buckling load:** Brackets, support members like, staircase, hoardings panels,
2. **Torsion:** Automobile drive shafts, industrial machinery shafts under high torsional and buckling load

Unit V	**Principal Stresses, Theories of Failure**	**(07 Hours)**

Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses

Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory (only theory part), Maximum strain energy theory (only theory part).

Real World Assignment

Activities on Application based combined loading & stresses (Based on load and stress condition studied in Unit I to Unit IV)

Activity I:-Analyzing combined loading problem in real-world structural applications.

Activity II:- Analyzing eccentrically loaded sign boards (hoardings) for combined loading.

Activity III:-Analyze mobile/high transmission tower against self-weight and wind pressure.

Exemplars / Practical Applications

1. Design against seismic loading, mobile and high transmission tower design, knuckle joints, toggle jack, crank shaft under different stresses etc

Learning Resources

Text Books:

1. R. K. Bansal, “Strength of Materials”, Laxmi Publication
2. S. Ramamurtham, “Strength of material”, Dhanpat Rai Publication
3. S.S. Rattan, “Strength of Material”, Tata McGraw Hill Publication Co. Ltd.
4. S S Bhavikatti, “Strength of Material”, Vikas publishing house Pvt Ltd
5. Singer and Pytel, “Strength of materials”, Harper and row Publication
6. R. C. Hibbeler, “Mechanics of Materials”, Prentice Hall Publication
7. R. S. Khurmi, “Strength of Materials”, S. Chand Publication

Reference Books:

1. Egor. P. Popov, “Introduction to Mechanics of Solids”,Prentice Hall Publication
2. G. H. Ryder, “Strength of Materials”, Macmillan Publication
3. Beer and Johnston, “Strength of materials”, CBS Publication
4. James M. Gere, “Mechanics of Materials”, CL Engineering
5. Timoshenko and Young, “Strength of Materials”, CBS Publication, Singapore

MOOC / NPTEL/ YouTube Links: -

1. Prof. S.K. Bhattacharyya, IIT Kharagpur , “NPTEL Web course material” https://drive.google.com/file/d/1N2Eyv9ofPimIT2OSMZeMrSxe68Ulclei/view?usp=sharing

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC-202-MEC: Engineering Thermodynamics

Teaching Scheme		Credit	Examination Scheme	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End-Semester**	**60 Marks**

Prerequisite Courses, if any:

- Higher Secondary Science Courses, Engineering Physics, Engineering Mathematics–I and II

Course Objectives:

1. To INTRODUCE the fundamental concepts of thermodynamics.
2. To UNDERSTAND the laws of thermodynamics.
3. To be ACQUAINTED with the concept of entropy and availability.
4. To UNDERSTAND the behavior of a pure substance and analyze vapour power cycles.
5. To UNDERTAKE the performance analysis of a steam generator

Course Outcomes:

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

CO 1: DESCRIBE the basics of thermodynamics with heat and work interactions.
CO 2: APPLY the second law of thermodynamics to steady flow and non-flow processes.
CO 3: APPLY the concept of entropy and availability for an open and closed system.
CO 4: ANALYSE the performance of a vapour power cycle with working mediums a pure substance.
CO 5: DEMONSTRATE the performance of steam generators.

Course Contents

Unit I	Fundamentals and First Law of Thermodynamics	(07 Hours)

Fundamentals of Thermodynamics: Introduction, Review of basic definitions, Zeroth law of Thermodynamics, Macro and Microscopic Approach, State Postulate, State, Path, Process and Cycles, Point function and Path function, Quasi-static process, Equilibrium, Thermocouples: Type, working principle and applications

First Law of Thermodynamics: Concept of heat and work, Sign convention and its conversion. First law of thermodynamics, Joules experiments, (Field Assignment), Equivalence of heat and work. Application of first law to flow and non-flow Processes and Cycles. Steady flow energy equation (SFEE), Applications of SFEE to devices such as Nozzle, Turbine, Compressors, Boilers and Heat Exchangers; especially condensers and evaporators, PMM-I kind. (Numerical on SFEE).

Real World Assignment

1. **Application of SFEE in a Hair Dryer**
   Activity: Measure temperature and airflow before and after heating in a hair dryer.
   Concepts Covered: Application of the steady flow energy equation (SFEE) to real-world devices

Exemplars / Practical Applications

- Power Plants, Automotive, Aerospace Engineering and HVAC Systems.
- Process Engineering, Mechanical System Design.

Unit II	Ideal Gas Equations and Second Law of Thermodynamics	(07 Hours)

Ideal Gas Equations: Ideal Gas definition, Gas Laws: Boyle's law, Charle's law, Avogadro'sLaw, (Field Assignment) Equation of State, Ideal Gas constant and Universal Gas constant, Ideal gas Processes-on P-v and T-s diagrams, Constant Pressure, Constant Volume, Isothermal, Adiabatic, Polytrophic, Throttling Processes (Open and Closed systems), Calculations of Heat transfer, Work done, Internal Energy (Numerical).

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, Heat Engine, Refrigerator and Heat pump: Schematic representation, Efficiency and Coefficient of Performance

(COP), Kelvin-Planck & Clausius Statement of the Second law of Thermodynamics; PMM-II kind, Equivalence of the two statements (Numerical).

Real World Assignment

1. Air Expansion in a Balloon
   - Activity: Observe pressure-volume changes by inflating a balloon in a heated vs. cold environment.
   - Concepts Covered: Ideal gas law, Boyle's law, Charles's law

Exemplars / Practical Applications

Refrigeration and Air Conditioning, Compressors. Heat Engine, Heat Pump.

Unit III	**Entropy and Availability**	**(07 Hours)**

Entropy: Clausius Inequality, Concept of Reversibility and Irreversibility, Entropy as a property, Principle of increase of Entropy, Entropy changes for an Open and Closed System, (Field Assignment) Change of Entropy for an ideal gas (Numerical).

Availability: Available and Unavailable Energy, Concept of Availability, Availability of heat source at constant temperature and variable temperature, Availability of non-flow and steady-flow Systems(No Numerical Treatment)

Real World Assignment

1. Entropy
   - Entropy in arranging student serially
   - Entropy in sorting-colored chalks
   - Entropy in Paper Distribution as per sets (set A, B, C) to students serially.
   - Entropy in Arranging Books on a Shelf
2. Availability in a Cup of Hot Coffee
3. Problem-Solving Task (Quantitative Analysis)
4. Real-World Connection (Critical Thinking & Creativity)

Exemplars / Practical Applications

1. **Thermodynamics (Heat Engines):** Entropy is used to analyze the efficiency of heat engines, helping engineers understand the limits of energy conversion, such as in the Carnot cycle.
2. **Refrigeration Systems:** Entropy helps assess the energy dissipation in refrigeration cycles, guiding the design of more efficient cooling systems. .
3. **Heat Recovery and Waste Energy Utilization:** Availability is key in designing systems to recover and use waste heat, increasing the overall efficiency of energy systems.

Unit IV	**Properties of Pure substances & Vapour Power Cycle**	**(07 Hours)**

Properties of Pure substances: Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of p-v, T-s and h-s plots (Mollier Chart) for steam, Dryness fraction and its determination using combined separating and throttling calorimeter, Change of properties, work transfer and heat transfer in Non-flow and Steady flow vapour processes.

Vapour Power Cycle: Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, (Field Assignment)Introduction to Steam power Plant, Efficiency of Rankine Cycle, Effect of Varying operating parameters like Superheat, Boiler and Condenser Pressure on performance of Rankine cycle, Modified Rankine Cycle. (Numerical on Carnot cycle and Rankine cycle only).

Real World Assignment

1. Homemade Rankine Cycle with Waste Heat
   - Design a closed system Rankine cycle using small electric boilers and turbines.
   - Multidisciplinary: Energy Systems, Thermodynamics.
2. Steam Pressure and Temperature Measurement in Domestic Pressure Cooker
   - Measure and analyze changes, plotting Mollier charts manually.
   - Multidisciplinary: Thermodynamics, Measurement.

3. AI Prediction of Steam Consumption in Small Turbine System (Simulation)
    - AI model to predict performance based on temperature-pressure data.
    - Multidisciplinary: AI, Thermodynamics.

Exemplars / Practical Applications

1. Essential in steam quality measurement for power generation industries.
2. Used in steam cycles and industrial boilers for energy optimization.

Unit V	**Steam Generators & Boiler Draught**	**(07 Hours)**

Steam Generators: Classification, Introduction to IBR Act, Non-IBR boilers, Fire tube and water tube boilers, Low pressure boilers - Cornish & Locomotive, High pressure boilers- Babcock &Wilcox, LaMont, Boiler mountings and accessories.

Boiler Performance Calculations: Equivalent Evaporation, Boiler efficiency, Heat balance Sheet. (Numerical). Boiler Draught: Classification, Necessity of Draught, Natural draught, Determination of Height of chimney, Diameter of chimney, condition for maximum discharge, Forced draught, Induced draught, Balanced draught, Draught losses (Field Assignment). (No Numerical Treatment)

Real World Assignment

Debate or Poster Presentation

Comparing Fire-Tube and Water-Tube Boilers

- **Activity:** Analyze diagrams/models of fire-tube and water-tube boilers and discuss efficiency.
- **Concepts Covered**: Boiler classification, heat transfer.

Exemplars / Practical Applications

1. Used in the power plant for heat generation.
2. Used in Multiple industries like automobile, pharmaceutical, dairy products

Learning Resources

Text Books:

1. P. K. Nag, “Engineering Thermodynamics”, Tata McGraw Hill Publications.
2. R. K. Rajput, “Engineering Thermodynamics”, EVSS Thermo, Laxmi Publications.
3. P. L. Ballaney, “Thermal Engineering”, Khanna Publishers.
4. C.P. Arora, “Thermodynamics”, Tata McGraw Hill.
5. Domkundwar, Kothandaraman and Domkundwar, “Thermal Engineering”, Dhanpat Rai Publishers.
6. M. M. Rathore, “Thermal Engineering”, Tata McGraw-Hill

Reference Books:

1. Rayner Joel, “Basic Engineering Thermodynamics”, AWL-Addison Wesley
2. Cengel and Boles, “Thermodynamics an Engineering Approach”, McGraw-Hill
3. G.Van Wylen, R. Sonntag and C. Borgnakke, “Fundamentals of Classical Thermodynamics”, John Wiley & Sons
4. Holman J.P., “Thermodynamics”, McGraw Hill
5. M. Achuthan, “Engineering Thermodynamics”, PHI
6. Steam Tables/Data Book

MOOC / NPTEL/ YouTube Links: -

1. https://www.youtube.com/watch?v=GMBpZZtjXM&list=PLDEBABBC
2. https://www.youtube.com/watch?v=pMmHdWvN_FI&list=PLyqSpQzTEM_QOKxVxZnQgOkzgzWP
3. https://www.youtube.com/watch?v=LPQXF-GoA&list=PLwdnzlVogoWV-nYItOMxgPXfEiM
4. https://www.youtube.com/watch?v=WgAaVHWEjw&list=PLpekhDcoNDSxcDCCoObBEgVKIwWVZ

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC-203-MEC: Engineering Materials & Metallurgy

Teaching Scheme		Credit	Examination Scheme	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End-Semester**	**60 Marks**

Prerequisite Courses, if any:

- Higher Secondary Science courses, Engineering Physics, Engineering Chemistry

Course Objectives:

1. To IMPART fundamental knowledge of material science and engineering.
2. To ESTABLISH significance of structure property relationship.
3. To EXPLAIN various characterization techniques.
4. To INDICATE the importance of heat treatment on structure and properties of materials.
5. To EXPLAIN the material selection process.

Course Outcomes:

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

CO1. COMPARE crystal structures and ASSESS different lattice parameters.
CO2. CORRELATE crystal structures and imperfections in crystals with mechanical behavior of materials.
CO3. DIFFERENTIATE and DETERMINE mechanical properties using destructive and nondestructive testing of materials.
CO4. IDENTIFY & ESTIMATE different parameters of the system viz., phases, variables, component, grains, grain boundary, and degree of freedom. etc.
CO5. ANALYSE effect of alloying element & heat treatment on properties of ferrous & nonferrous alloy.
CO6. SELECT appropriate materials for various applications

Course Contents

Unit I	Crystal Structures, Materials Properties and Characterization Techniques	(08 Hours)

Crystal Structures: Introduction to crystal structure, Miller indices, Crystal imperfections, and Diffusion Mechanisms, introduction to Material Properties, Destructive Testing: Impact test, Cupping test, Non-**Destructive Testing**: Eddy current test, Sonic, Ultrasonic testing, X-ray Radiography testing (Principle and Applications only)

Microscopic Techniques: Sample Preparation and etching procedure, optical microscopy, Electronic microscopy - only SEM, TEM and X-ray diffraction (Principle and Applications only)

Macroscopy: Sulphur printing, flow line observation, spark test

Real World Assignment

Prepare a report on material : major application, compatibility for the application (considering strength, Conductivity, corrosion resistance, mechanical, electrical, or thermal properties), crystal structure, List and explain key properties (e.g., hardness, tensile strength, conductivity, brittleness, ductility), Relate these properties to the crystal structure or defects (dislocations, grain boundaries), Hardness test comparison.

Exemplars / Practical Applications

surface microstructure analysis, flaws in materials without damage, field equipment identification

Unit II	Phase Diagrams and Iron-Carbon Diagram	(07 Hours)

Solid solutions: Introduction, Types, Humerothery rule for substitutional solid solutions

Solidification: Nucleation, crystal growth, solidification of pure metals and alloys.

Phase Diagrams: Cooling curves, types of phase diagrams, Gibbs phase rules

Iron-Carbon Diagram: Iron-carbon equilibrium diagrams in detail with emphasis in the invariant reactions.

Real World Assignment

Iron-Carbon Phase Diagram Analysis, Microstructural Changes

Exemplars / Practical Applications

Alloy Design in Aerospace and Automotive Industry, Casting and Metal Forming Industries, Heat Treatment Processes in Tool and Die Industry

Unit III	Heat Treatments	(07 Hours)

Austenite transformation in steel: Time temperature transformation diagrams, continuous cooling transformation diagrams. Retained austenite and its effect, Steps in Heat Treatment and Cooling Medium,

Heat Treatment Processes: Introduction, Annealing (Full annealing, Process annealing, Spheroidise annealing, isothermal annealing, stress relief annealing), Normalizing, Hardening, Tempering, Austempering, Martempering, Sub-Zero Treatment, Hardenability

Surface Hardening: Classification, Flame hardening, Induction hardening, Carburizing, Nitriding, Carbonitriding

Real World Assignment

Heat Treatment Process Overview, making of iron and steel, Industrial applications, Automobile sectors, Power Plants, Aerospace, and Marine Industries.

Exemplars / Practical Applications

Tool and Die Manufacturing, Bearing and Gear Industries, Automotive Component Production

Unit IV	Ferrous Materials	(07 Hours)

Carbon Steel: Classification, types & their composition, properties and Industrial application

Alloy Steels: Classification of alloy steels & Effect of alloying elements, examples of alloy steels, (Stainless steel, Tool steel) sensitization of stainless steel ,Designation of carbon steel and alloy steels as per IS, AISI, SAE Standards

Cast Iron: Classification, types; their composition, properties and Industrial application of (White CI, Gray CI, SG CI, Malleable Cast and alloy Cast Iron) Microstructure and property relationship of various ferrous Materials

Real World Assignment

Material Identification, Material Properties, Processing and Manufacturing, Advantages & Limitations [Mild Steel, Medium & High Carbon Steel, Cast Iron, Stainless Steel, Tool Steel, Alloy Steel (e.g., 4140, 4340)].

Exemplars / Practical Applications

Manufacturing engine parts, chassis components, and tools requiring wear resistance and toughness.

Unit V	Non-Ferrous Materials	(07 Hours)

Classification of Non-Ferrous Metals: Study of Non-ferrous alloys with Designation, Composition, Microstructure.

