Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

National Education Policy (NEP)-2020 Compliant Curriculum

Second Year Engineering (2024 Pattern) -Revised

In

Automobile Engineering

*(*With effect from Academic Year 2026-27*)*

Contents

Nomenclature

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

Preface by Board of Studies

Dear Students and Teachers,

The Board of Studies – Automobile Engineering is delighted to present the Second Year Automobile Engineering syllabus(Revised), effective from the Academic Year 2026–27 (2024 Pattern). The syllabus aims to be both engaging and rigorous. It will be implemented for Second Year Engineering in 2026–27 and extended to the Third and Final Years in 2027–28 and 2028–29, respectively.

Automobile Engineering, a vital branch of engineering, requires continual syllabus updates to stay aligned with industry demands. The dynamic field integrates core engineering principles to foster innovation in design, manufacturing, energy, materials, automation and emerging automotive trends. The revised curriculum offers a strong in fundamentals, emerging technologies and real-world applications to prepare students for the evolving automotive industry.

Aligned with the vision of NEP-2020 and frameworks set by Savitribai Phule Pune University, AICTE, UGC and accreditation bodies, the syllabus incorporates recent advancements and industry requirements to enhance professional readiness.

Wherever relevant, supplementary resources such as SWAYAM- NPTEL links are included at the end of each course. Students are encouraged to utilize these platforms for self-learning, participate in online courses and undertake additional projects. Upon completion, they are advised to submit course certifications to further support their academic development.

The curriculum is developed through collaboration among academic experts, industry professionals and alumni to ensure its relevance and quality. It is structured to meet industry expectations and support aspirations for higher education, research and entrepreneurship in the field of Automobile Engineering.

This curriculum is intended to motivate students to become technically proficient professionals, responsible citizens and contributors to technological and sustainable progress.

Dr. Pradeep A. Patil
Chairman
Board of Studies – Mechanical and Automobile Engineering

Program Specific Outcomes

PSO1: SPECIFY, DESIGN, and EVALUATE automobile components and systems using appropriate modelling, simulation and analysis tools.

PSO2: APPLY knowledge of automotive systems, manufacturing processes, vehicle dynamics, advanced materials and modern management techniques for the design and manufacturing of automobile components and assemblies.

PSO3: APPLY core principles of thermal and fluid sciences to analyse and optimize the performance of automotive powertrains, propulsion systems and thermal management systems.

Program Educational Objectives

PEO1: Graduates will establish successful careers in the domain of automobile engineering by demonstrating advanced technical skills, research capability, and a strong sense of professional ethics.

PEO2: Graduates will effectively contribute to multidisciplinary teams and dynamic work environments by exhibiting teamwork, adaptability, communication skills and leadership potential.

PEO3: Graduates will engage in continuous learning and skill enhancement, staying responsive to emerging technologies and evolving industry trends.

Program Outcomes

Program Outcomes define the specific competencies that students are expected to acquire by the time they complete the program. These outcomes are closely aligned with the Program Educational Objectives and represent the knowledge, skills, attitudes and professional attributes developed throughout the learning process. Upon successful completion of B.E. programme in Automobile Engineering, the 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.	Title/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.	40
End-Semester Examination (ESE)	Conducted at university level, typically covering the entire syllabus through summative examination.	60
	Total Marks per Subject	**100**

A) Comprehensive Continuous Evaluation (CCE)

To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 30 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 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.

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 test 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) End-Semester Examination (ESE)

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– Automobile 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															
PCC201ABE	Major Course-1	Mechanics of Structures	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC202ABE	Major Course-2	Thermal Science	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC203ABE	Major Course-3	Material Science and Metallurgy	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC204ABE	Major Course-3A	Material Testing and characterization Lab	-	2	-	-	-	-	50	-	50	-	-	1	1
MDM221ABE	Multidisciplinary Course-1	Mathematical Methods in Engineering	3	-	-	40	60	-	-	-	100	3	-	-	3
MDM222ABE	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
VSE231ABE	Vocational Skill Course	Workshop Practices	-	2	-	-	-	-	25	-	25	-	-	1	1
HSSM232ABE	Entrepreneurship/ Management course	Entrepreneurship Development and Innovation	1	-	-	25	-	-	-	-	25	1	-	-	1
VEC233ABE	Value Education Course	Universal Human Values	2	-	-	20	30	-	-	-	50	2	-	-	2
CEP241ABE	Community Engagement Project	Community Engagement Project	-	4	-	-	-	50	-		50	-	-	2	2
Total			**17**	**10**	**-**	**225**	**300**	**50**	**125**		**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) – Automobile 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															
PCC251ABE	Major Course-4	Fluid Statics and Dynamics	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC252ABE	Major Course-5	Manufacturing Technology	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC253ABE	Major Course-6	Applied Thermodynamics and Heat Transfer	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC254ABE	Major Course-6A	Thermo- Fluid Engineering Lab	-	2	-	-	-	-	50	-	50	-	-	2	2
MDM271ABE	Multidisciplinary Course-2	Artificial Intelligence and Machine Learning	2	-	-	50	-	-	-	-	50	2	-	-	2
	Open Elective	Open Elective-II	2	-	-	20	30	-	-	-	50	2	-	-	2
VSE281ABE	Vocational Skill Course	Solid modeling and drafting	-	2	-	-	-	-	50	-	50	-	-	1	1
VSE282ABE	Vocational Skill Course	Data Science and AIML	-	2	-	-	-	-	50	-	50	-	-	1	1
AEC283ABE	Ability Enhancement Course	Modern Indian Language: 02	-	2	1	-	-	50	-	-	50		1	1	2
HSSM284ABE	Entrepreneurship/ Management course	Engineering Economics and Financial Management	2	-	-	50	-	-	-	-	50	1	-	-	1
VEC285ABE	Value Education Course	Environmental Science and Sustainable Development	2	-	-	20	30	-	-	-	50	2	-	-	2
Total			**17**	**8**	**1**	**260**	**240**	**50**	**150**	**-**	**700**	**16**	**1**	**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.

 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 - Automobile Engineering

Semester III Courses

Savitribai Phule Pune University Second Year of Automobile Engineering (2024 Pattern)				
PCC-201-ABE: Mechanics of Structures				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End-Semester**	**60 Marks**

Prerequisite Courses:

- Engineering Mechanics

Course Objectives:

1. To familiarize fundamentals of stress, strain and loading.
2. To realize shear force and bending moment in statically determinate structures under various loading conditions.
3. To comprehend bending and shear stresses; slope and deflection in beams.
4. To emphasize torsional shear stress in shafts and buckling in columns.
5. To understand principal stresses and elastic failure theories for safer design.

Course Outcomes:

On completion of the course, learner will be able to

CO1. To ANALYZE stress-strain behavior and EVALUATE safety of components
CO2. To APPLY loading concepts to construct SFD/BMD and ANALYZE critical points.
CO3. To ANALYZE beams under different loading conditions
CO4. To APPLY torsion and buckling theories to ANALYZE shafts and columns.
CO5. To DETERMINE principal stresses and EVALUATE failure using standard strength theories

Course Contents

Unit I	**Mechanics of Materials Under Load**	**(07 Hours)**

Simple stress and strain: Introduction to types of loads (static, dynamic, and 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 beams, homogeneous and composite bars under concentrated loads and self-weight; thermal stresses in plain and composite members.

Real World Assignment

1. Ductile vs. Brittle Materials Comparison
   (Compare stress-strain behavior using test data or plots)
2. Bookshelf Load Analysis
   (Study stresses in wooden vs. composite shelves)
3. Thermal Stress in Railway Tracks
   (Compute thermal stresses due to temperature variation)
4. Stress and strain analysis of an automotive suspension arm:
   (Force diagrams, stress-strain graphs, tabulated material properties and safety analysis)

Unit II	**Shear Force and Bending Moment Analysis of Statically Determinate Beams**	**(07 Hours)**

Shear force and bending moment diagrams: Introduction to shear force (SFD) and bending moment diagrams (BMD); SFD and BMD for statically determinate beams due to concentrated load, uniformly distributed load, and combined loading; relationship between rate of loading, shear force, and bending moment; concept of zero shear force, maximum bending moment and point of contra-flexure.

Real World Assignment

1. Balcony Cantilever Load Analysis
   (Analyze a cantilever balcony under live (people) and dead (self-weight) loads)
2. Bridge Girder under Traffic Loa
   (Model a simply supported bridge beam under vehicle loads)
3. Street Light Pole Bracket
   (Study bracket supporting a light pole (horizontal beam with end load)
4. Load distribution and bending moment in a suspension control arm
   (Evaluate shear force and bending moment in the suspension control arm of an automobile)

Unit III	**Analysis of Determinate Structures**	**(07 Hours)**

Bending stress on a beam: Theory of simple bending; bending stress distribution along unsymmetrical I and T sections.
Shear stress on a beam: Introduction to transverse shear stress on a beam with application; shear stress distribution diagram along unsymmetrical I and T sections.
Slope and deflection on a beam: Macaulay method for different types of loading and end conditions.

Real World Assignment

1. Bending Stress in a Crane Hook (T-section)
   (Bending stress in unsymmetrical sections, neutral axis shift)
2. Shear Stress in a Bus Chassis Cross-Section (I-beam)
   (Transverse shear stress, real-world I-sections)
3. Slope and Deflection in a Street Sign Pole (Macaulay Method)
   (Deflection under eccentric loads, boundary conditions)
4. Stress and deflection analysis of an automotive suspension beam
   (Analyze bending stress, shear stress, and deflection in a suspension beam subjected to loads)

Unit IV	**Torsion of Shafts and Buckling of Columns**	**(07 Hours)**

Torsion of circular shafts: Basic torsion formulae and assumption in torsion theory, Torque transmission on strength and rigidity basis, Shaft subject to bending and combined loading, Equivalent torque, Design of propeller shaft and axle.

Buckling of columns, various end conditions. Analysis of columns and structs by Euler, Rankine and Johnson theories.

Real World Assignment

1. Torsional Analysis of a Vehicle Propeller Shaft
   (Analyze strength and rigidity of a hollow circular shaft under torque)
2. Torsional analysis of an automobile driveshaft
   (Torsion calculations, stress distribution analysis, recommendations for material selection)
3. Buckling analysis of an automobile chassis frame:
   (Perform buckling analysis of an automobile chassis frame under loading conditions)
4. Structural Stability of a Telescopic Pole (Rankine & Johnson Theories)
   (Real-world column failure modes)

Unit V	Principal Stresses and Theories of Elastic Failure	(07 Hours)

Principal stresses: Transformation of plane stress; analysis of principal stresses and planes by analytical method only.

Theories of elastic failure: Maximum principal stress theory, maximum shear stress theory, maximum distortion energy theory and applications. Comparison of various theories of failure.

Real World Assignment

1. Stress Analysis of a Welded Joint in a Crane Arm
   (Analyze plane stresses in a welded L-joint under load)
2. Principal stress analysis of an automotive brake caliper
   (Evaluate stress distribution and identify critical stress regions in a brake caliper under braking load)
3. Comparison of Failure Theories for Aircraft Wing Support
   (Apply different failure theories to a wing support under complex loading)
4. Failure analysis of an engine connecting rod using distortion energy theory:
   (Assess the risk of elastic failure in a connecting rod subjected to loads)

Learning Resources

Text Books:

A. S.S. Bhavikatti, "Strength of Materials ",Vikas Publishing House
B. Dr. B.C. Punmia, "Mechanics of Materials", Laxmi Publications Pvt Limited
C. R. K. Bansal, "Strength of Materials", Laxmi Publication
D. S. Ramamurtham, "Strength of material", Dhanpat Rai Publication
E. Russell C. Hibbeler, Mechanics of Materials, Pearson Education

Reference Books:

1. S.S. Rattan, "Strength of Materials", Tata McGraw Hill Publication Co. Ltd.
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall publications.