Mechanical & other properties for Industrial Applications: Copper and its Alloys (Gilding Metal, Cartridge Brass, Muntz Metal, Tin Bronze, Beryllium Bronze), Aluminium and its Alloy (LM5, Duralumin, Y-Alloy, Hinduminum), Nickel and its Alloys (Invar, Inconel), Titanium and its Alloys (Classification, lead based alloys, tin based alloys), Age Hardening.

Microstructure and Property relationship of various Non-ferrous Materials. Recent Material used in **Additive Manufacturing**: Properties, Composition and Application only

Real World Assignment

Material Overview, Real-Life Product or Component, Key Properties, Processing Methods, Advantages vs. Limitations

Exemplars / Practical Applications

Electrical wiring, connectors, and circuit boards

Learning Resources

Text Books:

1. Dr. V. D. Kodgire & S. V. Kodgire, "Material Science & Metallurgy For Engineers", Everest Publication.
2. William D. Callister, "Materials Science and Engineering an Introduction", Jr, John Wiley & Sons, Inc

Reference Books:

1. A. K. Bhargava, C.P. Sharma, "Mechanical Behaviour & Testing of Materials", P H I Learning Private Ltd.
2. Raghvan V., "Material Science & Engineering",Prentice Hall of India, New Delhi. 2003
3. Avner, S.H., "Introduction to Physical Metallurgy", Tata McGraw-Hill, 1997.
4. Higgins R. A., "Engineering Metallurgy", Viva books Pvt. Ltd.
5. George Ellwood Dieter, "Mechanical Metallurgy", McGraw-Hill 1988
6. Smith, W.F, Hashemi, J., and Prakash, R., "Materials Science and Engineering in SI Units", Tata McGraw Hill Education Pvt. Ltd

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/113/104/113104096/
2. https://archive.nptel.ac.in/courses/113/105/113105024/
3. https://archive.nptel.ac.in/courses/113/102/113102080/

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC-204-MEC: Material Testing and Characterization Lab

Teaching Scheme		Credit	Examination Scheme	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses, if any:

- Engineering Mechanics, Manufacturing processes workshop, Engineering Chemistry

Course Objectives:

1. To ACQUIRE basic knowledge of stress, strain due to various types of loading for different types of materials
2. To DRAW Shear Force and Bending Moment Diagram for transverse loading and to DETERMINE Bending, Shear stress, Slope and Deflection on Beam.
3. To IMPART fundamental knowledge of material science and engineering and to ESTABLISH significance of structure property relationship.
4. To INDICATE the importance of heat treatment on structure and mechanical properties of materials.
5. To EXPLAIN the material selection process
6. To UTILIZE the concepts of Solid Mechanics and Engineering Materials on application based combined mode of loading and failures

Course Outcomes:

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

CO1: DETERMINE various types of stresses and strain developed on determinate and indeterminate members.

CO2: CALCULATE Shear force and bending moment for various types of transverse loading and Support and COMPUTE the slope & deflection, bending stresses and shear stresses on a beam.

CO3: EXAMINE micro structures and different phases also LINK phase distribution with mechanical properties of materials.

CO4: DIFFERENTIATE and TEST mechanical properties using destructive and nondestructive methods

CO5: CATAGORIZE and RECOMMNOD appropriate materials for various applications.

CO6: UTILIZE the concepts of SFD & BMD, principal stresses, heat treatment and microstructure to SOLVE combined loading application-based problems virtually IoT based tools

List of Practical's

Experiment 01

1. Validation of experimental results of Tension and Compression tests using ductile and brittle (Comparison of other materials stress strain plots with tested samples. materials (Compare and conclude on failure behavior using experiment results graph)
2. Comparison of other materials stress strain plots with tested samples

Exemplars / Practical Applications

Aerospace Industry: Validation of aircraft structural components (e.g., wing spars, fuselage frames). Automotive Engineering: Crashworthiness and durability of vehicle frames and body panels

Experiment 02

1. Experimental verification of flexural formula in bending for cantilever and simply supported beam using strain gauges.
2. Case study on cantilever and simply supported structures and their failure.

Exemplars / Practical Applications

Quality Control in Beam Manufacturing (Steel, Aluminum, Concrete): Testing - standard beam sections (e.g., I-beams, T-beams) to verify mechanical properties before deployment. Design Validation in Mechanical Engineering Structures: Used in verifying the stress/strain profile in machine components like

support arms, robotic limbs, or levers.

Experiment 03

1. Conduction of torsional/ shear test on ductile material
2. Case study on part failure under torsion/shear

Exemplars / Practical Applications

Design and Validation of Shafts in Mechanical Systems: Drive shafts, crankshafts, camshafts, and axles in vehicles and machines Fastener and Threaded Component Testing: Bolts, screws, and threaded rods Automotive Powertrain and Steering Component Analysis: Torsion bars, drive shafts, steering knuckles

Experiment 04

1. Impact Test for Steel, Aluminum, Brass and Copper(Charpy/Izod)
2. Failure case studies under impact loading of any one material on which trials conducted

Exemplars / Practical Applications

Quality Control in Structural Steel Fabrication: Steel used in Bridges, high-rise buildings, offshore platforms Crashworthiness in Automotive Components: Aluminum, Steel, Brass used in Bumpers, crash zones, engine mounts, control arms

Experiment 05

1. Test of Creep, Fatigue and Fluorescence Microscope using simulator
2. Case studies of any one tested

Exemplars / Practical Applications

Creep Testing (Using Simulators): Turbine Blades in Jet Engines and Power Plants, Boiler Tubes and Steam Pipes Fatigue Testing (Using Simulators): Aircraft Wings and Fuselage Panels, Automotive Suspension and Chassis, Railway Tracks and Wheels Fluorescence Microscopy (Using Simulators): Material Science (Fluorescent Dye Penetrant)

Experiment 06

1. Material Hardness measurement using Brinell's / Vicker's / Rockwell / Poldi's Hardness testing set up. Test samples should be before and after case harden and core harden heat treatment
2. Visit to heat treatment plant/lab for hardening process.

Exemplars / Practical Applications

Quality Control in Gear Manufacturing: Test Sample: Steel gears before and after case hardening Inspection of Automotive Components (Camshafts, Crankshafts): Forged shafts after core hardening and induction hardening Heat Treatment Verification in Structural Steel Plates and Beams: Steel plate samples before and after quench and temper

Experiment 07

1. Analysis of given sample using any one of the Non-destructive tests: Dye Penetrant Test/ Magnetic Particle test/ Ultrasonic Test.
2. Samples can be collected from various failures occurring with automobiles, machine parts, household appliances, etc and analysis of parts failed.

Exemplars / Practical Applications

Dye Penetrant Test (DPT) – For Surface Crack Detection: Inspection of Welded Joints in Pressure Vessels Magnetic Particle Test (MPT) – For Surface & Near-Surface Flaw: Rail Axle and Wheel Shaft Inspection made up of Ferromagnetic materials like carbon steel ,Ultrasonic Test (UT) – For Internal Defect Detection: Inspection of Structural Steel in Bridges

Experiment 08

1. Interpretation and Drawing of Microstructures of Ferrous (Steel, cast iron) and Non-ferrous materials (Aluminum, nickel) of various compositions. Identified microstructures can be used for interpretation of material compositions
2. Visit to test lab for Reading and interpretation of standard material test report (certificate) of ferrous and non-ferrous materials (These test reports can be availed from Workshop, Industry)

Exemplars / Practical Applications

FERROUS MATERIALS: Low Carbon Steel (<0.25% C) - Ferrite + small amount of pearlite, Medium Carbon Steel (0.25–0.6% C) - Increased pearlite + ferrite, High Carbon Steel (>0.6% C) - Predominantly pearlite with some cementite, Gray Cast Iron - Graphite flakes in a pearlitic or ferritic matrix, White Cast Iron -Cementite and pearlite, no graphite

Experiment 09

1. Case study on material selection considering functional and environmental requirements
2. Identify various ASTM standards used or required in this case study and make comprehensive report of it

Exemplars / Practical Applications

Bicycle Frame Design for Urban Commuters : Functional Requirements: Lightweight, Corrosion resistant, Affordable Environmental Requirements: Recyclable material, Low manufacturing emissions Material Chosen: Aluminum, bamboo, or recycled steel: Sustainable transport, green mobility programs

Automotive Body Panel Design: Functional Requirements: High strength-to-weight ratio, good formability and crash resistance, Corrosion resistance Environmental Requirements: Low CO_2 footprint during production, Recyclability at end-of-life Material Chosen: Aluminum alloy or advanced high-strength steel (AHSS) : Used by companies like Ford and BMW in lightweight vehicle design

Wind Turbine Blade Material: Functional Requirements: High fatigue strength, Lightweight, Weather and UV resistance Environmental Requirements: Low embodied energy, Possibility for recyclable or bio-based composites Material Chosen: Glass fiber-reinforced polymer (GFRP) with epoxy or bio-resins: Used in offshore and onshore wind farms

Experiment 10

1. Conduction of any one test on VLab from the list: Tensile Test on Mild steel, Tensile Test on Cast Iron, Compression Test on Mild Steel, Compression Test on Cast Iron, Direct shear test on Mild steel Rod, Direct Shear test on Timber Specimen, Direct shear test on Mild steel Plate, Bending Test on Mild steel, Torsion Test on Mild Steel, flexural formula in bending for simply supported and cantilever beam, stress strain measurement through strain gauge, torsion formula for bar, flexural formula validation through other software.
2. Each student should have different load condition and case study of failure of such loading condition.

*** All destructive and non-destructive tests shall be performed as per applicable ASTM / BIS standards

Learning Resources

Text Books:

1. S. Ramamurtham, “Strength of material”, Dhanpat Rai Publication
2. S.S. Rattan, “Strength of Material”, Tata McGraw Hill Publication Co. Ltd.
3. R. K. Bansal, “Strength of Materials”, Laxmi Publication
4. Dr. V. D. Kodgire & S. V. Kodgire, “Material Science & Metallurgy For Engineers”, Everest Publication.
5. William D. Callister, “Materials Science and Engineering an Introduction”, Jr, John Wiley & Sons, Inc

Reference Books:

1. G. H. Ryder, “Strength of Materials”, Macmillan Publication
2. James M. Gere, “Mechanics of Materials”, CL Engineering
3. George Ellwood Dieter, “Mechanical Metallurgy”, McGraw-Hill 1988
4. A. K. Bhargava, C.P. Sharma, “Mechanical Behaviour & Testing of Materials”, P H I Learning Private Ltd
5. Raghvan V., “Material Science & Engineering”,Prentice Hall of India, New Delhi. 2003

MOOC / NPTEL/ YouTube Links: -

Prof. S.K. Bhattacharyya, IIT Kharagpur , “NPTEL Web course material”
https://drive.google.com/file/d/1N2Eyv9ofPimIT2OSMZeMrSxe68Ulclei/view?usp=sharing

Savitribai Phule Pune University Second Year of Mechanical Engineering (2024 Pattern) Revised				
MDM-221-MEC: Engineering Mathematics-III				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End-Semester**	**60 Marks**

Prerequisite Courses, if any:

- Differential & Integral calculus, Differential equations of first order & first degree, Fourier series, Collection, classification and representation of data and Vector algebra.

Course Objectives:

1. To familiarize the students with concepts and techniques in Ordinary differential equations, Statistical methods, Probability theory, Numerical Methods and Vector calculus. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines

Course Outcomes:

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

CO1: **SOLVE** higher order linear differential equations and its applications to model and analyze mass spring systems.

CO2: **APPLY** Statistical methods like correlation, regression in analyzing and interpreting experimental data applicable to reliability engineering and probability theory in testing and quality control.

CO3: **SOLVE** Algebraic & Transcendental equations and System of linear equations using numerical techniques.

CO4: **OBTAIN** Interpolating polynomials, numerical differentiation and integration, numerical solutions of ordinary differential equations used in modern scientific computing applicable to Mechanical engineering.

CO5: **PERFORM** Vector differentiation & integration, **ANALYZE** the vector fields and **APPLY** to fluid flow problems.

Course Contents

Unit I	**Linear Differential Equations (LDE) and Applications**	**(07 Hours)**

LDE of nth order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous DE. Modelling of Mass-spring systems, Free & Forced damped and undamped systems

Real World Assignment

1. Modelling of Mass-spring systems, Free & Forced damped and undamped systems.
2. Determination of natural frequency and resonant analysis of mechanical systems using LDE.

Exemplars / Practical Applications

Electrical Circuit Analysis, Structural Engineering

Unit II	**Statistics & Probability**	**(08 Hours)**

Introduction to Data Science, Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis,

Correlation: Karl Pearson's correlation, Spearman's rank correlation, Regression analysis and Reliability of regression estimates.

Probability, Probability density function, and Central limit theorem, Probability distributions: Binomial, Poisson, Normal, and Test of hypothesis: Chi-square test and t- test

Real World Assignment

1. Analyze statistical features of experimental data/standard datasets in mechanical engineering applications.
2. Problem solving and decision making related to quality control, reliability engineering, and predictive maintenance using probability theory.
3. Implement problem solving using software such as C/C++/Python/MATLAB.

Exemplars / Practical Applications

Quality Control in Manufacturing, assess product reliability and failure rates for maintenance scheduling

Unit III	**Numerical methods for solving algebraic and transcendental equations**	**(08 Hours)**

Numerical Solution of Algebraic and Transcendental equations: Bisection, Secant, Regula-Falsi, Newton– Raphson and Successive Approximation Methods, Convergence and Stability.

Numerical Solutions of System of linear equations: Gauss elimination with partial pivoting, LU Decomposition, Jacobi and Gauss-Seidel Methods.

Real World Assignment

1. Numerical solution of applied to Newton's laws of motion, Heat & Mass transfer equations and thermodynamic processes.
2. Numerical solution of coupled mass spring systems
3. Implement problem solving using software such as C/C++/Python/MATLAB

Exemplars / Practical Applications

Engineering Design Optimization, Electrical Power System Analysis, Computational Fluid Dynamics (CFD), Control System Engineering, Finance and Economics Modeling

Unit IV	**Numerical Interpolation and solution of ODE**	**(08 Hours)**

Interpolation: Finite Differences, Newton's and Lagrange's Interpolation formulae, Numerical Differentiation.

Numerical Integration: Trapezoidal and Simpson's rules, Bound of truncation error.

Solution of Ordinary differential equations (ODE): Euler's, Modified Euler's, Runge-Kutta 4th order methods and Predictor-Corrector methods.

Real World Assignment

1. Obtain interpolating polynomial passing through equally or unequally spaced data points applicable to fluid flow problems and material properties.
2. Use of numerical integration to calculate areas volumes forces fluid mechanics, heat transfer and machine design.
3. Numerical solution of ODE to predict temperature profile and transient behavior in heat conduction analysis.
4. Implement problem solving using software such as C/C++/Python/MATLAB**.**

Exemplars / Practical Applications

Data fitting and curve estimation, Engineering simulations and modeling, Signal processing and image reconstruction, Numerical weather prediction, Control systems and robotics modeling

Unit V	**Vector Calculus**	**(08 Hours)**

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal & Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Real World Assignment

1. Obtain fluid flow behavior such as velocity fields, rotational motion and scalar potential field.
2. Compute work done, circulation and determination of fluid flow rate.

Exemplars / Practical Applications

Electromagnetic field analysis, Fluid dynamics and aerodynamics, Structural stress and strain analysis, Heat transfer and thermodynamics, Robotics and control system design

Learning Resources

Text Books:

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

Reference Books:

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
3. Differential Equations, 3e by S. L. Ross (Wiley India).
4. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press)
5. Steven C. Chapra, 'Applied Numerical Methods with MATLAB for Engineers and Scientist', (Tata Mc- Graw Hill Publishing Co. Ltd).
6. Jason Brownlee, 'Statistical Methods for Machine Learning', Machine learning Mastery.