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/105/105/105105108/
2. https://archive.nptel.ac.in/courses/112/107/112107146/
3. https://archive.nptel.ac.in/courses/112/107/112107147/
4. https://archive.nptel.ac.in/courses/105/105/105105108/

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

PCC-202-ABE: Thermal Science

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

Prerequisite Courses:

- Engineering Chemistry, Engineering Mathematics – I and II.

Course Objectives:

1. To understand thermodynamic systems, properties, equilibrium and heat/work concepts.
2. To introduce energy forms and apply the First Law to processes and devices.
3. To explore phase-change phenomena, property tables and gas behaviour.
4. To develop insight into the Second Law, entropy and ideal thermodynamic cycles.
5. To introduce exergy and psychometrics for thermodynamic analysis

Course Outcomes:

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

CO1: To **EXPLAIN** thermodynamic systems, properties, and heat–work interactions.
CO2: To **APPLY** the First Law and **ANALYZE** energy exchange in engineering systems.
CO3: To **INTERPRET** phase-change processes and gas behaviour using property data.
CO4: To **ANALYZE** entropy changes and **EVALUATE** heat engine and refrigerator performance.
CO5: To **EVALUATE** second-law efficiency and **ANALYZE** psychrometric processes.

Course Contents

Unit I	Introduction to Thermodynamic Systems and Fundamental Concepts	(07 Hours)

Thermodynamic systems – closed, open, isolated, control volume, boundaries, surroundings, macroscopic and microscopic approaches.
Thermodynamic properties – intensive, extensive, specific, point and path functions, state, path, process, cycle, quasi-static and non-quasi-static processes.
Thermodynamic equilibrium – thermal, mechanical, chemical equilibrium.
Zeroth Law of Thermodynamics, concept of temperature and temperature scales,
Concept of continuum and relevance of molecular approach, Concept of work and heat – adiabatic work, dimensional homogeneity, Overview of ideal gases and real gases.

Real World Assignment

1. **Identify Thermodynamic Systems in Daily Life**

Task: Observe and document 3 everyday devices (e.g., electric kettle, car engine, air conditioner).
Objective: Classify each as an open, closed, or isolated system; define boundaries, surroundings, and type of process.
Deliverable: Table with system classification, justification, and labelled diagram.

2. **Application of Zeroth Law of Thermodynamics**

Task: Use 3 objects (e.g., metal blocks) and a thermometer to experimentally verify the Zeroth Law.
Objective: Show that if object A = object B in temperature and B = C, then A = C.
Deliverable: Experimental procedure, observations, and thermal equilibrium explanation.

3. **Work and Heat in a Bicycle Pump**

Task: Analyse the air compression in a pump.
Objective: Explain the energy transfer—mechanical work input, heat transfer, and temperature change using the concept of quasi-static vs. non-quasi-static processes.
Deliverable: Short report explaining the process path and thermodynamic analysis.

4. **Continuum vs. Molecular View in Micro-Scale Devices**

Task: Study a real micro device (e.g., MEMS sensor or micro valve).

Objective: Determine when the continuum assumption breaks down, and when molecular models are more appropriate.
Deliverable: Summary of device behaviour, relevance of mean free path, and comparison of modelling approaches.

Unit II	Energy Transfer, Work and First Law of Thermodynamics	(07 Hours)

Forms of energy – internal, kinetic, potential, chemical, mechanical, electrical,
Work transfer – isothermal, polytropic, adiabatic, and isobaric processes,
Heat transfer and thermodynamic sign conventions,
First Law for closed systems – application to various processes,
First Law for open systems – control volume formulation,
Steady Flow Energy Equation (SFEE),
Applications of SFEE – turbines, compressors, nozzles, diffusers, pumps, heat exchangers, throttling valves, Enthalpy, specific heats of solids, liquids and gases, Perpetual Motion Machine of the First Kind (PMM-I) and its violation, Thermodynamic definition of boundary work and displacement work

Real World Assignment

1. **Energy Balance in a Pressure Cooker**

Task: Analyse a pressure cooker heating phase.
Objective: Apply the First Law for a closed system to calculate internal energy change, heat input, and boundary work.
Deliverable: Report showing energy terms and assumptions used.

2. **SFEE in a Hair Dryer or Vacuum Cleaner**

Task: Model air flow in a hair dryer as a control volume.
Objective: Apply the Steady Flow Energy Equation (SFEE) to determine work done and energy changes in air.
Deliverable: SFEE-based energy diagram and explanation.

3. **Identify and Explain PMM-I Devices in Fiction/Ads**

Task: Find a real or fictional example of a Perpetual Motion Machine of the First Kind.
Objective: Explain why it violates the First Law using thermodynamic reasoning.
Deliverable: One-page explanation with diagram and thermodynamic critique.

4. **Work and Heat Transfer in a Car Radiator (Heat Exchanger)**

Task: Evaluate energy transfer in a car radiator using SFEE and heat transfer analysis.
Objective: Identify energy flows, define control volume and calculate enthalpy change of coolant.
Deliverable: Energy balance with assumptions and practical observations.

Unit III	Properties of Pure Substances, Phase Change and Gas Behavior	(07 Hours)

Pure substances and phase-change phenomena – subcooled liquid, saturated liquid, saturated mixture, superheated vapour, P–V, T–S, and H–S diagrams for water and refrigerants, Use of steam tables and Mollier charts, Calculation of properties using interpolated data, Concept of dryness fraction and measurement using throttling and separating calorimeters, Ideal and real gas behaviour, Van der Waals and other equations of state, Compressibility factor, generalized compressibility charts, Mixtures of ideal gases – molar and mass fractions, Dalton's Law of Partial Pressures, Amagat's Law of Partial Volumes, Gas laws – Boyle's Law, Charles's Law, Avogadro's Law, Specific heats and Mayer's relation for gases.
Thermodynamic Relations: Maxwell relations, Clapeyron equation, Joule-Thomson effect.

Real World Assignment

1. **Steam Quality Estimation in a Boiler Lab Setup**

Task: Measure pressure and temperature after throttling; estimate **dryness fraction** using a throttling calorimeter.
Objective: Determine steam quality and phase using **steam tables** and **Mollier chart**.
Deliverable: Dryness fraction calculation and steam condition (wet/dry/superheated).

2. **Refrigerator Performance Study Using P–H Diagrams**

Task: Obtain pressures and enthalpies across the refrigeration cycle components.
Objective: Plot cycle on **P–H (Mollier)** diagram and calculate COP using enthalpy differences.
Deliverable: Cycle plot, enthalpy values, and real vs. ideal performance comparison.

3. **Gas Mixture Behavior Simulation (Using Dalton & Amagat Laws)**

Task: Mix known quantities of air and CO_2 in a simulation or experiment.
Objective: Calculate total pressure/volume using **Dalton's Law** and **Amagat's Law**.

Deliverable: Table of molar/mass fractions, predicted vs. actual pressure/volume.

4. **Joule–Thomson Coefficient Evaluation for CO_2**

Task: Use throttling data to evaluate temperature change across a porous plug for CO_2.
Objective: Analyze the **Joule–Thomson effect** and determine whether cooling or heating occurs.
Deliverable: Joule–Thomson coefficient computation and physical interpretation.

Unit IV	Second Law of Thermodynamics, Entropy and the Carnot Cycle	(07 Hours)

Limitations of the First Law – need for Second Law, heat engines and heat pumps – efficiency and COP, Kelvin–Planck and Clausius statements, equivalence and implications, concepts of reversible and irreversible processes, Carnot cycle – theoretical heat engine and refrigerator, Carnot efficiency, Carnot theorems and thermodynamic temperature scale.

Clausius inequality and entropy – concept and property, Entropy change during processes for pure substances and ideal gases, Entropy generation and principle of increase of entropy, T–DS equations, entropy–enthalpy and entropy–internal energy relations, Second Law analysis of systems and control volumes, Numerical problems using entropy balance and irreversibility estimation.

Real World Assignment

1. **Analyse the Efficiency of a Home Refrigerator**

Task: Measure electrical input and cooling output (via estimated heat absorbed from a compartment).
Objective: Calculate the **Coefficient of Performance (COP)** and compare it with ideal values using **Carnot efficiency**.
Deliverable: COP calculation and analysis of deviations from the ideal case.

2. **Identify and Classify Reversible vs. Irreversible Processes**

Task: Observe and report on 3 real processes (e.g., mixing coffee and milk, tire friction, air flow in a fan).
Objective: Classify them based on entropy generation and justify using **Second Law principles**.
Deliverable: Table with process description, classification, and thermodynamic justification.

3. **Carnot Cycle Simulation using Ideal Gas Assumptions**

Task: Simulate or calculate a Carnot cycle using ideal gas processes.
Objective: Compute work done, heat transferred, and **Carnot efficiency**.
Deliverable: Cycle diagram, thermodynamic calculations, and discussion on feasibility.

4. **Entropy Change in Heating Water (Real System Analysis)**

Task: Heat a known quantity of water from ambient to boiling in a kettle.
Objective: Estimate **entropy change of water**, **entropy generation**, and discuss **irreversibility** of the process.
Deliverable: Calculations, assumptions, and control volume energy-entropy analysis.

Unit V	Exergy, Availability and Psychometrics in Thermodynamic Systems	(07 Hours)

Concept of exergy (availability), available and unavailable energy, Exergy for closed and open systems, Dead state and ambient conditions, Irreversibility and Gouy–Stodola theorem, Exergy destruction, exergy balance for steady flow systems, Second-Law (rational) efficiency, Basic concepts of atmospheric air and psychometrics, specific humidity, relative humidity, dew point temperature, dry bulb and wet bulb temperature, adiabatic saturation temperature,

Use of psychrometric charts,

Psychrometric processes – sensible heating, sensible cooling, humidification, dehumidification, mixing of air streams,

Applications to air-conditioning systems and cooling towers.

Real World Assignment

1. **Exergy Analysis of an Air Conditioner (Room-Based Study)**

Task: Record ambient and room conditions; estimate the useful work potential and exergy destruction in cooling.
Objective: Apply exergy balance and calculate second-law efficiency.
Deliverable: Exergy flow diagram, calculations, and a summary of irreversibility sources.

2. **Use of Psychrometric Chart in Real Weather Conditions**

Task: Record real atmospheric data (dry bulb, humidity) from a weather app and plot the state point on a psychrometric chart.
Objective: Determine dew point, enthalpy, specific humidity, and cooling potential.
Deliverable: Labeled chart, calculated air properties, and commentary on air conditioning needs.

3. **Evaluate Cooling Tower Performance using Psychrometrics**

Task: Use sample input/output air and water temperatures from a cooling tower system.

Objective: Assess latent heat transfer and efficiency using psychrometric principles.
Deliverable: Cooling curve sketch, enthalpy difference, and humidification analysis.

4. **Exergy Loss Audit in Household Appliances**

Task: Select 3 appliances (e.g., fridge, heater and mixer) and estimate exergy inputs and losses.
Objective: Identify dead states, irreversibility sources, and suggest design improvements.
Deliverable: Exergy flow breakdown for each device and suggestions for performance enhancement.