MOOC / NPTEL/ YouTube Links: -

1. https://nptel.ac.in/courses/111107098/
2. http://nptel.ac.in/courses/111105041/
3. https://nptel.ac.in/courses/111107105/
4. https://nptel.ac.in/courses/111105122/

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

MDM-222-MEC: Electrical/ Electronics and Computer Interfacing Technology Lab

Teaching Scheme		Credit	Examination Scheme	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses, if any:

- Basics of Electrical and Electronics Engineering
- Fundamentals of Programming (C/C++ or Python)
- Engineering Physics

Course Objectives:

1. To INTRODUCE students to microcontroller programming and interfacing with digital and analog components.
2. To EQUIP students with skills for data acquisition and processing from various sensors (temperature, distance, etc.).
3. To TEACH students motor control techniques using microcontrollers for precise actuation and automation.
4. To ENABLE students to design and implement integrated systems that demonstrate real-world automation applications..

Course Outcomes:

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

CO1: IDENTIFY and DEMONSTRATE the use of microcontroller-based input/output interfacing techniques.

CO2: DEVELOP programs to acquire and process data from analog and digital sensors.

CO3: IMPLEMENT control strategies for actuators such as DC, stepper, and servo motors using microcontrollers.

CO4: DESIGN and INTEGRATE sensor-actuator systems to create basic automation projects

List of Experiments

Experiment 1	Introduction to Arduino and Digital I/O Control

Objective: To understand digital input/output operations by interfacing LEDs and push buttons with Arduino.

Task:

1. Connect LEDs and push buttons to Arduino.
2. Write a program to turn LEDs ON/OFF based on button press.
3. Observe the response on the Serial Monitor.

Exemplars

1. **Industrial Sensor Monitoring** – Reading digital signals from sensors to track machine or process status.
2. **Automated Machine Control** – Controlling actuators like motors and relays for automation tasks using digital outputs.

Experiment 2	Analog Sensor Interfacing (Temperature Sensor -LM35)

Objective: To interface the LM35 analog temperature sensor with Arduino and display the output on Serial Monitor or LCD

Task:

1. Connect LM35 to Arduino analog pin.
2. Write code to read and convert analog voltage to Celsius.
3. Display output on Serial Monitor or LCD.

Exemplars / Practical Applications

1. **Temperature Monitoring Systems** – Continuously measure and log ambient or equipment temperature in industrial environments.
2. **HVAC Control Systems** – Regulate heating, ventilation, and air conditioning based on real-time temperature readings**.**

Experiment 3	**Interfacing Potentiometer for Position Control Simulation**

Objective: To simulate position control by using a potentiometer as analog input to drive a servo motor.

Task:

1. Connect potentiometer to Arduino analog input and servo to PWM output.
2. Map the potentiometer values to servo angles.
3. Observe servo position change as potentiometer is rotated.

Exemplars

1. **Robotic Arm Position Control** – Simulate and control joint angles using potentiometer feedback.
2. **Motorized Valve Positioning** – Adjust and monitor valve positions in process control systems using potentiometer input.

Experiment 4	**Interfacing IR or Ultrasonic Sensor for Distance Measurement**

Objective: To measure distance using an ultrasonic sensor and display results on LCD or Serial Monitor

Task:

1. Connect HC-SR04 sensor to Arduino.
2. Write code to calculate distance using time of flight.
3. Display output in cm on LCD or Serial Monitor

Exemplars / Practical Applications

1. **Obstacle Detection in Automation Systems** – Detect objects or barriers in conveyor or robotic systems using distance sensors.
2. **Level Measurement in Tanks** – Measure fluid or material levels in storage tanks using non-contact distance sensing.

Experiment 5	**Controlling DC Motor Using Transistor Driver Circuit**

Objective: To control a DC motor's speed using PWM output from Arduino through a transistor driver circuit.

Task:

1. Connect DC motor through to Arduino.
2. Use analogWrite() to vary motor speed.
3. Implement a simple ramp-up or potentiometer-based speed control.

Exemplars / Practical Applications

1. **Conveyor Belt Speed Control** – Regulate the speed of DC motors driving conveyor belts in manufacturing lines.
2. **Cooling Fan Control in Equipment** – Control the operation of DC cooling fans based on temperature or system load.

Experiment 6	**Data Logging Using Arduino and Excel (Serial Communication)**

Objective: To log real-time sensor data from Arduino to a computer using PLX-DAQ or Python and visualize it

Task:

1. Write Arduino code to send temperature data from LM35 over serial.
2. Use Excel + PLX-DAQ or Python to capture and save the data.
3. Plot data over time (optional)

Exemplars:

1. **Industrial Process Monitoring** – Record sensor data like temperature, pressure, or humidity for analysis and quality control.
2. **Preventive Maintenance Tracking** – Log equipment usage data to predict and schedule maintenance activities**.**

Experiment 7	**Stepper Motor Control via Microcontroller**

Objective: To control the rotation and direction of a stepper motor using Arduino and a ULN2003 driver.
Task:

1. Connect stepper motor and driver to Arduino.
2. Write code to rotate motor clockwise and counter-clockwise.
3. Vary delay to change motor speed.

Exemplars / Practical Applications

1. CNC Machine Axis Control – Precisely control linear or rotary motion of machine tool axes using stepper motors.
2. 3D Printer Mechanism – Drive the print head and bed movement for accurate layer-by-layer fabrication

Experiment 8	**Mini Project – Interfacing a Mechanical System**

Objective: To design and implement a mini project using sensors and actuators interfaced with Arduino for a mechanical application.
Task:

1. Choose a mini project (e.g., line follower, fan control, smart gate).
2. Design circuit and write control code.
3. Demonstrate and document system functionality.

Exemplars

1. **Automated Sorting System** – Use sensors and actuators to sort products based on size, shape, or weight on a conveyor belt.
2. **Robotic Arm Control** – Interface a robotic arm with a microcontroller for tasks like assembly, pick-and-place, or material handling.
3. **Automated Packaging System** – Control mechanical systems for packaging items, including labeling, sealing, and stacking.
4. **Precision Manufacturing** – Integrate mechanical systems with sensors for precision machining or assembly in manufacturing lines.

(*Example provided above for understanding; you may choose any real-life application other than this)

Learning Resources

Text Books:

"Exploring Arduino: Tools and Techniques for Engineering Wizardry" by Jeremy Blum, Wiley

Reference Books:

1. "Getting Started with Arduino" by Massimo Banzi, Maker Media
2. "The 8051 Microcontroller and Embedded Systems" by Muhammad Ali Mazidi
3. "Programming Arduino: Getting Started with Sketches" by Simon Monk

MOOC / NPTEL/ YouTube Links: -

1. NPTEL: Introduction to Embedded Systems
2. Coursera: Interfacing with the Arduino
3. YouTube:
   a) Paul McWhorter Arduino Tutorial Series
   b) Microcontroller Series

Real World Problem Statements (Any One assignment)

1. **Design and implement a line-following robotic system** to automate material transportation in smart warehouses and delivery environments, enabling efficient and hands-free logistics management.
2. **Develop an automated object counting system** for packaging lines, capable of accurately tracking the number of products moving along a conveyor belt without manual supervision.
3. **Create an intelligent temperature-controlled fan system** suitable for industrial workshops or smart homes, designed to maintain optimal environmental conditions for enhanced comfort, productivity, and safety.

Savitribai Phule Pune University Second Year of Mechanical Engineering (2024 Pattern) Revised				
VSE-231-MEC: Workshop Practices				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**25 Marks**

Prerequisite Courses, if any:

- Manufacturing Processes
- Manufacturing Practice Workshop
- Engineering Physics, Chemistry
- Engineering Graphics
- Engineering Materials and Metallurgy

Course Objectives:

1. To DEVELOP an understanding of safety standards and precautions applicable in mechanical workshops, industries, and service centers ensuring a safe working environment.
2. To ENHANCE practical skills in machining and production processes by performing multi-operation jobs involving various manufacturing techniques such as turning, milling, drilling, and surface finishing.
3. To PROVIDE hands-on experience in metal joining and fabrication processes, including welding (TIG, MIG, and GAS welding), soldering, and brazing, along with the study of related defects.
4. To FAMILIARIZE students with casting and forging processes, including defect analysis, process simulation, and real-world applications through industrial visits.
5. To ENABLE students to perform material selection, process planning, and cost estimation for engineering components and assemblies, incorporating green manufacturing principles and a variety of materials.

Course Outcomes:

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

CO1. APPLY safety protocols effectively in mechanical workshop and related industrial environment to minimize risks and hazards.

CO2. DEMONSTRATE proficiency in machining operations and manufacturing processes through hands-on production of assembly jobs using appropriate machining parameters.

CO3. PERFORM welding and fabrication techniques to join similar or dissimilar metals, analyze defects, and understand the applications of different joining methods**.**

CO4. UNDERSTAND and EVALUATE casting and forging processes, identify casting defects, and utilize simulation tools or industrial visits to correlate theory with practical scenarios.

CO5. PREPARE comprehensive material selection and manufacturing plans for multi-component engineering products, including process sheets, machining calculations, and cost analysis aligned with sustainable manufacturing practices.

List of Experiments

Experiment 1	**02 hrs.**

Study and analyze the safety standards and safety measures implemented in various sections of a mechanical workshop, prepare informative posters or comprehensive reports.

Prepare a report/presentation on safety precautions in workshop/industry/power plants/service centers etc.

Exemplars / Practical Applications

Mechanical workshop layout planning, Machine tool safety implementation, Welding and fabrication safety management, Material handling and storage safety, Personal protective equipment (PPE) compliance and training

Experiment 2	**12 hrs.**

Production/machining of assembly job containing 2-3 components and suitable for assembly with standard

components viz. nut, screw, bearing etc. consisting at least 4-5 operations from the following list:

1. Raw material selection (Suitable for job in assignment)
2. Raw material preparation like hacksaw cutting, etc.
3. Rough turning on lathe/CNC
4. Rough milling on Milling machine or VMC viz. machining flats, gear cutting, keyways, etc.
5. Drilling/tapping/threading
6. Finishing on CNC/VMC (or combined operations from step 3 to 6 on CNC/VMC)
7. Surface finishing using Grinding/Polishing/Buffing, etc.
8. Surface treatment for corrosion/wear resistance, aesthetics, etc.

Students are expected to perform following activities under this experiment:

a) Selection of suitable Engineering material viz. ferrous/non-ferrous/non-metallic material available easily in market at least cost considering energy & environmental aspects of Green Manufacturing
b) Select appropriate form of material for job under consideration e.g. Casting/Forging/Round Bar/Hex Bar/Sheet metal/flats, etc. (Refer Machinery Handbook/Westermann Table, or any available reliable sources, etc.)
c) Plan machining using Process Sheets
d) Select appropriate machines, cutting tools & machining parameters viz. Cutting Speed (Vc m/min), feed (mm/rev or mm/minute) & Depth of Cut (DoC)
e) Calculate Machining Power requirement, Material Removal Rate (MRR) and resulting Surface finish using online machining calculators available on cutting tools manufacturers sites
f) Select appropriate surface finishing process for surface protection for Surface treatment/finishing of any component manufactured above processes using grinding/ cylindrical grinding / buffing/honing/ burnishing operation
g) Estimate material & machining costs

Experiment 3	**04 hrs.**

Fabrication of a component by joining two similar or dissimilar metals using TIG, MIG, or gas welding techniques.

a) Comparative study of soldering, brazing & welding processes and respective applications
b) Study of defects and case studies

Exemplars / Practical Applications

Automotive exhaust system fabrication, Aerospace frame assembly, Bicycle frame welding, Industrial piping and tubing fabrication, Custom metal furniture manufacturing

Experiment 4	**04 hrs.**

1. Manufacturing one engineering component using casting/forging in available workshop facilities of any engineering material like wax, tin, etc.

OR

1. Observe and demonstrate the manufacturing processes of castings and forgings during an industrial visit.
2. Casting considerations, study of defects in the cast product.
3. Demonstration of defects/temperature distributions using suitable mold flow analysis or equivalent simulations
4. Industrial visit report in case of demonstration

Exemplars / Practical Applications

Prototype component casting, Decorative metal item fabrication, Educational model making, Small gear or pulley forging, Custom bracket manufacturing

Experiment 5	**04 hrs.**

1. Calculation on sheet metal layout, finishing process of sheet metal parts.
2. Manufacture a simple component using a press machine involving operations such as punching,

blanking, bending, and shearing, using any suitable engineering material.

OR

2. Observe and demonstrate the manufacturing processes of sheet metal components during an industrial visit.

Experiment 6	**02 hrs.**

Self-study – Students will choose an engineering-related domestic product composed of at least 4–5 components and prepare detailed material selection and manufacturing plans, considering a broad range of materials including ferrous and non-ferrous metals, as well as non-metallic materials.

* Students are required to prepare a brief report summarizing the processes studied throughout the course and providing a cost analysis related to the selected project..

Students are expected to select available products viz.

i. Domestic products viz. Oven/Microwave/Blender/Cooker/Kitchen Sink, Kettle, etc.

ii. Robotic floor cleaner, Electric razors, etc.

iii. Ceiling fans/table fan/exhaust fans, etc.

***Note: Students can choose engineering products of their interest consisting of 4-5 components manufactured by verity of manufacturing processes and materials.

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

HSSM-232-MEC: Entrepreneurship Development and Innovation

Teaching Scheme		Credit	Examination Scheme	
Theory	**1 Hours/Week**	**1**	**CCE**	**25 Marks**
Practical	**NA**		**End-Semester**	**NA**

Prerequisite Courses, if any:

- None (Open to all engineering branches)

Course Objectives:

1. APPLY innovation techniques to develop solutions to real-world problems.
2. DESIGN a viable business model using structured tools.
3. EVALUATE the feasibility of a startup idea from technical, financial, and market perspectives.
4. COLLABORATE in teams to develop and pitch an entrepreneurial solution.

Course Outcomes:

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

CO1: DESCRIBE entrepreneurial traits and innovation processes (Remember/Understand), and IDENTIFY business opportunities through design thinking (Apply).

CO2: DEVELOP a lean business model and MVP (Apply/Analyze) and CREATE a startup pitch and demonstrate entrepreneurial mindset (Create)

Course Contents

Unit I	Entrepreneurial Mindset, Creativity and Innovation	(08 Hours)

- Entrepreneurial mindset: curiosity, resilience, risk-taking, leadership
- Types of entrepreneurs – Technical, Non-technical, Social, Entrepreneur
- Innovation types: product, service, process, frugal (Jugaad) innovation
- Design Thinking: Empathize, Define, Ideate, Prototype, Test
- Creativity tools: Mind Mapping, SCAMPER, TRIZ
- Success stories from Indian innovators
- Case studies: Innovative Indian products/startups

Assignments and Exercises (Any Three, Community Engagement Project is compulsory)

1. **Guest Session + Reflection Report**
   Application: Invite an Indian entrepreneur (e.g., local startup founder or alumni) for a guest talk.
   Task: Students write a 1-page reflection/ Quiz on entrepreneurial mindset, risks taken, and innovation style.
2. **Case Study Presentation**
   Activity: Select an Indian startup and analyze:
   - The problem it solves
   - Type of innovation (product, process, frugal, etc.)
   - Entrepreneurial mindset of the founder

   Deliverable: Present as a 5-minute video or a PPT with voice narration.
3. **Present any one Course Project/ Community Engagement Project(CEP) in context with Design Thinking**

Activity: In small groups, students will solve a common college problem (e.g., canteen cleanliness, Wi-Fi issues, exam stress, long queues, absenteeism, lack of seating, etc.) using the Design Thinking process in 45–60 minutes:

a. Empathize (5–10 min): Talk to 2–3 students or staff to understand the issue

b. Define (5 min): Clearly write the problem in one sentence

c. Ideate (10–15 min): Brainstorm at least 5–7 possible solutions

d. Prototype (10–15 min): Create a quick sketch, model, or chart of the best solution

e. Test (10 min): Share the idea with another group and collect feedback

Deliverable: Student should present 1 page summary/ poster/ prototype of the Course Project / Community Engagement Project(CEP) in context with Design Thinking

4. **Campus Creativity Challenge**
   Application:
   - Use **Mind Mapping** to improve a college service (e.g., library hours, parking space).
   - Apply **SCAMPER** to redesign a student-used item (e.g., backpack, ID card).
   - Use **TRIZ** to resolve a contradiction (e.g., "How to make exams easy but still effective").
   - Use **Design Thinking** process to solve college problem (e.g., canteen cleanliness, Wi-Fi issues, exam stress, long queues, absenteeism, lack of seating, etc)

Deliverable: Student should present 1 page summary/ poster/ prototype of the Course Project in context with Design Thinking.

Exemplars / Practical Applications: Problem solving in Startups

Unit II	**Opportunity Identification and Business Modelling**	**(08 Hours)**

- Opportunity Recognition and Idea Generation - Problem identification and need analysis
- Market research: tools and techniques
- Business Model Canvas: customer segments, value proposition, channels
- Lean Startup methodology & Minimum Viable Product (MVP)
- Business plan components and structure
- Cost estimation, revenue models, and unit economics
- Funding options: Government schemes (Startup India, MSME), VC, Angel Investors,
- Crowd funding
- Basics of financial literacy: Profit-Loss, Break-even, cash flow.

Assignments and Exercises *(Any Three)*

1. **Conduct Startup Financials Workshop**
   Application: Hands-on session using a fictional startup (e.g., chai café):
   - Calculate fixed and variable costs
   - Identify breakeven point
   - Build a simple cash flow chart for 6 months

   Outcome: Submit an Excel sheet with key financial metrics and a one-page interpretation.
2. **Government Funding Scheme Research**
   Application:
   - Each group explores one government scheme (e.g., Startup India Seed Fund, MUDRA loan, PMEG Scheme, MSME credit)
   - Analyze eligibility, application process, benefits, and success stories
3. **Opportunity Recognition and Need Analysis**
   Activity: Identify 3 real-life problems a community face (e.g., water waste, long queues, and costly transportation) or college.
   - Conduct informal interviews or surveys to understand the need.
   - Analyze user pain points and existing gaps.
   - Select one high-potential problem and formulate an idea to solve it.

   Deliverable: Opportunity report with problem statement, user quotes, and proposed idea.
4. **Business Model Canvas + MVP Design**
   Activity: Choose a startup idea and:
   - Create a detailed **Business Model Canvas** (cover all 9 blocks).
   - Develop a basic **Minimum Viable Product (MVP)** – this could be a sketch, clickable prototype, or service flow.

   Deliverable: BMC template filled + MVP mock-up/photo.
5. **Business Plan + Funding Strategy + Pitch**
   Activity: Prepare a **business plan** including:
   - Executive summary
   - Product/service details
   - Market research insights
   - Costing and basic unit economics
   - Revenue model
   - Funding plan (choose and justify one: govt scheme, VC, angel, crowd funding)
   - Prepare elevator pitch / 1 minute pitch

Deliverable: 4–6 page business plan document + pitch deck (5–7 slides).
Outcome: Awareness of the Government startup funding schemes and prepare a report of 3 to 4 pages.

Exemplars / Practical Applications: Arranging Mock Pitching Competitions

Learning Resources

Text Books:

1. Entrepreneurship Development – S.S. Khanka
2. Entrepreneurship Development and Small Business Enterprises – Poornima M. Charantimath
3. Entrepreneurship: New Venture Creation– David H. Holt (Indian Edition by Vikas Publishing)
4. Innovation and Entrepreneurship – Dr. R.G. Desai
5. Essentials of Entrepreneurship and Small Business Management – Nandan H.

Reference Books:

1. The Lean Startup – Eric Ries
2. Disciplined Entrepreneurship: 24 Steps to a Successful Startup – Bill Aulet (MIT)
3. Zero to One – Peter Thiel
4. The Startup Owner's Manual – Steve Blank & Bob Dorf
5. Jugaad Innovation – Navi Radjou, Jaideep Prabhu, and Simone Ahuja
6. Stay Hungry Stay Foolish – Rashmi Bansal
7. Connect the Dots – Rashmi Bansal
8. Innovation and Entrepreneurship – Peter F. Drucker
9. Startup Sutra – Rohit Prasad
10. Dream With Your Eyes Open – Ronnie Screwvala

MOOCs / NPTEL / SWAYAM Courses (Free): -

1. Entrepreneurship Essentials – Offered by IIT Kharagpur (NPTEL)
   Duration: 8 weeks | Level: UG/PG
   Covers: Entrepreneurial process, business models, marketing, funding.
2. Entrepreneurship and Innovation – IIT Roorkee
   Duration: 12 weeks
   Covers: Types of innovation, design thinking, ecosystem, and scaling.
3. Product Management and Entrepreneurship – IIM Bangalore
   Duration: 8 weeks
   Focus: Customer discovery, MVPs, and product-led growth.
4. Innovation, Business Models and Entrepreneurship – IIT Madras
   Explores innovation in products and services, and lean canvas approach.
5. Design Thinking - A Primer – IIT Madras
   Ideal for teaching creativity and problem-solving using design thinking.
6. Coursera: Design Thinking for Innovation by University of Virginia
7. edX: Entrepreneurship in Emerging Economies by Harvard

YouTube Channels / Playlists :

1. Startup India Official Channel •
2. Regular videos on policies, funding opportunities, and success stories.
   a. IIT Madras – NPTEL Entrepreneurship Playlist
      Covers fundamentals of startup creation and innovation strategy.
   b. Dr. HYPERLINK "https://www.youtube.com/user/MrVivekBindra"Vivek HYPERLINK "https://www.youtube.com/user/MrVivekBindra" HYPERLINK "https://www.youtube.com/user/MrVivekBindra"Bindra HYPERLINK "https://www.youtube.com/user/MrVivekBindra" – Entrepreneur HYPERLINK "https://www.youtube.com/user/MrVivekBindra"& HYPERLINK "https://www.youtube.com/user/MrVivekBindra" Motivational Speaker
   c. Popular in India; motivational and strategic content (more business-oriented).
   d. Desh HYPERLINK "https://www.youtube.com/@DeshDeshpandeFoundation" Deshpande Foundation
      Videos on grassroots entrepreneurship and social innovation.
3. Stanford HYPERLINK "https://www.youtube.com/user/ecorner"eCorner

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

VEC-233-MEC: Universal Human Values

Teaching Scheme		Credit	Examination Scheme	
Theory	**2 Hours/Week**	**2**	**CCE**	**20 Marks**
Practical	**NA**		**End Sem**	**30 Marks**

Prerequisite Courses, if any:

- Student Induction Program (SIP) (desirable)

Course Objectives:

1. To help the students develop a holistic, humane world-vision, and appreciate the essential complementarity between values and skills to ensure mutual happiness and prosperity
2. To elaborate on 'Self-exploration' as the process for Value Education.
3. To facilitate the understanding of harmony at various levels starting from self and going towards family and society.
4. To elaborate on the salient aspects of harmony in nature and the entire existence.
5. To explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.
6. To provide the vision for a holistic way of living and facilitate transition from chaotic life to an Orderly life.

Course Outcomes:

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

1. RECOGNIZE the concept of self-exploration as the process of value education and see they have the potential to explore on their own right.
2. EXPLORE the human being as the coexistence of self and body to see their real needs / basic aspirations clearly.
3. EXPLAIN relationship between one self and the other self as the essential part of relationship and harmony in the family.
4. INTERPRET the interconnectedness, harmony and mutual fulfilment inherent in the nature and the entire existence and draw ethical conclusions in the light of Right understanding

Course Contents

Unit I	Introduction to Value Education	(07 Hours)

1. Understanding Value Education
2. Self-exploration as the Process for Value Education
3. Continuous Happiness and Prosperity - the Basic Human Aspirations and their Fulfilment
4. Right Understanding, Relationship and Physical Facility
5. Happiness and Prosperity - Current Scenario
6. Method to Fulfil the Basic Human Aspirations

Unit II	Harmony in the Human Being	(07 Hours)

1. Understanding Human being as the Co-existence of the Self and the Body
2. Distinguishing between the Needs of the Self and the Body
3. The Body as an Instrument of the Self
4. Understanding Harmony in the Self
5. Harmony of the Self with the Body
6. Programmer to Ensure self-regulation and Health

Unit III	Harmony in the Family and Society	(08 Hours)

1. Harmony in the Family - the Basic Unit of Human Interaction "Trust' - the Foundational Value in Relationship
2. 'Respect' - as the Right Evaluation
3. Values in Human-to-Human Relationship
4. Understanding Harmony in the Society
5. Vision for the Universal Human Order

Unit IV	Harmony in the Nature (Existence)	(08 Hours)

1. Understanding Harmony in the Nature
2. Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
3. Realizing Existence as Co-existence at All Levels
4. The Holistic Perception of Harmony in Existence
5. Professional Ethics in the light of Right Understanding
6. Strategies for Transition towards Value-based Life and Profession

Learning Resources

Text Books:

1. A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-7-3 (Printed Copy), 978-81-957703-6-6 (e-book)
2. Teacher's Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-5-9 (Printed Copy), 978-81-957703-0-4 (e-Book)

Reference Books:

1. P. L. Dhar, R. R. Gaur (1990) Science and Humanism, Commonwealth Publishers.
2. A. Nagaraj (1999) Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak.
3. B. P. Banerjee (2005) Foundations of Ethics and Management, Excel Books.
4. A. N. Tripathy (2003) Human Values, New Age International Publishers.
5. E. G. Seebauer & Robert L. Berry (2000) Fundamentals of Ethics for Scientists & Engineers, Oxford University Press.
6. B. L. Bajpai (2004) Indian Ethos and Modern Management, New Royal Book Co., Lucknow.
7. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.
8. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

MOOC / NPTEL/ YouTube Links: -

1. Swayam Course on "Understanding Human Being Nature and Existence Comprehensively" by Dr. Kumar Sambhav, Director, UP Institute of Design (UPID), Noida. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview
2. NPTEL Course on "Exploring Human Values: Visions of Happiness and Perfect Society" by Prof. A. K. Sharma, Department of Humanities and Social Sciences, IIT Kanpur. https://nptel.ac.in/courses/109104068

E-Resources:

1. https://fdp-si.aicte-india.org/download.php#1/
2. https://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/
3. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

Savitribai Phule Pune University Second Year of Mechanical Engineering (2024 Pattern) Revised				
CEP-241-MEC: Community Engagement Project				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**NA**	**2**	**Termwork**	**25 Marks**
Practical	**4 Hours/Week**		**Oral**	**25 Marks**

Prerequisite Courses, if any:

Students should have prior knowledge of

1. Basic understanding of social and ethical responsibilities
2. Teamwork and communication skills acquired in prior coursework or group activities
3. Familiarity with problem-solving methodologies and project planning
4. Conversation in local language

Companion Course :

1. CEP is an experiential learning approach that combines education, learning, community development, and meaningful community service.
2. Project involves students in community development and service activities and applies the experience to personal and academic development.
3. The targeted contribution of college students to the village/local development will benefit the community.
4. The college has an opportunity to help students become more socially conscious and responsible while simultaneously becoming a socially conscious organization

Course Objectives:

1. Establish a mutually beneficial relationship between the college and the community
2. Opportunities to engage with their local community, fostering empathy, teamwork, and problem solving skills while contributing positively to their surroundings.
3. An understanding of the challenges faced by the local community and the role of engineering in addressing those challenges.
4. The ability to apply technical knowledge and skills to design solutions or interventions that create a positive impact on the community.
5. The skills to evaluate and critically analyze the outcomes of their engagement activities, deriving actionable insights for sustainable impact

Course Outcomes:

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

CO1: Identify and Analyze local community needs and challenges by engaging with stakeholders and evaluating real-world problems.

CO2: Design and Implement practical, creative, and context-specific solutions using engineering principles to address community issues.

CO3: Reflect and Evaluate the effectiveness of their interventions and articulate lessons learned through reports and presentations.

Course Contents
Implementation
• A group of 3 to 4 students or a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay/college premise. • Each group is allotted to a faculty member of the department as a mentor. • The group of students will be associated with a government official / village authorities /NGOs etc. concerned, allotted by the district administration, during the duration of the project. • The Community Engagement Project should be different from the regular programmes of NSS/NCC/Green Club/Hobby Clubs, Special Interests Groups etc • An activity book has to be maintained by each of the students to record the activities undertaken/involved and will be countersigned by the concerned mentor/HoD. • Project report shall be submitted by each student/group of students. • An internal evaluation shall also be conducted by a committee constituted by the HoD. Evaluation to be done based on the active participation of the student and marks could be awarded by the mentor/HoD. • Students groups can conduct an awareness programme on Health and Hygiene or in Organic Farming or in Fisheries or in advocating prohibition of liquor or about renewable energy, e-waste management or any other activity in an area of their studies and as per his/her aptitude
Suggestive list of topics under Community Engagement Project
The below lists are not exhaustive and open for HoD's or mentors to add, delete or modify. It is expected that the focus should be on specific local issues in their nearby areas. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a student/group of students shall 1. Use/ miss-use of cell phones 2. Career orientation of youth 3. Water facilities and drinking water availability 4. Health and hygiene of the school going students, home makers and old personals 5. Health intervention and awareness programmes 6. Horticulture 7. Herbal and Nutrition 8. Traditional and Modern health care methods 9. Food habits 10. Air /Sound /Water pollution 11. Plantation and Soil protection 12. Renewable energy and Solar Systems 13. Yoga awareness and practice 14. Health care awareness programmes and their impact 15. Organic farming 16. Food adulteration 17. Incidence of Diabetes and other chronic diseases 18. Blood groups and blood levels 19. Chemicals in daily life 20. Music and dance 21. Women education and empowerment

Project Scope
• Conduct workshops or awareness drives on topics like digital literacy, environmental sustainability, mental health, or career planning for local stakeholders. • Develop a simple prototype or solution that addresses a real-world problem (e.g., a water-saving device, simple mobile apps, or tools for community use). • Organize clean-up drives, tree plantations, recycling campaigns, or energy conservation initiatives. • Promote health through awareness programs on hygiene, nutrition, and exercise. • Teach basic computer or technical skills to students, staff, or the community
Proposal Submission
CEP Group should Submit a two-page project proposal, preferably prior to the term commencement outlining the following:- • Title of the project • Aim, Objective and expected outcome • Plan of execution (timeline and activities). • Place of the CEP and involvement of any local authority, NGP • Required resources (if any). • Get approval from the designated faculty mentor.
Learning Resources
Text Books: 1. Waterman, A. Service-Learning: A Guide to Planning, Implementing, and Assessing Student Projects. Routledge, 1997. 2. Beckman, M., and Long, J. F. Community-Based Research: Teaching for Community Impact. Stylus Publishing, 2016. 3. Design Thinking for Social Innovation. IDEO Press, 2015. 4. Dostilio, L. D., et al. The Community Engagement Professional's Guidebook: A Companion to The Community Engagement Professional in Higher Education. Stylus Publishing, 2017
MOOC / NPTEL/ YouTube Links: - 1. NPTEL course: Ecology and Society, https://onlinecourses.nptel.ac.in/noc20_hs77/preview
Web Links: - **1.** UNESCO: Education for Sustainable Development https://www.unesco.org **2.** EPICS (Engineering Projects in Community Service) https://engineering.purdue.edu/EPICS **3.** Ashoka: Innovators for the Public https://www.ashoka.org **4.** Design for Change https://www.dfcworld.com

Savitribai Phule Pune University, Pune

Maharashtra, India

SE - Mechanical Engineering (2024 Pattern) Revised

Semester IV Courses

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC-251-MEC: Fluid Mechanics

Teaching Scheme		Credit	Examination Scheme	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End Sem**	**60 Marks**

Prerequisite Courses, if any:

- Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mechanics, Engineering Physics

Course Objectives:

1. To UNDERSTAND fundamental principles of fluids and fluid Statics.
2. To LEARN fluid kinematics and dynamics
3. To STUDY internal flow physics
4. To STUDY external flow physics
5. To LEARN to establish relation between flow parameters.

Course Outcomes:

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

CO.1 APPLY concepts of fluid properties and Hydrostatics to real world engineering systems.