Learning Resources

Text Books:

1. **Yunus A. Çengel and Michael A. Boles**, Thermodynamics: An Engineering Approach, McGraw Hill
2. **P. K. Nag**, Engineering Thermodynamics, Tata McGraw-Hill Publications
3. **R. K. Rajput**, Engineering Thermodynamics, EVSS Thermo, Laxmi Publications
4. **C. P. Arora**, Thermodynamics, Tata McGraw-Hill
5. **M. M. Rathore**, Thermal Engineering, Tata McGraw-Hill

Reference Books:

1. **J. P. Holman**, Thermodynamics, McGraw Hill
2. **Rayner Joel**, Basic Engineering Thermodynamics, AWL–Addison Wesley
3. **Gordon Van Wylen, Richard Sonntag, and Claus Borgnakke**, Fundamentals of Classical Thermodynamics, John Wiley & Sons
4. **M. Achuthan**, Engineering Thermodynamics, PHI Learning
5. **Steam Tables / Thermodynamic Data Book** (ISI/Publisher Recommended Edition)

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/128/106/128106015/
2. https://archive.nptel.ac.in/courses/103/103/103103144/
3. https://archive.nptel.ac.in/courses/112/105/112105266/
4. https://archive.nptel.ac.in/courses/112/105/112105220/
5. https://archive.nptel.ac.in/courses/101/104/101104067/
6. https://archive.nptel.ac.in/courses/102/106/102106026/
7. https://archive.nptel.ac.in/courses/112/104/112104113/
8. https://archive.nptel.ac.in/courses/112/105/112105123/
9. https://archive.nptel.ac.in/courses/103/107/103107208/

Savitribai Phule Pune University Second Year of Automobile Engineering (2024 Pattern)				
PCC-203-ABE: Materials Science and Metallurgy				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**3 Hours/Week**	**3**	**CCE**	**40 Marks**
Practical	**NA**		**End-Semester**	**60 Marks**

Prerequisite Courses:

- Engineering Chemistry

Course Objectives:

1. To understand the fundamental concepts of atomic structure, bonding, crystal structures, and imperfections in engineering materials.
2. To gain familiarity with phase transformations, phase diagrams, and microstructural evolution in metallic systems.
3. To develop awareness of various heat treatment processes and strengthening mechanisms used to modify the properties of ferrous alloys.
4. To gain insight into the mechanical behaviour, failure mechanisms, and testing methods of engineering materials.
5. To gain exposure to the classification, properties, corrosion behaviour, and applications of ferrous, non-ferrous, and advanced engineering materials.

Course Outcomes:

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

CO1: **ANALYZE** the relationship between atomic bonding, crystal structure, and defects to **DETERMINE** their influence on material properties.

CO2: **INTERPRET** phase diagrams and transformation curves to **PREDICT** microstructure evolution and phase composition under various thermal conditions.

CO3: **EVALUATE** the effects of different heat treatment and strengthening processes on the microstructure and mechanical properties of steels and cast irons.

CO4: **CONDUCT** mechanical and non-destructive tests to **ANALYZE** material behaviour under various loading conditions and **INTERPRET** failure characteristics.

CO5: **CLASSIFY** engineering alloys, **EVALUATE** their corrosion behaviour and **SELECT** appropriate materials for specific applications, including nanomaterials and shape memory alloys.

Course Contents

Unit I	**Structure of metals and crystalline solids**	**(07 Hours)**

Classification of engineering materials, atomic structure, bonding types (metallic, ionic, covalent, van der Waals), crystal structures (BCC, FCC, HCP), crystallographic planes and directions, imperfections (point, line, surface defects), grain boundaries, grain size, solidification, metallography basics.

Real World Assignment

1. **Material Classification Chart:**
   Create a comparative chart of engineering materials (metals, ceramics, polymers, composites) with examples, bonding types, and typical applications.
2. **Crystal Structure Modelling:**
   Build 3D physical or digital models of BCC, FCC, and HCP unit cells; identify coordination numbers and atomic packing factors.
3. **Grain Size vs. Strength Analysis:**
   Analyse metallographic images (real or simulated) to measure grain sizes and correlate with mechanical properties using Hall-Petch relation.
4. **Defect Identification Assignment:**
   Label and explain types of imperfections in given microstructure images; relate them to changes in

material properties.

Unit II	Phase diagrams and phase transformations	(07 Hours)

Gibbs phase rule, unary phase diagrams, binary phase diagrams, lever rule, tie-line rule, eutectic reactions, eutectoid reactions, peritectic reactions, iron–iron carbide diagram, TTT diagrams, CCT diagrams, nucleation, growth, pearlite, bainite, martensite, microstructure evolution, numerical problems.

Real World Assignment

1. **Binary Phase Diagram Analysis:**
   Use a real alloy system (e.g., Cu-Ni) to apply the lever rule and tie-line rule; determine phase fractions at specified temperatures.
2. **Iron–Iron Carbide Interpretation:**
   Analyze the Fe-Fe_3C diagram to identify microstructures at different compositions and cooling rates; explain eutectoid transformation.
3. **TTT/CCT Diagram Application:**
   Given steel composition, use TTT/CCT diagrams to predict resulting microstructures under various heat treatment conditions.
4. **Microstructure Evolution Case Study:**
   Study and report how pearlite, bainite, and martensite form in a quenched steel sample with reference to nucleation and growth processes.

Unit III	Heat treatment and strengthening of materials	(07 Hours)

Annealing, normalizing, hardening, tempering, carburizing, nitriding, flame hardening, induction hardening, heat treatment of alloy steels, heat treatment of cast irons, hardenability, quench test, grain size control, solid solution strengthening, cold work, recovery, recrystallization, grain growth, numerical problems.

Real World Assignment

1. **Heat Treatment Process Comparison:**
   Compare the effects of annealing, normalizing, and hardening on the microstructure and hardness of alloy steels. Perform a quench test to measure hardenability.
2. **Carburizing vs. Nitriding Analysis:**
   Study the effects of carburizing and nitriding on the surface hardness and wear resistance of steel; include experimental data to compare results.
3. **Grain Size Control and Strengthening:**
   Investigate the relationship between grain size and mechanical properties in steel after heat treatment (e.g., tempering).
4. **Recrystallization and Cold Work Effect:**
   Perform experiments to evaluate the effects of cold work, recovery, and recrystallization on the microstructure and mechanical properties of metals, with an emphasis on grain growth.

Unit IV	Mechanical behavior and failure of materials	(07 Hours)

Stress–strain behavior, elastic deformation, plastic deformation, hardness testing (Brinell, Rockwell, Vickers), tensile testing, impact testing, fatigue, creep, ductile fracture, brittle fracture, crack propagation, fractography, failure analysis, non-destructive testing techniques, numerical problems.

Real World Assignment

1. **Stress-Strain Curve Analysis:**
   Perform tensile testing on a metal sample, plot the stress-strain curve, and analyse elastic and plastic deformation characteristics, including yield strength and ultimate tensile strength.
2. **Hardness Testing Comparison:**
   Conduct Brinell, Rockwell, and Vickers hardness tests on the same material, then compare and analyse the results to understand the relationship between hardness and material properties.
3. **Fatigue and Fracture Analysis:**
   Simulate fatigue loading on a component (e.g., a metal rod) and perform a fractographic analysis to study crack initiation, propagation, and the final fracture.
4. **Non-Destructive Testing (NDT) Techniques:**

   Use ultrasonic or X-ray NDT techniques on a metal specimen to detect internal defects. Compare the

findings with actual physical failure modes and propose preventive measures based on the results.

Unit V	Engineering alloys, corrosion and emerging topics	(07 Hours)

Plain carbon steels, alloy steels, stainless steels, gray cast iron, white cast iron, malleable cast iron, ductile cast iron, aluminum alloys, copper alloys, nickel alloys, titanium alloys, magnesium alloys, corrosion types (galvanic, pitting, stress corrosion), shape memory alloys, electrochemical corrosion, cathodic protection, protective coatings, powder metallurgy, nanomaterials, applications of nanomaterials.

Real World Assignment

1. **Material Selection:**
   Compare plain carbon steels, stainless steels, and aluminium alloys for a specified application, considering mechanical properties and corrosion resistance.
2. **Corrosion Analysis:**
   Study galvanic, pitting, and stress corrosion in alloys, and propose solutions like cathodic protection or coatings to mitigate these issues.
3. **Shape Memory Alloys:**
   Explore the use of shape memory alloys in practical applications (e.g., medical devices), highlighting their unique properties and benefits.
4. **Nanomaterials in Industry:**
   Investigate the role of nanomaterials in electronics or biomedical applications, emphasizing their advanced properties and uses.

Learning Resources

Text Books:

1. Raghvan V., “Material Science and Engineering”, Prentice Hall of India, New Delhi. 2003
2. William D. Callister, “Materials Science and Engineering an Introduction”, Jr, John Wiley & Sons, Inc.
3. Dr. V. D. Kodgire & S. V. Kodgire, “Material Science & Metallurgy For Engineers”, Everest Publication.

Reference Books:

1. Higgins R. A., “Engineering Metallurgy”, Viva books Pvt. Ltd
2. A. K. Bhargava, C.P. Sharma, “Mechanical Behaviour & Testing of Materials”, P H I Learning Private Ltd.
3. Avner, S.H., “Introduction to Physical Metallurgy”, Tata McGraw-Hill, 1997.
4. George Ellwood Dieter, “Mechanical Metallurgy”, McGraw-Hill 1988

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/113/104/113104105/
2. https://archive.nptel.ac.in/courses/113/105/113105106/
3. https://archive.nptel.ac.in/courses/113/104/113104104/
4. https://archive.nptel.ac.in/courses/113/104/113104101/
5. https://archive.nptel.ac.in/courses/113/104/113104102/
6. https://archive.nptel.ac.in/courses/113/106/113106101/
7. https://archive.nptel.ac.in/courses/113/105/113105099/
8. https://archive.nptel.ac.in/courses/113/106/113106098/

Savitribai Phule Pune University Second Year of Automobile Engineering (2024 Pattern)				
PCC-204-ABE: Material Testing and Characterization Lab				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses:

- 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

Laboratory Guidelines

Experiment 01

Real World Assignment

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

Experiment 02

Real World Assignment

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.

Experiment 03

Real World Assignment

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

Experiment 04

Real World Assignment

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

Experiment 05

Real World Assignment

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

Experiment 06

Real World Assignment

1. Visit to heat treatment plant/lab for hardening process.
2. 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

Experiment 07

Real World Assignment

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

Experiment 08

Real World Assignment

1. 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)
2. 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

Experiment 09

Real World Assignment

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

Experiment 10

Real World Assignment

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
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 Automobile Engineering (2024 Pattern)

MDM-221-ABE: Mathematical Methods in Engineering

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

Prerequisite Courses:

- Engineering Mathematics – I and II, Fundamentals of Programming Languages, Python

Course Objectives:

1. To understand numerical methods for solving ordinary and partial differential equations.
2. To utilize regression, interpolation, and modeling techniques for engineering applications.
3. To comprehend curve fitting, regression analysis, and data modeling techniques in engineering.
4. To understand statistical and probability concepts for engineering applications.

To realize statistical inference and reliability methods in manufacturing and product lifecycle analysis.

Course Outcomes:

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

CO1. **APPLY** mathematical methods to solve engineering problems involving differential equations.

CO2. To **APPLY** curve fitting, regression analysis and data modeling in engineering.

CO3. To **ANALYZE** data using curve fitting techniques.

CO4. To **ANALYZE** data using statistical methods.

CO5. To **APPLY** statistical inference, reliability analysis and FMEA to engineering problems.

Course Contents

Unit I	Numerical Analysis of Differential Equations	(07 Hours)

Initial and boundary value problems: introduction.

Initial value problems:

Ordinary differential equations (ODE): Taylor method, Euler method, Runge-Kutta 4th order, simultaneous equations using Runge-Kutta 2nd order method.

Boundary value problems (BVP). Introduction.

Partial differential equations (PDE): finite difference method to 1D problems, Rayleigh's method, Galerkin's method, Laplace equation in 2D.