CO.2 EXPLORE the detailed analysis of kinematics and dynamics of fluid and exploit the conservation equations for the flow regimes of practical interest.

CO.3 APPLY principles of fluid dynamics to laminar flow and ESTIMATE friction and minor losses in internal flows.

CO.4 DETERMINE boundary layer formation over an external surface and Understand the concept of lift & drag.

CO.5 CONSTRUCT mathematical correlation considering dimensionless parameters, also able to PREDICT the performance of prototype using model laws.

Course Contents

Unit I	Fundamental Principles	(08 Hours)

Properties of Fluid: Definition of fluid, concept of continuum, density, specific weight, specific gravity, viscosity, viscosity laws, types of fluid and rheology, vapor pressure surface tension, capillarity, compressibility.

Laws of fluid statics: forces acting on fluid element, Pascal's law, hydrostatics law. Pressure measurement: pressure scale, piezometer, barometer, manometer - simple, inclined, differential, micro manometer, inverted.(Field Assignment)

Forces acting on surfaces immersed in fluid: total pressure and center of pressure on submerged plane surfaces, curved surface submerged in liquid. Buoyancy: flotation, stability of bodies.(Field Assignment)

Real World Assignment

1. Comparative analysis of detergents in context with surface tension and preparation of effective alternative powder with additives.
2. Calculate the total force on the walls of a dam or water reservoir/tank due to fluid pressure. Also draw pressure variation w.r.t depth of water level: A case study.
3. Design ship using principle of Buoyancy and floatation: A case study.
4. Design/calculate forces acting on a hydraulic Jack using Pascal's Law: A case study

Exemplars

Lubrication oil, bearings, detergent powder, dam construction, ship design.

Unit II	Fluid Kinematics & Dynamics	(07 Hours)

Flow description methods, types of flows, velocity and acceleration fields, continuity equation in 1D & 3D flow, flow visualization (path line, stream line and streak line), stream tube, stream function and velocity

potential function, flow net

Various forces acting on fluid elements, Euler's equation of motion along streamline, Bernoulli's theorem and modified Bernoulli's theorem, stagnation pressure, HGL, TEL (Field Assignment) Flow measurement: venturimeter, orifice meter, pitot tubes, Introduction to orifices, notches & weirs. (Field Assignment)

Real World Assignment

1. Analyze fluid particle trajectories in spray painting to achieve a uniform coating on car bodies.
2. Development of ducted augmented wind turbine for power generation.
3. Development and testing of window fitted natural cooling system with waste bottles.

Exemplars

Venturimeter used in Agriculture, in carburetor, electrical analogy

Unit III	**Internal Flow**	**(07 Hours)**

Laminar flow: Entrance region theory, velocity and shear Stress distribution for laminar flow through pipe, fixed parallel plates(Field Assignment) and Couette flow(Field Assignment), velocity profile of turbulent flow.

Losses - major & minor losses (without expressions), hydro dynamically smooth and rough boundaries, Moody's chart, compounding of pipes & equivalent pipe, siphons, transmission of power. (Field Assignment)

Real World Assignment

1. Design an efficient water distribution system in home/society, minimizing pressure losses and leakages.
2. Printing press application for couette flow.
3. Water leakage in wall.
4. Design a Siphon to take water from open channel.

Exemplars

Power absorbed in bearings, municipal water distribution to society/ home, Hydroelectric power plant

Unit IV	**External Flow**	**(07 Hours)**

Boundary layer formation over a flat plate, boundary layer thickness, displacement thickness, momentum thickness and energy thickness, boundary layer separation and methods to control separation, drag and lift concepts, types of drag, drag & lift coefficient, aerofoil, bluff body, streamline body

Real World Assignment

1. Optimize the front-end shape of an electric vehicle to ensure it behaves more like a streamlined body, reducing energy consumption.
2. Analysis of Commercial Jeep and Sports Car for its stream lined body and reducing energy consumption.
3. Survey report on applications of Boundary layer Separation

Exemplars

Cricket Ball Swinging. Aero plane, bird's wing

Unit V	**Dimensional Analysis**	**(07 Hours)**

Dimensional Analysis: Introduction, system of dimensions, Dimensional homogeneity, Buckingham-Pi Theorem, repeating variables, dimensionless numbers and their physical significance

Similitude & Model Testing: Model & prototype, similarity, scaling parameters, model laws, objectives, importance and application of model studies.

Real World Assignment

1. Derive a generalized formula for drag force acting on a car moving at high speed.
2. Apply Reynolds number similarity to design a miniature wind turbine for testing before manufacturing full-scale blades

Exemplars

Turbine model, wind tunnel model test, irrigation system, dam model analysis

Learning Resources

Text Books:

1. Sukumar Pati, “Fluid Mechanics and Hydraulics Machines”, TATA McGraw Hill.
2. Munson, Young and Okiishi, “Fundamentals of Fluid Mechanics”, Wiley India
3. Potter Wiggert, “Fluid Mechanics”, Cengage Learning
4. Fox, Pichard, “Introduction to Fluid Mechanics”, McDonald- Wiley
5. Modi P. N. and Seth S. M, “Hydraulics and Fluid Mechanics”,Standard Book House.
6. Cengel & Cimbla, “Fluid Mechanics”,TATA McGraw-Hill
7. F. M. White, “Fluid Mechanics”, TATA McGraw-Hill
8. R. K. Bansal, ”Fluid Mechanics & Hydraulic Machines”, Laxmi Publication

Reference Books:

1. Kundu, Cohen, Dowling, “Fluid Mechanics”, Elsevier India
2. Chaim Gutfinger David Pnueli, “Fluid Mechanics” Cambridge University press.
3. Edward Shaughnessy, Ira Katz James Schaffer, “Introduction to Fluid Mechanics”, Oxford University Press

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/112/104/112104118/#
2. https://archive.nptel.ac.in/courses/112/105/112105269/
3. https://archive.nptel.ac.in/courses/112/105/112105171/
4. https://www.youtube.com/watch?v=fa0zHI6nLUo

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC-252-MEC: Manufacturing Processes-I

Teaching Scheme		Credit	Examination Scheme	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End Sem**	**60 Marks**

Prerequisite Courses, if any:

- Manufacturing Practice Workshop
- Prerequisite Courses Material Science and Metallurgy, Engineering Physics

Course Objectives:

1. To KNOW about fundamentals of metal cutting process, tool wear and tool life.
2. To DESCRIBE various casting methods and aspects related to mould design.
3. To UNDERSTAND basics of metal forming processes and tooling.
4. To CLASSIFY, DESCRIBE and CONFIGURE the principles of various welding techniques.
5. To EXPLAIN various grinding and advanced finishing techniques.

Course Outcomes:

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

CO1. APPLY metal cutting mechanics and tool wear analysis to optimize machining processes.
CO2. DESIGN gating systems, risers, and ANALYZE casting defects for efficient metal casting processes.
CO3. COMPUTE forces, power, and deformation in rolling, forging, and sheet metal operations.
CO4. COMPARE welding techniques, interpret weld symbols, and EVALUATE defects for quality joining.
CO5. SELECT appropriate grinding and finishing processes based on surface finish requirements

Course Contents

Unit I	Theory of metal cutting	(08 Hours)

Basics of subtractive manufacturing, operations on Lathe, Milling. Basics of metal cutting mechanics, Chip formation and types of chips, Orthogonal and oblique cutting, Shear angle and Merchant's theory, Cutting Forces and Power Estimation, Properties of cutting tool materials, Tool signature, Tool wear and tool life, Taylor's tool life equation

Real World Assignment

Calculation of Power and Energy Calculations: Cutting power, shear power, and friction power, Calculation of cutting force components using experimental data

Exemplars / Practical Applications

Automotive component manufacturing, Aerospace part machining, Precision tooling and dies production, General engineering and machine tool industries, Manufacturing of medical devices and implants

Unit II	Metal Casting Technology	(08 Hours)

Introduction to casting processes, Patterns: Pattern materials, types of pattern, allowances pattern design, molding sand, Properties of molding sands, Core making, melting practices and furnaces, Pouring and Gating system, Cleaning and Finishing of casting, Defects and remedies. Principle and equipment of Die casting, Centrifugal casting, Investment casting, Continuous casting.

Numerical estimation to find mold filling time, Riser design and placement, Principles of cooling and solidification of casting, Directional and Progressive solidification, Estimation of solidification rate

Real World Assignment

Design of Gating System: Calculating Sprue height, runner dimensions, and gate area, Estimating pouring time and metal flow rate, Design of Risers: Calculation of riser size using Caine's method and modulus method, Comparing riser efficiency for different shapes,

Exemplars / Practical Applications

Foundry and casting industries, Automotive engine block manufacturing, Aerospace component fabrication, Heavy machinery and equipment production, Jewelry and art casting

Unit III	Metal Forming Technology	(08 Hours)

Introduction to Metal Forming- Stress-Strain Analysis in Metal Forming, Bulk Deformation Processes, Defects in Metal Forming,

Rolling: Types, defects, and applications, Rolling force estimation, Torque and power requirements for rolling mills

Forging: Open-die, Closed-die, and Impression-die forging, Estimation of Forging Load using uniform deformation energy equation,

Sheet Metal Working: Types of sheet metal operations, Press working equipment and terminology**, design of simple progressive die:** strip lay-out and percentage utilization, clearance analysis, centre of pressure, estimation of cutting forces and press capacity

Real World Assignment

Load calculation for open-die forging and closed-die forging or Design of simple drawing dies

Exemplars / Practical Applications

Metal forming in automotive manufacturing, Rolling mills in steel production, Forging of aerospace components, Sheet metal fabrication in appliance industry, Press working in electronics manufacturing

Unit IV	Joining Technology	(06 Hours)

Joining process classification, soldering, brazing, welding symbols, types of joint, Electrodes- types and purpose of electrodes, electrode coatings (flux), welding defects, testing and inspection of welds, Working principles, applications of welding processes: Arc welding: MIG, TIG, Resistance welding: Spot, Seam, Heat generation in resistance welding, Gas Welding: Types of flames, oxy-acetylene gas welding. Solid State Welding: Friction Welding, Modern Welding Processes: Laser welding plasma arc welding, submerged arc welding, projection welding, electron beam welding, ultrasonic welding

Real World Assignment

Appropriate selection of non-conventional welding process for particular applications like plasma arc welding, submerged arc welding, projection welding, electron beam welding, ultrasonic welding

Exemplars / Practical Applications

Welding in automotive assembly, Construction and infrastructure fabrication, Shipbuilding industry, Aerospace component joining, Electronic device manufacturing

Unit V	Finishing and Fine finishing processes	(06 Hours)

Grinding Process: Introduction, types of grinding machines, Grinding wheel: Introduction, types, shapes, designation and selection, grit, grade & structure of wheels, mounting, glazing, loading, dressing, truing, balancing, Surface Finish Measuring Instruments.

Advanced Fine finishing processes: (Construction, working and process parameters) Introduction to Honing and Lapping, Magnetic abrasive finishing, Ultrasonic finishing, Abrasive flow machining.

Real World Assignment

1. Machining time calculation for cylindrical and plunge grinding,
2. Appropriate selection finishing process for given application

Exemplars / Practical Applications

Precision surface finishing in automotive parts, Tool and die manufacturing, Aerospace component finishing, Medical device polishing, Electronics and semiconductor wafer processing

Learning Resources

Text Books:

1. A Text book of Manufacturing Technology, Metal Cutting and Machine Tools, P. N. Rao, Vol. 2nd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2002
2. P. N. Rao, "Manufacturing Technology Vol. I & II" , Tata McGraw Hill Publishers
3. P. C. Sharma, "Production Engineering", Khanna Publishers

Reference Books:

1. Theory of Metal Cutting, M. C. Shaw, 1st Edition, Oxford and I.B.H. publishing, 1994
2. Production Technology Manufacturing Systems Vol. - I & II, R. K. Jain, Khanna Publishers
3. Production Technology - HMT, Tata McGraw Hill publication

MOOC / NPTEL/ YouTube Links: -

1. https://nptel.ac.in/courses/112103248
2. https://nptel.ac.in/courses/112104028
3. https://nptel.ac.in/courses/112107215
4. https://nptel.ac.in/courses/112104301
5. https://nptel.ac.in/courses/112104195
6. https://nptel.ac.in/courses/112103420
7. https://nptel.ac.in/courses/112107250
8. https://nptel.ac.in/courses/112103528
9. https://nptel.ac.in/courses/112104162
10. https://nptel.ac.in/courses/112103244
11. https://nptel.ac.in/courses/112103263
12. https://nptel.ac.in/courses/112103305
13. https://nptel.ac.in/courses/112103250
14. https://nptel.ac.in/courses/112105212

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC-253-MEC: Applied Thermodynamics

Teaching Scheme		Credit	Examination Scheme	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End Sem**	**60 Marks**

Prerequisite Courses, if any:

- Systems in Mechanical Engineering, Basics of Engineering Thermodynamics, Engineering Chemistry & Engineering Mathematics.

Course Objectives:

1. To STUDY working of engine, Actual, Fuel-Air and Air standard cycle and its Performance.
2. To PROVIDE in-depth knowledge of IC engine thermodynamics and combustion techniques.
3. To UNDERSTAND Combustion in SI and CI engines and factors affecting performance parameters
4. To ESTIMATE performance parameters by conducting a test on I. C. Engines.
5. To DETERMINE performance parameters of Positive displacement compressor

Course Outcomes:

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

CO1. ANALYZE the working principles of IC engines, the effects of fuel-air and actual cycles on engine performance, and the impact of cycle losses.

CO2. ASSESS the combustion characteristics in SI and CI engines, the influence of fuel properties on knocking, and the suitability of alternative fuels for improved efficiency and emissions.

CO3. EVALUATE engine performance by conducting tests, interpreting characteristic curves, and applying emission control strategies to meet regulatory standards.

CO4. INVESTIGATE the functions of ignition, cooling, and lubrication systems, along with advanced IC engine technologies such as EMS, AI-based diagnostics, and HCCI.

CO5. APPLY thermodynamic principles to solve problems on reciprocating and rotary compressors, including multi-stage compression and FAD.

Course Contents

Unit I	Fundamentals of IC Engines & Fuel, Air and Actual Cycle Cycles	(07 Hours)

Fundamentals of IC Engines: Heat Engine, Engine classification, Applications, I.C. Engine construction - components and materials, Engine nomenclature, Valve timing diagram, Intake and exhaust system.

Fuel, Air and Actual Cycle: Air-standard cycles- Otto, Diesel & Dual Cycle (Derivation of Efficiencies & MEP), fuel air cycles, and actual cycles, Effects of variables on performance, various losses and Comparison of Air standard with Fuel and Actual cycle. (Numerical on Air-standard cycles)

Real World Assignment

1. Identification of different components of recent modern IC Engines (workshop/ Garage).
2. Case Study on selection of engine for various applications (e.g. Marine, sports, aircraft, etc).

Practical Applications

Used in different engine types for efficiency optimization in vehicles, power plants, and Automotive industrial engines.

Unit II	Combustion in IC Engines & Fuel Technology	(07 Hours)

Combustion in IC Engines: Fuel injection system in SI & CI Engines Combustion in SI and CI engines and factors affecting efficiency, Knocking in SI and CI engines, Combustion Chambers used in SI & CI Engine.

Fuel Technology: Biofuels, hydrogen, synthetic fuels, LPG, CNG, ethanol blends. Role of octane and cetane numbers, fuel additives.

Real World Assignment

1. Study of alternative fuels as a replacement to petro-diesel.
2. Case study on modern fuel injection system used in two wheeler/ four wheeler.

Practical Applications

1. Used in modern Petrol & Diesel engines to improve fuel efficiency and Emissions.
2. Used in diesel generators, agricultural machinery, and marine diesel engines.
3. Biodiesel & hydrogen fuel used in transportation fleets to reduce carbon footprint..

Unit III	Engine Performance & Testing, Emission Control Technologies	(07 Hours)

Engine Testing Procedure and Engine parameters, Measurement of indicated power, Brake power, fuel consumption, Air Consumption, Measurement of friction power by Willan's Line Method and Morse Test, calculation of mean effective pressure, various efficiencies, specific fuel consumption, heat balance sheet of IC Engines and performance Characteristic curves. (Numerical on Engine parameters & HBS). Role of supercharging and turbocharging in engine performance improvement.

Emission Control Technologies: Pollutants from engines- CO, HC, NOx, PM, and their impact on air quality, Emission reduction strategies: Exhaust Gas Recirculation (EGR), Selective Catalytic Reduction (SCR), Diesel Particulate Filters (DPF), Three-Way Catalysts (TWC), BS-VI and Euro 6 emission standards

Real World Assignment

1. Analyzing the various engine parameters which affect performance and emission characteristics.
2. Case study on Revolutionizing Carbon Management: Generation, Emission Control, Capture, and Reuse.

Practical Applications

1. The selection of IC Engines according to their specifications and performance for different applications such as automotive, aviation, power generation, marine, and industrial machinery.
2. Used in Power generation, construction, and marine sectors have adopted DPF, TWC, and BS-VI/Euro 6 emission standards to meet stringent environmental regulations.

Unit IV	Engine Systems & Recent Trends in I.C Engine	(07 Hours)

Ignition system: battery coil ignition system, magneto ignition system, Electronics Ignition (CDI- Capacitor Discharge Igniter, TCI-Transistor Controlled Igniter).

Cooling system: Air Cooling, Liquid cooling.

Lubrication system: Objectives of lubrication system, properties of lubricant, Methods of lubrication system,

Recent Trends in IC Engine: Introduction to engine management systems (EMS) and ECU-controlled ignition, Advanced combustion technologies: HCCI (Homogeneous Charge Compression Ignition), AI-based predictive maintenance, fault diagnosis, and digital twins in IC engines..

Real World Assignment

1. Case study on real world applications where AI & IoT have improved IC Engine performance.
2. Develop a DIY model for any of the system (Ignition, Cooling, Lubrication)

Practical Applications

Automotive Industry – Used in cars, trucks, and buses for fuel efficiency, emissions control, and performance optimization.

Unit V	Positive Displacement Compressor	(07 Hours)

Reciprocating Compressor: Applications of compressed air, single stage compressor (without clearance and with clearance volume), volumetric efficiency, isothermal efficiency, effect of clearance volume, free air delivery (FAD), actual indicator diagram for air compressor, Multi staging of compressor, optimum intermediate pressure, intercooler, after cooler, Capacity control of compressors. (Numerical).
Rotary Compressors: Roots blower, Vane type, Screw compressor and Scroll compressor.

Real World Assignment

1. Study manufacturer catalogues, compare different compressor models and select the most suitable one for a given industrial applications (eg. Pneumatic tools, refrigeration, manufacturing etc).
2. Case study on any rotary compressor with its real world applications.

Practical Applications

Air compressors Used in Manufacturing, pneumatic tools, automotive industry, Workshop tools, HVAC systems, food packaging, Process industries, mining, and chemical plant.

Learning Resources

Text Books:

1. V. Ganesan, “Internal Combustion Engines”, Tata McGraw-Hill
2. M. L. Mathur and R.P. Sharma, “A course in Internal combustion engines”, Dhanpat Rai & Co.
3. H.N. Gupta, “Fundamentals of Internal Combustion Engines”, PHI Learning Pvt. Ltd.

Reference Books:

1. Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill
2. Domkundwar & Domkundwar, “Internal Combustion Engine”, Dhanpat Rai & Co.
3. R. Yadav, “Internal Combustion Engine”, Central Book Depot, Ahmedabad.
4. S. Domkundwar, C.P. Kothandaraman, A. Domkundwar, “Thermal Engineering”,DhanpatRai & Co.

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/112/103/112103307/
2. https://nptel.ac.in/courses/112103262
3. https://archive.nptel.ac.in/courses/112/103/112103262/
4. https://archive.nptel.ac.in/courses/112/103/112103307/
5. https://nptel.ac.in/courses/107106088
6. https://onlinecourses.nptel.ac.in/noc25_me19/preview
7. https://www.youtube.com/watch?v=1X20Rdi4Vnk
8. https://youtu.be/F24UWsOkMSI
9. https://www.youtube.com/watch?v=QoruG4ma210
10. https://nptel.ac.in/courses/107106088
11. https://archive.nptel.ac.in/courses/112/103/112103262/
12. https://archive.nptel.ac.in/courses/112/103/112103262/
13. https://www.youtube.com/watch?v=MVQ1wbQELJM
14. https://www.youtube.com/watch?v=NakOoD-G0IY

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

PCC-254-MEC: Thermo- Fluid Engineering Lab I

Teaching Scheme		Credit	Examination Scheme	
Theory	**NA**	**2**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses, if any:

- Basics of Engineering Thermodynamics, Applied Thermodynamics, Fluid Mechanics.

Course Objectives:

1. To UNDERSTAND steam generation and thermodynamic properties through practical experiments using calorimetry and boilers.
2. To EVALUATE the performance and efficiency of internal combustion engines and air compressors through actual test methods.
3. To APPLY fluid mechanics principles such as Bernoulli's theorem, pressure loss, and flow measurement using lab equipment.
4. To INVESTIGATE fluid and lubricant properties including viscosity and discharge coefficients using standard instruments.
5. To DEVELOP practical insights into industrial applications of thermo-fluid systems through plant visits and technical documentation.

Course Outcomes:

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

CO1 EVALUATE steam properties and boiler performance through experimental analysis.

CO2 ANALYZE engine and compressor performance characteristics using test procedures and calculations.

CO3 INVESTIGATE fluid flow behavior and pressure losses in pipelines and flow systems.

CO4 MEASURE and INTERPRET viscosity and discharge characteristics of various fluids using laboratory tools.

CO5 APPLY theoretical knowledge to real-world industrial systems through case studies and site visits

List of Experiments

Experiment 01

Determination of dryness fraction of steam using combined separating and throttling calorimeter

Description: The separating calorimeter mechanically separates water particles from steam. It provides partially dry steam. The throttling calorimeter then superheats the partially dry steam by allowing it to expand through a throttling process (constant enthalpy) and measures the temperature and pressure of the superheated steam.

Dryness Fraction of Steam (Calorimeter):

Assignment: Prepare a technical report comparing dryness fractions in different industries (e.g., textile vs. food processing) and explain its impact on energy efficiency.

Exemplars / Practical Applications: In food industries for separating fatty acids from mixtures. For removing organic contaminants.

Experiment 02

Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.

Description: The boiler trial helps evaluate the performance of the boiler and identify possible inefficiencies due to losses through flue gases.

- To conduct a trial on a boiler in order to:

1. Determine boiler efficiency
2. Calculate equivalent evaporation
3. Prepare an energy balance sheet

- Boiler Trial for Efficiency and Energy Balance:
- Assignment: Calculate and compare energy efficiency for a packaged boiler and a power plant boiler. Suggest improvements based on observed losses

Exemplars / Practical Applications: In steam power plants for power generation. In textile industries for processes like dyeing and finishing fabrics. In food industries for steaming and sterilizing food.

Experiment 03

Performance and Morse Test on multi cylinder Petrol engine.

Description: The performance test provides the overall efficiency and fuel consumption characteristics of the engine. Morse test enables measurement of individual cylinder performance, helping in diagnosing imbalance or poor performance in one or more cylinders

Performance and Morse Test on Petrol Engine:

Assignment: Analyze engine data from a car service center and evaluate the impact of misfiring cylinders on performance using Morse Test logic

Exemplars / Practical Applications:

In automobiles like cars and motorcycles.

In smaller and portable machinery like lawn movers and generators.

Experiment 04

Performance test on Diesel engine and to draw heat balance sheet

Description: The Performance test on Diesel engine provides insight into engine efficiency and energy distribution. A good-performing diesel engine will have brake thermal efficiency around 30–40%, and remaining losses in cooling, exhaust, and radiation.

1. To determine brake power, fuel consumption, thermal efficiencies, and specific fuel consumption.
2. To prepare a heat balance sheet for the engine.

Performance Test on Diesel Engine (Heat Balance Sheet)

Assignment: Collect real-time data from a generator at your institute and prepare a heat balance sheet comparing theoretical and actual efficiency

Exemplars / Practical Applications: In automobiles like heavy vehicles such as Trucks and buses. In Power plants for generation of power. Tractors and other farm machineries use diesel engines.

Experiment 05

Trial on Multi stage Positive displacement air compressor.

Description: The air compressor trial demonstrates the effectiveness of multi-stage compression in reducing work input per kg of air and increasing efficiency. Deviations in efficiency point to heat losses, friction, and imperfect intercooling.

To conduct a trial on a multi-stage positive displacement air compressor in order to determine:

1. Volumetric efficiency
2. Isothermal efficiency
3. Mechanical efficiency
4. Power consumption

Multi-stage Positive Displacement Air Compressor:

Assignment: Conduct a case study on the use of multistage compressors in bottling plants or refrigeration units and evaluate energy savings**.**

Exemplars / Practical Applications: In operating or powering the pneumatic tools in construction and automobile service station and spray painting. In various industries for processes like metal fabrication and

woodworking.

Experiment 06

Determination of Major and Minor Losses in Pipe Lines (Metal / Plastic).

Description: The major losses when the fluid is flowing through the pipe is mainly due to friction and minor losses are due to geometry and pipe fittings. The losses reduce the power transmitting capacity of the flow. Hence the losses should be as minimum as possible

- Major and Minor Losses in Pipelines:
- Assignment: Design a small-scale piping system (e.g. for a water purification unit) and identify areas with potential major/minor losses.

Exemplars / Practical Applications: In food processing industries, chemical industries, piping industries and hydraulic power plants.

Experiment 07

Bernoulli's Theorem experimental Demonstration and verification

Description: When the fluid flows in a horizontal pipe so that there is no change in potential energy or head, then the increase in the fluid velocity is associated with the decrease in fluid pressure.

- Bernoulli's Theorem Demonstration:
- Assignment: Create a video or presentation showing real-life application of Bernoulli's principle in aircraft wing design or carburetors.

Exemplars / Practical Applications: The principle is used in atomizers like perfume bottles. In designing the wings of the aeroplanes.

Experiment 08

Determination of Coefficient of discharge, Coefficient of velocity of venturimeter / orifice meter.

Description: Orifice meter and venturimeter are flow measuring devices. The devices work on the principle of Bernoulli's theorem. The fluid flow rate can be measured by finding the coefficient of discharge and coefficient of velocity of the devices.

Flow Measurement (Venturimeter/Orifice Meter):

Assignment: Compare different flow measurement devices used in municipal water supply systems and justify the use of each based on discharge coefficients.

Exemplars / Practical Applications: For accurate measurement of flow of fluids in pipelines in various industries like chemical processing, Oil and gas, food processing, automotive and aerospace etc.

Experiment 09

Determination of dynamic and kinematic viscosity of any oil using Redwood Viscometer.

Description: Viscosity is the resistance offered by the fluid for its own flow. It quantifies the internal resistance offered by one layer of fluid to the other. The flow rate or velocity of the fluid will be more if the viscosity is less.

Viscosity Using Redwood Viscometer:

Assignment: Collect samples of different lubricants used in automotive workshops and compare their viscosities and suitability for engine parts.

Exemplars / Practical Applications: It is used in selection of lubricants, hydraulic brake system, coating and spray painting. In manufacturing processes like ink production, adhesives and food processing.

Experiment 10

Industrial Visit: Visit to any Food Processing Industry/Plant having Boiler equipped with Accessories/Automobile Service station.

Description: Idea about generation of steam in a boiler and mountings and accessories of the boiler can be accumulated with the visit to a Plant equipped with Boiler. The working of Internal Combustion engines, method of cooling system employed, lubrication and various parts of an engine and their working can be understood with the visit to any service station.

Industrial Visit Report:
Assignment: Submit a detailed case study of the visited plant, identifying types of boilers used, working conditions, accessories installed, and safety measures.

Exemplars / Practical Applications: Power plants, textile industries, food processing, chemical industries, automobiles, aerospace.

Important Note:

1. Experiment no.1, 2 and 10 are compulsory.
2. Perform any 2 Experiments from 3 to 5 and
3. Perform any 3 Experiments from 6 to 9

Exemplars / Practical Applications

1. Power plants, textile industries, and paper mills where steam generation efficiency is critical.
2. Automotive engine tuning, backup generator maintenance, and industrial air compression systems.
3. Designing piping systems in water treatment plants, HVAC systems, and irrigation setups.

Learning Resources

Text Books:

1. P. K. Nag, “Engineering Thermodynamics”, Tata McGraw Hill Publications.
2. R. K. Rajput, “Engineering Thermodynamics”, EVSS Thermo, Laxmi Publications.
3. P. L. Ballaney, “Thermal Engineering”, Khanna Publishers.
4. V. Ganesan, “Internal Combustion Engines”, Tata McGraw-Hill.
5. M. L. Mathur and R.P. Sharma, “A course in Internal combustion engines”, Dhanpat Rai & Co.
6. Modi P. N. and Seth S. M, “Hydraulics and Fluid Mechanics”, Standard Book House.
7. R. K. Bansal,”Fluid Mechanics & Hydraulic Machines”, Laxmi Publication.

Reference Books:

1. Cengel and Boles, “Thermodynamics an Engineering Approach”, McGraw Hill.
2. Holman J.P., “Thermodynamics”, McGraw Hill.
3. Domkundwar & Domkundwar, “Internal Combustion Engine”, Dhanpat Rai & Co.
4. R. Yadav, “Internal Combustion Engine”, Central Book Depot, Ahmedabad.
5. Kundu, Cohen, Dowling, “Fluid Mechanics”, Elsevier India
6. Chaim Gutfinger David Pnueli, “Fluid Mechanics” Cambridge University press

MOOC / NPTEL/ YouTube Links: -

1. https://nptel.ac.in/courses/112105275
2. https://nptel.ac.in/courses/112104118
3. https://archive.nptel.ac.in/courses/112/103/112103316/

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

MDM-271-MEC: Artificial Intelligence and Machine Learning

Teaching Scheme		Credit	Examination Scheme	
Theory	**2 Hours/Week**	**2**	**CCE**	**50 Marks**
Practical	**NA**		**End Sem**	**NA**

Prerequisite Courses, if any:

- Linear Algebra, Probability, Statistics, Logical Reasoning

Course Objectives:

1. To ACQUAINT with fundamentals of artificial intelligence and machine learning.
2. To LEARN feature extraction and selection techniques for processing data set.
3. To UNDERSTAND basic algorithms used in classification and regression problems.
4. To OUTLINE steps involved in development of machine learning model.
5. To FAMILIARIZE with concepts of reinforced and deep learning.

Course Outcomes:

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

CO1. DEMONSTRATE fundamentals of artificial intelligence and machine learning.
CO2. APPLY feature extraction and selection techniques.
CO3. APPLY machine learning algorithms for classification and regression problems.
CO4. DEVELOP a machine learning model using various steps.
CO5. APPLY concepts of reinforced and deep learning.

Course Contents

Unit I	Introduction to AIML and Feature Extraction and Selection	(06 Hours)

Introduction to AI & ML, Need of AI in Mechanical Engineering, Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical, Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning. Introduction to Data, Elements of Dataset, Introduction to various types of data Feature extraction: Statistical Features, Principal Component Analysis, Feature selection: Ranking, Decision tree - Entropy reduction and information gain (Numerical 2-3 Features- Preference (IG), Exhaustive, best first, Greedy forward & backward, Multi collinearity – Heatmap

Real World Assignment

1. Machine Failure Prediction
2. Decision Tree-Based Fault Detection in CNC Machines

Practical Applications

1. AI in Industry: Fault Diagnosis in Turbines / Identifying Wear Patterns in Engines
2. Predictive Maintenance of Machinery

Unit II	ML Algorithms: Classification & Regression	(06 Hours)

Supervised Learning: Linear Regression (Line, Plane & Hyperplane) Concept, Multi-Variable Linear Regression, Poly Regression, Logistic Regression, Naive Bayes Classifiers, k-NN Classification, Support Vector Machines **Ensemble Techniques** (Regression & Classification): Decision tree (ID3-IG), Random Forest, Bagging & Boosting, XGB Classifier.