Real World Assignment

1. **Transient cooling of brake disc (IVP - ODE using Euler and Taylor methods)**
   (Model the cooling behaviour of a brake disc after sudden braking using ODE and solve using Euler and Taylor methods).
2. **Heat transfer in an engine cylinder wall (BVP - PDE)**
   (Analyse the steady-state temperature distribution across a 1D or 2D engine cylinder wall using the finite difference method (Laplace equation in 2D))

Unit II	Numerical Integration	(07 Hours)

Numerical Integration (1D): Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Gauss quadrature for 2-point and 3-point method, double integration.

Double integration: Trapezoidal rule, Simpson's 1/3rd rule.

Real World Assignment

1. **Evaluate work done in an engine cycle (P–V diagram)**
   (Compute the work done in one cycle of an internal combustion engine using P–V data and numerical integration.)
2. **Heat transfer over a fin surface.**
   (Estimate the total heat transfer from a rectangular fin surface using 2D temperature distribution data.)

Unit III	Curve Fitting and Regression Techniques	(07 Hours)

Curve fitting: least square technique; first order, quadratic, power equation, exponential equation.
Regression analysis: linear regression, multiple regressions.
Interpolation: Lagrange forward and inverse interpolation, Newton forward interpolation.

Real World Assignment

1. **Engine performance curve fitting using experimental data.**
   (Fit curves to engine performance data (e.g., torque vs. RPM, power vs. RPM))
2. **Fuel efficiency prediction using multiple regression.**
   (Predict fuel efficiency using multiple vehicle parameters like weight, engine capacity, gear ratios, and drag coefficient)
3. **Regression analysis for vehicle weight and braking distance.**
   (Investigate how vehicle curb weight affects braking distance under standard conditions)

Unit IV	Statistics and probability	(07 Hours)

Measures of central tendency: arithmetic mean, median, mode.
Measurement of variability and dispersion: range, interquartile range, variance, standard deviation, coefficient of variation.
Measure of shape: definition of shape parameters, skewness, types of skewness, Karl Pearson's coefficient of skewness, kurtosis, types of kurtosis, mesokurtic, leptokurtic, platykurtic.
Correlation: concept of correlation, Karl Pearson's coefficient of correlation, Spearman's rank correlation.
Probability: joint, conditional and marginal probability, Bayes' theorem, Discrete and continuous probability distributions, normal, lognormal and Weibull distributions, applications.

Real World Assignment

1. **Quality control of cylinder bore diameter measurements.**
   (Analyse a batch of cylinder bore diameter measurements from engine manufacturing.)
2. **Vibration data analysis for ride comfort.**
   (Evaluate vibration readings from seats or suspension systems under different road conditions.)
3. **Failure probability analysis of automotive components.**
   (Predict the probability of component failure using real-world or simulated failure data)

Unit V	Statistical Inference and Reliability	(07 Hours)

Statistical inference: test of hypothesis, null and alternative hypotheses, type I and II errors, level of significance, p-value, chi-square test, t-test, ANOVA, ANCOVA, manufacturing process validation.
Reliability: introduction to reliability, reliability definition, failure rate, repair rate, reliability function, and reliability models, exponential distribution, mean time to failure (MTTF), mean time between failures (MTBF).
Failure Mode and Effects Analysis (FMEA): product life cycle prediction, preventive maintenance planning, system design optimization (theoretical treatment only).

Real World Assignment

1. **Hypothesis testing for surface roughness in CNC machining.**
   (Validate whether new tool material improves surface finish)
2. **Reliability estimation of automotive battery life.**
   (Estimate the reliability and failure rate of EV batteries under different operating conditions)
3. **Chi-square test for fitment of gearbox defect categories.**
   (Determine whether observed gearbox failure types match expected frequencies)
4. **FMEA for electric vehicle battery pack.**
   (Perform a failure mode and effects analysis (FMEA) on the battery pack of an electric vehicle to

predict potential failure modes)

Learning Resources

Text Books:

1. B. S. Grewal, 'Higher Engineering Mathematics', Khanna Publication.
2. B. S. Grewal, 'Numerical Methods in Engineering and Science', Khanna Publication.
3. S. P. Gupta, "Statistical Methods", Chand & Sons
4. Karman, Theodore. V, Mathematical Methods in Engineering, McGraw-Hill book company, Inc.
5. K. Krishnaiah, Reliability Engineering for Engineers, Pearson Education.
6. Steven C. Chapra, 'Applied Numerical Methods with MATLAB for Engineers and Scientist', Tata Mc-Graw Hill Publishing Co. Ltd.
7. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).

Reference Books:

1. Erwin Kreyszig, 'Advanced Engineering Mathematics', Wiley India
2. Joe D. Hoffman, 'Numerical Methods for Engineers and Scientists', CRC Press
3. McQuarrie, Donald A, Mathematical methods for scientists and engineers, McGraw-Hill Book Company.
4. Robert J. Schilling, Sandra L. Harris, 'Applied Numerical Methods for Engineering using MATLAB and C', Cengage Learning India Pvt. Ltd.
5. Jason Brownlee, 'Statistical Methods for Machine Learning', Machine learning Mastery.

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/111/105/111105164/
2. https://archive.nptel.ac.in/courses/111/105/111105166/
3. https://archive.nptel.ac.in/courses/111/106/111106164/
4. https://archive.nptel.ac.in/courses/111/102/111102160/
5. https://archive.nptel.ac.in/courses/111/101/111101153/
6. https://archive.nptel.ac.in/courses/111/104/111104146/

Savitribai Phule Pune University Second Year of Automobile Engineering (2024 Pattern)				
MDM-222-ABE: 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:

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

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

Laboratory Practical/ Real World Assignments

Experiment 1	**Introduction to Arduino and Digital I/O Control**

Real World Assignment

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.

Experiment 2	**Analog Sensor Interfacing (Temperature Sensor -LM35)**

Real World Assignment

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.

Experiment 3	Interfacing Potentiometer for Position Control Simulation

Real World Assignment

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.