Unsupervised Learning: K-means Clustering, Hierarchical Clustering, Dimension Reduction-PCA

Classification Algorithm & Regression Algorithms: Bias-Variance Trade off, Distance Parameters in Machine Learning (Formula).

Real World Assignment

1. Predicting Machine Wear & Tear Using Linear Regression
2. Classification of Defective vs. Non-Defective Components Using SVM

Practical Applications

1. Predictive Maintenance Using Regression & Classification
2. Fault Detection in Rotating Equipment Using Clustering

Unit III	Feature Engineering, Development of ML Model & Evaluation	(06 Hours)

Feature Engineering, Model Selection & Tuning: Feature engineering, Model selection, Model tuning, Model performance measures, Regularizing the Linear models, ML pipeline, Bootstrap sampling, Grid search CV, Randomized search CV, K fold cross-validation.

Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (Accuracy, Precision, Recall, True Positive, False Positive, etc.), Hyper parameter Tuning: 1) Probability 2) Hypothesis 3) Confusion Matrix (Common dataset – Common problem statement), Influence of Type 1 & Type 2 error

Real World Assignment

1. Machine Condition Monitoring Using Feature Engineering
2. Fault Detection Using Confusion Matrix Analysis

Practical Applications

1. Predictive Maintenance of Industrial Machines
2. Optimizing Engine Performance Using Regression Models

Unit IV	Reinforced and Deep Learning	(06 Hours)

Neural Network: Introduction to Perceptron & NN, Activation Function & Loss Function, Gradient Descent & Gradient Acescent, Batch Normalization, Hyper Parameter Tuning

Characteristics of reinforced learning; Algorithms: Framework of RL, characteristics, Exploration Vs. Exploitation Trade-off, Bellman Optimality Principle, Types of RL: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; Models: Markov Decision Process, Q Learning, SARSA.

Computer Vision: Introducing Image Dataset, Introduction to CNN, Convolution, Pooling & Padding, CNN Forward & Backward Propagation, CNN architectures, Transfer Learning.

Applications of Reinforced, Computer Vision and Deep Learning in Mechanical Engineering (Jobs), Industry 5.0

Real World Assignment

1. Computer Vision-Based Defect Detection in Mechanical Parts
2. Reinforcement Learning for Robotic Arm Optimization

Practical Applications

1. AI in Automobiles/ Agriculture/ Robotics/ Health science/ Computer Vision for Analysis, Quality Assessment & Security, etc.
2. Computer Vision: Object Detection

Learning Resources

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015

4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003

Reference Books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

MOOC / NPTEL/ YouTube Links: -

1. http://nptel.ac.in/courses/111101003/
2. https://nptel.ac.in/courses/106/106/106106202/
3. https://nptel.ac.in/courses/112/103/112103280/
4. https://www.analyticsvidhya.com/

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

VSE-281-MEC: Solid Modeling and Drafting

Teaching Scheme		Credit	Examination Scheme	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses, if any:

- Engineering Graphics, Solid Mechanics, Engineering Materials and Metallurgy

Course Objectives:

1. To INTRODUCE the basic principles of solid modeling and computer-aided drafting (CAD) with an emphasis on industry-relevant applications.
2. To IMPART capabilities of solid modeling software for creating 2D drawings and 3D models of mechanical components and assemblies.
3. To INCULCATE understanding abilities of reading, interpreting, and creating standard engineering drawings with appropriate dimensions, tolerances, and annotations according to BIS/ISO standards.
4. To DEVELOP the ability to apply geometric and dimensional constraints in part modeling and to ANALYZE how these constraints influence the design intent and functionality.
5. To DEVELOP ability of visualizing mechanical systems and simulating their motion and interaction using assembly modeling techniques.

Course Outcomes:

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

CO1: APPLY (3) the tools from CAD software's to complete 2D sketches of the mechanical components
CO2: BUILD (3) a complete 3D model of components by applying different commands and constraints
CO3: CONCLUDE (4) on appropriate constraints between different parts of the assemblies for generating the complete model
CO4: CREATE (5) a complete working drawing of mechanical components/Assembly.
CO5: DEVELOP (5) a 3D model based on surface parameters

List of Experiments

Experiment 1 | Introduction to CAD Software

Introduction to user interface of CAD software, Drawing tools (line, circle, arc, polygon, etc.) Modifying tools (move, copy, trim, offset, mirror, etc.) and Constraints
Simple sketching of any 5 objects by using the above mentioned commands

Exemplars / Practical Applications

Mechanical part design, Architectural drafting, Electrical circuit layout, Automotive component modeling, Product prototyping and visualization

Experiment 2 | Part Modeling

Sketch-based modeling (by using commands like extrude, revolve, sweep, loft etc.) Constraints (geometric and dimensional) Parametric modeling, Analytical modeling, Material and Mass property calculations
Creating any 2 simple machine parts by using 3D modeling software and calculation of mass properties by applying suitable material.

Exemplars / Practical Applications

Automotive body and chassis design, Aerospace structural component modeling, Consumer product design and development, Industrial machinery and equipment design, Architectural modeling and building information modeling (BIM)

Experiment 3 | Assembly Modeling

Types of assemblies, significance and limitations, Inserting components into an assembly, mates and constraints, Assembly motion and interference checking
Creating assembly of model consisting of minimum 5 parts (Such as Knuckle joint, Flange coupling, C-

Clamp, Vice etc.)

Exemplars / Practical Applications

Automotive engine assembly design, Aerospace system integration, Consumer electronics product assembly, Industrial machinery assembly planning, Robotics and automation system design

Experiment 4	**Drafting from 3D Models**

Generating views from 3D parts and assemblies, Exploded views, Bill of Materials (BOM), GD&T symbols, Dimensioning

Generation of 2D working drawings (minimum 2 views) of parts and assembly created in experiment 3 above

Exemplars / Practical Applications

Automotive manufacturing documentation, Aerospace component assembly instructions, Consumer electronics product manuals, Industrial equipment fabrication, Construction and architectural detailing

Experiment 5	**Surface Modeling**

Introduction to surface modeling (patch, loft, and sweep), free form surfacing, creation of closed volume

Generation of 3D model by using surface parameters (Such as product casing design, automotive body panel design etc.)

Exemplars / Practical Applications

Automotive exterior and interior design, Aerospace aerodynamic surface modeling, Consumer product casing design, Ship hull and marine structure design, Medical device ergonomic modeling

Learning Resources

Text Books:

1. Zeid, I and Sivasubramania, R., (2009), “CAD/CAM : Theory and Practice”, 2nd edition, McGraw Hill Education, ISBN-13: 978-0070151345
2. Rao, P. N., (2017), “CAD/CAM: Principles and Applications”, 3rd edition, McGraw Hill Education, ISBN-13: 978-0070681934
3. Chang, Kuang-Hua, (2015), "e-Design: Computer-Aided Engineering Design", Academic Press, ISBN13: 978-0123820389

Reference Books:

1. Lee, Kunwoo, (1999), "Principles of CAD/CAM/CAE Systems", Pearson/Addison-Wesley, ISBN-13: 978-0201380361
2. Bordegoni, Monica and Rizzi, Caterina, (2011), "Innovation in Product Design: From CAD to Virtual Prototyping", Springer, ISBN-13: 978-1447161875
3. Vukašinovic, Nikola and Duhovnik, Jože, (2019), "Advanced CAD Modeling: Explicit, Parametric, Free-Form CAD and Re-engineering", Springer, ISBN-13: 978-3030023980
4. Um, Dugan, (2018), "Solid Modeling and Applications: Rapid Prototyping, CAD and CAE Theory", 2nd edition, Springer, ISBN-13: 978-3319745930
5. Rogers, D. and Adams, J. A., (2017), “Mathematical Elements for Computer Graphics”, 2nd edition, McGraw Hill Education, ISBN-13: 978-0070486775

MOOC / NPTEL/ YouTube Links:

https://onlinecourses.nptel.ac.in/noc25_me157/preview

Guidelines for Instructor's Manual

The instructor’s manual is to be developed as a hands-on resource and reference. The instructor's manual needs to include prologue (about University/program/ institute/ department/foreword/ preface etc), copy of curriculum, conduction & Assessment guidelines, topics under consideration- concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Lab Journal

The laboratory assignments are to be submitted by students in the form of an electronic journal only. Journal consists of prologue, Certificate, table of contents, and model/sketch of each assignment (Title, Objectives, Problem Statement, Outcomes, Software & Hardware requirements, Date of Completion as per applicability. Assessment grade/marks and assessor's sign, As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journals

may be avoided. Use of Drive/Google classroom/Moodle platform containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Lab /TW Assessment

Continuous assessment of laboratory work is done based on overall performance and lab assignments performance of students. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Laboratory Conduction

List of laboratory assignments is provided below for reference. The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy should address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute them among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of coding style, proper indentation and comments.

Use of open source software and recent versions is to be encouraged.

In addition to these, instructors may assign one real life application in the form of a mini-project. Based on the concepts learned. Instructors may also set one assignment or mini-project that is suitable to each branch beyond the scope of the syllabus.

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

VSE-282-MEC: Data Science &AIML

Teaching Scheme		Credit	Examination Scheme	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses, if any:

- Linear Algebra, Probability, Statistics, Logical Reasoning

Course Objectives:

1. To INTRODUCE students to supervised, unsupervised, and reinforcement learning techniques.
2. To GUIDE students in acquiring, visualizing, and analyzing real-world datasets.
3. To ENABLE students to perform feature extraction, selection, and dimensionality reduction.
4. To FACILITATE the development and evaluation of classification and regression models.
5. To EXPOSE students to practical applications of Markov processes, RL, GA, and NN in engineering.

Course Outcomes:

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

CO1. UNDERSTAND different machine learning paradigms and their use cases.
CO2. ANALYZE and VISUALIZE datasets for machine learning applications.
CO3. APPLY feature engineering techniques including PCA and selection methods.
CO4. DEVELOP and EVALUATE classification and regression models.
CO5. IMPLEMENT Markov models, RL, GA, or NN for solving real-world problems

Guidelines for Practical's Conduction

Instruction to students:

1. The student shall complete the following activity as a Practical's
2. Students need to apply the computational algorithms using suitable software / programming language.
3. Experiment 1, 2, 3, 6 & 7 are compulsory. Experiment 2 to 7 to be taken on same data set.

List of Experiments

Experiment 01

To study supervised/unsupervised/reinforcement learning approach.

1. Group customers by shopping behavior
2. Classify emails as spam or not spam

Practical Applications

1. Email Filtering
2. Autonomous Driving

Experiment 02

To acquire, visualize and analyze the data set (from time-domain/frequency-domain/ etc.)

1. Comparison of engine vibration frequencies
2. Analyze motion sensor (accelerometer) data from a smartphone

Practical Applications

1. Vibration Monitoring in Engines
2. Voice Recognition

Experiment 03

To extract features from given data set and establish training data.

1. Extract color histograms from images

2. Extract word counts from news articles

Practical Applications

1. Face Recognition Systems
2. Speech-to-Text Systems

Experiment 04

To select relevant features using suitable technique

1. Sales prediction
2. Use Recursive Feature Elimination (RFE) with Logistic Regression

Practical Applications

1. Medical Diagnosis
2. Stock Price Prediction

OR

Experiment 05

To use PCA for dimensionality reduction

1. Apply PCA on air pollution data
2. Use PCA on climate data to analyze trends

Practical Applications

1. Fault Detection in Manufacturing
2. Handwriting Recognition

Experiment 06

To classify features/ To develop classification model and evaluate its performance (any one classifier).

1. Classify different bank customers
2. Classify flower species

Practical Applications

1. Credit Scoring
2. Image-based Quality Inspection

Experiment 07

To develop regression model and evaluate its performance (any one algorithm).

1. Predict house price
2. Predict student marks based on tests

Practical Applications

1. House Price Prediction
2. Energy Demand Forecasting

Experiment 08

Markov process for modelling manufacturing processes.

1. Inventory Simulation
2. Machine Maintenance

Practical Applications

1. Predictive Maintenance
2. Customer Behavior Modeling

OR

Experiment 09

Reinforced Learning for optimizing engineering designs / Robot Guidance and Navigation.

1. Optimize energy consumption
2. Optimize robot movement

Practical Applications

1. Warehouse Robotics
2. Optimize air conditioning systems

Experiment 10

GA for optimization of multi-dimensional function / path planning in robotics

1. Use GA to plan shortest path
2. Function Optimization

Exemplars / Practical Applications

1. Logistics & Route Optimization
2. Antenna Design Optimization

OR

Experiment 11

NN for parameter and model identification / tuning of Control Algorithms.

1. Predict student grades
2. Use NN for tuning or control

Practical Applications

1. Autonomous Vehicle Control
2. Industrial Process Modeling

Learning Resources

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), “Artificial Intelligence: A Modern Approach,” Third edition, Pearson, 2003.

Reference Books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

MOOC / NPTEL/ YouTube Links: -

1. http://nptel.ac.in/courses/111101003/
2. https://nptel.ac.in/courses/106/106/106106202/
3. https://nptel.ac.in/courses/112/103/112103280/
4. https://www.analyticsvidhya.com

Savitribai Phule Pune University Second Year of Mechanical Engineering (2024 Pattern)				
AEC-283-MEC: Modern Indian Language: 02				
Teaching Scheme		**Credit**	**Examination Scheme**	
Tutorial	**1 Hours/Week**	**1**	**Termwork**	**50 Marks**
Practical	**2 Hours/Week**	**1**		

❖ **अभ्यासक्रमाचे उद्दिष्ट :**

१. प्रगत भाषिक कौशल्यांची क्षमता विकसित करणे.
२. प्रसारमाध्यमांतील संज्ञापनातील स्वरूप आणि स्थान स्पष्ट करणे.
३. व्यक्तिमत्व विकास आणि भाषा यांच्यातील सहसंबंध स्पष्ट करणे.
४. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे यांचे परस्पर संबंध स्पष्ट करणे.
५. प्रसारमाध्यमांसाठी लेखनक्षमता विकसित करणे.

Course Contents

Unit I and II

घटक	तपशील	श्रेयांक	तासिका
१.	१. भाषा आणि व्यक्तिमत्त्व विकास : सहसंबंध २. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे	१	१५
२.	प्रसारमाध्यमांसाठी लेखन १. वृत्तपत्रासाठी बातमीलेखन आणि मुद्रितशोधन २. नभोवाणीसाठी भाषणाचे संहितालेखन ३. दूरचित्रवाणीसाठी माहितीपटासाठी संहितालेखन	१	१५

Unit III and IV

घटक	तपशील	श्रेयांक	तासिका
३.	१. भाषा, जीवन व्यवहार आणि नवमाध्यमे, समाजमाध्यमे २. नवमाध्यमे आणि समाजमाध्यमांचे प्रकार : ब्लॉग, फेसबुक, ट्विटर ३. नवमाध्यमे आणि समाजमाध्यमांविषयक साक्षरता, दक्षता, वापर आणि परिणाम	१	१५
४.	१. वेबसाईट आणि ब्लॉग, ट्विटरसाठी लेखन २. व्यावसायिक पत्रव्यवहार	१	१५

Learning Resources

संदर्भ ग्रंथ :

१. सायबर संस्कृती, डॉ. रमेश वरखेडे
२. उपयोजित मराठी, संपादक डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई
३. ओळख माहिती तंत्रज्ञानाची, टिमोथी जे. ओ. लिअरी
४. संगणक, अच्युत गोडबोले, मौज प्रकाशन, मुंबई
५. इंटरनेट, डॉ. प्रबोध चौबे, मनोरमा प्रकाशन, मुंबई
६. व्यावहारिक मराठी, डॉ. ल. रा. नसीराबादकर, फडके प्रकाशन, कोल्हापूर
७. आधुनिक माहिती तंत्रज्ञानाच्या विश्वात, शिक्रापुरकर दीपक, मराठे उज्ज्वल, उत्कर्ष प्रकाशन, पुणे

Guidelines for Ability Enhancement Courses - Modern Indian Language (Marathi)

Term Work Evaluation

1. Subject teacher should frame minimum 08 assignments-based covering on all four units.
2. They can identify students depending upon the degree of difficulty in understanding the Marathi language and frame the assignments accordingly.

Suggested List of Assignments

1. "**Samvad Sadara Kara" (Present a Dialogue):** Role-Playing Everyday Scenarios: Objective is to practice conversational Marathi, understanding social cues. In pairs or small groups, students create and perform a short dialogue based on a given scenario.
2. Read a daily Newspapers column (Sports, political, finance, editorial, education, international news etc) in the daily Marathi newspapers, summarize and present in the practical. A summary should be added as part of the journal.
3. **Creative writing**: Write blogs and posts on social media upto 200 words on recent development in their field of study
4. **Mala He Sangayche Aahe" (I Want to Say This):** Students show the object describe it to the class in Marathi. They should mention its color, size, use, why it's important to them, etc.
5. **Professional letter / report writing**

a. Write a letter to the principal/director for organizing NSS camp in nearby village. Preparation of the budget, permission letters and report submission in the University

b. Write a letter for internship sponsorship to any organization.

6. **Book Review** – Students are expected to read any novel, fiction or literature book of their choice and write a review on post it on social media of their choice.
7. Participation in Competitions (in college/outside the college) debate, declamation, elocution – A Report should be submitted
8. **Group Activity**: Road show, skit play, one-act play
9. Participation in One-Act-Play - Participation in Purushottam karandam, Firodia karandak, Dajikaka Gadgil Karandak and Shreetej Karandak.
10. **Marathi Film Review** – Watch the Marathi movie widely available on an OTT (Over-The-Top) platform , broadcaster in Television or availed on YouTube and write a review

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised

HSSM-284-MEC: Engineering Economics and Financial Management

Teaching Scheme		Credit	Examination Scheme	
Theory	**2 Hours/Week**	**1**	**CCE**	**50 Marks**
Practical	**NA**		**Practical**	**NA**

Prerequisite Courses, if any:

- Knowledge of company Operations, Design and Manufacturing, Basic principles and practices of Accounting and Budgeting, Analytical and Logical Thinking

Course Objectives:

1. To INTRODUCE the fundamental principles of economics and finance relevant to core engineering industries.
2. To DEVELOP an understanding of basic financial management concepts and enhance analytical skills for interpreting financial statements.
3. To FAMILIARIZE students with key financial terminologies and enable them to prepare and analyze various financial statements.
4. To PROVIDE insights into the budgeting process, including formulation, implementation, and control mechanisms.
5. To EXPLORE the financial dimensions of national and international business environments and their implications on engineering decisions.

Course Outcomes:

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

CO1: DEMONSTRATE an understanding of the business environment, fundamental economic concepts, and the demand-supply framework.

CO2: COMPREHEND accounting principles and effectively ANALYSE financial statements through ratio analysis.

CO3: INTERPRET key financial terms and ratios, and competently PREPARE various types of financial statements.

CO4: DEVELOP and SELECT appropriate budgeting techniques, understand budgetary control, and EVALUATE the influence of government policies, taxation, and inflation on financial decision-making.

CO5: UNDERSTAND the structure and functioning of national and international trade systems and their financial implications

Course Contents

Unit I	Introduction to Business Economics and Finance	(06 Hours)

Business Economics Basics: Definition, scope, and role in engineering, Microeconomics vs. Macroeconomics Demand, Supply & Market Equilibrium: Laws of demand & supply, elasticity, market forces.

Cost Concepts & Decision Making: Fixed, variable, marginal, sunk costs, Break-even analysis, profit maximization.

Basics of Financial Management: Financial statements (Balance Sheet, Income Statement, Cash Flow), Financial planning & decision-making for engineers.

Time Value of Money (TVM): Present & future value, simple & compound interest. Business & Financial Decisions in Engineering: Capital investment, risk assessment, Sources of financing (debt, equity, venture capital).

Real World Assignment (Any One)

1. Case study on micro economics business environment.

2. Analyze demand and supply fluctuations for any business of your choice and Propose pricing or inventory strategies based on findings.

3. Understand and apply break-even analysis to a real-world business scenario.

Exemplars / Practical Applications

Market Structure Analysis for Business Decision Making, Budgeting and Financial Planning, Understanding Economic Indicators for Investment Decisions.

Unit II	Cost Accounting	(05 Hours)

Introduction: Importance and difference between cost and financial accounting.

Cost Accounting: Types of costs: Fixed, variable, direct, indirect.

Costing methods: Job costing, process costing. Break-even analysis & budgeting for cost control.

Engineering Applications: Cost estimation, project budgeting, financial decision-making

Real World Assignment

1. List and classify the different types of costs involved in manufacturing a mechanical part.
2. Calculate the cost per unit by considering material cost, labor, and overheads of any mechanical element. Also estimate the total cost to produce 500 units.
3. For the nearby industry, using fixed and variable costs, calculate the break-even point for their production setup for any one item and suggest how many items must be sold to cover all costs

Exemplars / Practical Applications

All kind of industries where need to prepare standard costing and marginal costing of product, project based costing in EPC industries.

Unit III	Financial Accounting	(05 Hours)

Introduction: Importance of financial accounting.

Financial Accounting: Key financial statements: Balance Sheet, Income Statement, Cash Flow Statement.

Key Financial Terms: Revenue, Cost of Goods Sold (COGS), Operating Expenses like rent, utilities, salaries. Depreciation in asset value over time, Capital Expenditure.

Financial ratios: Profitability, liquidity, efficiency

Real World Assignment

1. Prepare financial statement of any organization.
2. Choose a company or firm and analyze its latest financial statements.
3. Prepare a balance sheet for any engineering organization.

Exemplars / Practical Applications

Engineering Industries, Banking sectors, Oil Gas industries, NGO for proper planning of cash flow.

Unit IV	Budget and Budgetary Control	(06 Hours)

Introduction to Budgeting: Definition, purpose, and importance in engineering and business.

Types of budgets: Fixed, flexible, zero-based, capital, and operational budgets.

Budgetary Control: Concept and objectives of budgetary control. Steps in budget preparation and implementation. Variance analysis: Comparing actual vs. budgeted performance.

Engineering Applications: Budgeting in manufacturing and project management. Cost control and resource allocation in engineering firms. Taxes and Financial Planning, Impact of government policies, Taxation and Inflation on Financial Management.

Real World Assignment (Any One)

1. Prepare and Interpret Budget and Standard Costs for any real business.
2. How can technology improve budget preparation and control? Discuss tools like Excel, ERP systems, or budgeting software.
3. How can businesses run against inflation and manage tax burdens efficiently? Suggest your financial strategies.

Exemplars / Practical Applications

To prepare Flexible Budgeting in all Engineering Industries, Zero budgeting in Government sectors, Sales and Operating Budgets for Retail Sector

Unit V	National and International Business and Finance	(06 Hours)

National Income (National Income Accounting – GDP, GNP, Real and Nominal Income) Fiscal Policy (Government Revenue, Expenditure and Financing). Concept of globalization, factors influencing globalization, concept of international business and motives, international trade, institutional framework in international business, the significance of foreign trade policy, export-import procedures.

Real World Assignment (Any One)

1. Choose any industry sector and research how GDP growth or decline has affected investments and job opportunities in this sector.
2. Visit an official economic data website (e.g., World Bank, IMF, National Bureau of Statistics) and collect the latest GDP and GNP data of our country. Compare the values and explain your findings about the country's economy.
3. Discuss the need of Foreign Capital and international finance.

Exemplars / Practical Applications

National Financing is needed in Small and Medium Enterprises, Calculation of GDP, National Stock Exchanges, Public Infrastructure Projects and International Financing is needed in Foreign Direct Investment (FDI), International Trade Financing, Global Financial Institution.

Learning Resources

Text Books:

1. Hay, Donald A. and Derek J. Morris. Industrial Economics and Organization: Theory and Evidence, 2nd Edition (Oxford: Oxford University Press), 1991.
2. Lall, Sanjaya. Competitiveness, Technology and Skills (Cheltenham: Edward Elgar), 2001.
3. Scherer, F. M. and D. Ross. Industrial Market Structure and Economic Performance, 3rd Edition (Houghton: Mifflin), 1990.
4. Financial Accounting", Dr. Kaustubh Sontakke [Himalaya Publishing House]
5. Chandra, Prasanna (2004). Financial Management: Theory and Practice. New Delhi: TATA McGraw Hill

Reference Books:

1. Accounting Theory & Practice Prof Jawahar Lal [Himalaya Publishing House] 79 | Page
2. Brearley, Richard A. and Myers, Stewart C. (1988). "Principles of Corporate Finance", New Delhi: McGraw-Hil
3. Engineering Economics, Tara Chand, Nem Chand and Brothers, Roorkee
4. Engineering Economy, Thuesen, G. J. and Fabrycky, W. J., Prentice Hall of India Pvt. Ltd.
5. Mechanical Estimating and Costing, T. R. Banga and S. C. Sharma, Khanna Publishers, Delhi
6. Industrial Organization and Engineering Economics, T. R. Banga and S. C. Sharma, Khanna Publishers, New Delhi
7. Mechanical Estimating and Costing, D. Kannappan et al., Tata McGraw Hill Publishing Company Ltd., New Delhi
8. A Text Book of Mechanical Estimating and Costing, O. P. Khanna, Dhanpat Rai Publications Pvt. Ltd., New Delhi
9. Industrial Engineering and Management, O. P. Khanna, Dhanpat Rai and Sons, New Delhi
10. Financial Management, I. M. Pandey, Vikas Publishing House Pvt. Ltd., New Delhi
11. Engineering Economics, James L. Riggs, David D. Bedworth and Sabah U. Randhawa, Tata McGrawHill Publishing Co. Ltd., New Delhi
12. Engineering Economy, Paul DeGarmo, Macmillan International Inc., New York

MOOC / NPTEL/ YouTube Links: -

1. https://onlinecourses.nptel.ac.in/noc22_ma44/
2. https://onlinecourses.nptel.ac.in/noc22_hs72/
3. https://onlinecourses.nptel.ac.in/noc22_mg63/

Savitribai Phule Pune University
Second Year of Mechanical Engineering (2024 Pattern) Revised
VEC-285-MEC: Environmental Science and Sustainable Development

Teaching Scheme		Credit	Examination Scheme	
Theory	**2 Hours/Week**	**2**	**CCE**	**20 Marks**
Practical	**NA**		**End-Semester**	**30 Marks**

Prerequisite Courses, if any:

- Knowledge of Chemistry, Biology and Earth Sciences

Course Objectives:

1. To INTRODUCE students to the fundamental concepts of environmental science, including the relationship between natural systems and human activities, concept of sustainable development and its significance in the day today life.
2. To FOSTER critical thinking skills regarding environmental issues such as climate change, pollution, resource depletion, deforestation, and habitat destruction.
3. To STUDY sustainable practices in energy use, agriculture, waste management, and urban planning, emphasizing the importance of balancing development with environmental preservation.
4. To EVALUATE the role of renewable energy, green technologies, and conservation efforts in promoting sustainability.
5. To ENCOURAGE students to apply their knowledge to real-world environmental challenges and sustainable development problems, through case studies, projects, and fieldwork.

Course Outcomes:

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

CO.1 To UNDERSTAND and EVALUATE the interdependence between environment, ecology, and natural resources, assess the impact of air pollution and ecological footprints, and ANALYZE the dynamic interactions between socio-economic systems.

CO. 2 To EVALUATE the causes of soil degradation and apply effective soil conservation and management practices to maintain soil health, enhance agricultural productivity, and promote sustainable land use.

CO.3 To IDENTIFY various water sources, ANALYZE issues related to water availability and quality, and APPLY sustainable water management practices to support environmental conservation and meet societal needs.

CO.4 To UNDERSTAND the principles of sustainability, EVALUATE environmental, social, and economic challenges, and APPLY practical sustainability practices to promote responsible resource use.

CO.5 To ANALYZE the principles of sustainable habitat design and sustainable energy systems, and APPLY environmentally responsible solutions such as green buildings, energy-efficient technologies, and renewable energy sources to promote sustainable living and reduce ecological impact.

Course Contents

Unit I	Introduction to ESD	(06 Hours)

Environment, ecology, natural resources, Air pollution, Ecological footprint, Interactions between socio-economic systems and eco-systems, Human health and the environment

Real World Assignment

1) Weather survey of your region of last 10 years
2) Air pollution and its effect on human health.

Exemplars / Practical Applications

1) Air purifiers
2) Air quality index indicators

Unit II	**Soil Conservation and Management**	**(06 Hours)**

Types and causes of soil degradation; Losses of soil moisture and its regulation, Nutrient depletion; impact of soil degradation on agriculture and food production , toxic organic chemicals, and organic contaminants in soils, Fertilizers and fertilizer management, Recycling of soil nutrients.

Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur.

Real World Assignment

1. Analysis of soil texture, Ph and organic matter content
2. Effect of chemical fertilizers on soil biogeochemical cycles and on human health

Composting of organic waste

Exemplars / Practical Applications

1. Contour farming
2. Strip forming
3. Natural fertilizers.

Unit III	**Water Sources and Management**	**(06 Hours)**

Hydrological cycle and water resources- surface, ground, desalination, Water pollution, Integrated water resources management, Usage and efficiency

Real World Assignment

Development of greywater recycling system

Exemplars / Practical Applications

1. Water source management in desert area
2. Recycling and reuse of waste water
3. Rainwater harvesting

Unit IV	**Sustainability and Sustainability Practices**	**(06 Hours)**

Sustainability- concept, needs and challenges-economic, social, Aspects of sustainability- from unsustainability to sustainability, Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Zero waste concept, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment.

Real World Assignment

1. Effect of global warming on human health
2. Indian government policies for sustainable development.

Exemplars / Practical Applications

Green roofs and Vertical Gardens

Unit V	**Sustainable Habitat and Sustainable Energy**	**(06 Hours)**

Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports, Sustainable energy: Non-conventional Sources, Energy Cycles- carbon cycle, emission and sequestration

Real World Assignment

Calculation of carbon foot print.

Exemplars / Practical Applications

Energy efficient buildings

Learning Resources

Text Books:

1. P. D. Sharma; Ecology and Environment; Volume 22 of Popular Biology Text Books Rastogi Publications, 2007
2. D.D. Mishra-Fundamental of Environmental Studies, S Chand & Co Ltd (1 December 2010).
3. M. Dayal- Renewable Energy; Environment and Development, Konark Pub.Pvt.Ltd.
4. Fulekar; Fundamental of Air pollution. 4th Edition, Daniel Vallero, Academic Press, Elsevier .

5. Ambasht R.S.; Environment and Pollution: An Ecological Approach, CBS Publishers & Distributors; 1st Ed. edition 2014

Reference Books:

1. Stanley E. Manahan; Fundamentals of Environmental Chemistry; Publisher: CRC Press 1993
2. E.D. Enger, B. E. Smith; Environmental Sciences-A study of Inter relationships, WCB Publication.
3. Kathy Wilson Peacock; Natural Resources and Sustainable Development.
4. Elizabeth Berner, Robert Berner; Global Enviroment - Water, Air, and Geochemical Cycles, Princeton University Press; 2nd Revised edition edition 2012.
5. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
6. Andrew Dessler, Introduction to Modern Climate Change, 2nd Edition, Cambridge University Press, 2015.
7. Bruce Glavovic, Mick Kelly, Robert Kay, Ailbhe Travers, Climate Change and the Coast: Building Resilient Communities, CRC Press, 2015.

MOOC / NPTEL/ YouTube Links: -

1. Environmental and Sustainability Studies - Raquel Friedmann - YouTube
2. Lecture 1 - Sustainable Development Concepts - YouTube
3. Climate Change - A Short Film [4K]

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