Experiment 4	Interfacing IR or Ultrasonic Sensor for Distance Measurement

Real World Assignment

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

Experiment 5	Controlling DC Motor Using Transistor Driver Circuit

Real World Assignment

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 analog Write() to vary motor speed.
3. Implement a simple ramp-up or potentiometer-based speed control.

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

Real World Assignment

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)

Experiment 7	Stepper Motor Control via Microcontroller

Real World Assignment

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.

Experiment 8	Mini Project – Interfacing a Mechanical System

Real World Assignment

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.

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 Automobile Engineering (2024 Pattern)

VSE-231-ABE: Workshop Practices

Teaching Scheme		Credit	Examination Scheme	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**25 Marks**

Prerequisite Courses:

- Engineering Graphics

Course Objectives:

1. Understand the structure, working, and setup of the center lathe.
2. Learn to operate turning tools and accessories safely.
3. Gain practical skills in facing, turning, tapering, knurling, and parting.
4. Interpret working drawings for turned components with dimensions and tolerances.
5. Develop measurement and inspection techniques using micrometers and Vernier calipers.

Course Outcomes:

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

CO1. OPERATE lathe to perform facing, turning, tapering and knurling as per drawing specifications while adhering to safety standards.
CO2. PERFORM face milling, slotting and keyway cutting by INTERPRETING industrial drawings with dimensional tolerances and surface finish requirements.
CO3. EXECUTE accurate drilling, reaming, shaping and slotting operations on metal components by APPLYING layout and dimensioning principles.
CO4. ANALYZE applicability of EDM, LBM and other special machining processes for complex geometries and tight tolerance components.
CO5. DEMONSTRATE arc welding techniques to FABRICATE basic welded joints using correct welding symbols and safety practices from engineering drawings.

Laboratory Practices

Practice 1: Lathe Operations — **4 hours**

To perform operations like facing, plain turning, step turning, taper turning, knurling and parting using the center lathe.

Real World Assignment

Prepare a stepped shaft drawing with dimensional tolerances and machining symbols. Interpret the drawing, plan the machining sequence and validate results using micrometer and Vernier caliper.

Practice 2: Milling Operations — **4 hours**

To perform face milling, side milling, slotting and keyway cutting on a milling machine using appropriate cutters.

Real World Assignment

Prepare a drawing for a milled block with slots and keyways. Annotate the drawing with GD&T symbols and surface finish requirements. Implement machining and measure dimensional accuracy.

Practice 3: Drilling, Shaping and Slotting Operations — **4 hours**

To perform marking, drilling, reaming and tapping operations on a pillar drill. Perform shaping and slotting on mild steel block surfaces.

Real World Assignment

Interpret a mechanical component drawing involving holes, slots and flat surfaces. Create a machining plan and verify the tolerances post-processing.

Practice 4: Special Machining Operations	**4 hours**
To understand special machining processes like EDM, Wire-cut EDM, USM and Laser cutting through live demonstration or simulator.	
Real World Assignment Analyze an industrial part made using non-traditional machining. Sketch the basic layout and identify reasons for selecting the special process. Annotate drawing with GD&T as applicable.	
Practice 5: Welding Operations	**4 hours**
To perform bead-on-plate welding and lap joint using arc welding. Demonstration of MIG/TIG.	
Real World Assignment Study a welding drawing with weld symbols and dimensions. Prepare a welded L-bracket or T-joint using SMAW and inspect for common weld defects.	

Learning Resources

Text Books:

1. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, Elements of Workshop Technology Vol. I & II, Media Promoters & Publishers, ISBN: 978-81-86037-35-1
2. P.N. Rao, Manufacturing Technology Vol. 1 & 2, McGraw Hill Education, 4th Edition, 2018, ISBN: 978-93-5260-534-8
3. V. Lakshminarayanan, R.S. Vaish Wanar, Production Drawing, Jain Brothers, New Delhi, ISBN: 978-81-8360-105-8
4. **K.L. Narayana, P. Kannaiah, K. Venkata Reddy,** Production Drawing, New Age International Publishers, ISBN: 978-81-224-2455-1
5. **S. Chandrasekharan,** Machine Drawing Including Production Drawing, CBS Publishers & Distributors, ISBN: 978-81-239-1652-1

Reference Books:

1. P.C. Sharma, A Textbook of Production Engineering, S. Chand Publishing, ISBN: 978-81-219-0421-3
2. H.N. Gupta, R.C. Gupta, Arun Mittal, Manufacturing Processes, New Age International Publishers, ISBN: 978-81-224-2339-4
3. Richard L. Little, Welding and Welding Technology, McGraw Hill Education, ISBN: 978-00-7138-709-2
4. K. C. John, Mechanical Workshop Practice, PHI Learning Pvt. Ltd., ISBN: 978-81-203-4511-1
5. Amitabh Ghosh, Ashok Kumar Mallik, Manufacturing Science, East West Press Pvt. Ltd., ISBN: 978-81-7371-046-3

Savitribai Phule Pune University
Second Year of Automobile Engineering (2024 Pattern)
HSSM-232-ABE: Entrepreneurship Development and Innovation

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

Prerequisite Courses:

- Business Communication / Soft Skills

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),
CO2: IDENTIFY business opportunities through design thinking (Apply)
CO3: DEVELOP a lean business model and MVP (Apply/Analyze)
CO4: 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 start up founder or alumni) for a guest talk.
Task: Students write a 1-page reflection/ Quiz on entrepreneurial mind set, risks taken, and innovation style.

2.Case Study Presentation

Activity: Select an Indian startup and analyze:

a. The problem it solves
b. Type of innovation (product, process, frugal, etc.)
c. 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: -

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 Automobile Engineering (2024 Pattern)				
VEC-233-ABE: Universal Human Values				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**2 Hours/Week**	**2**	**CCE**	**20 Marks**
Practical	**NA**		**Endsem**	**30 Marks**

Prerequisite Courses:

- UHV-1 of 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:

CO1- RECOGNIZE the concept of self-exploration as the process of value education and see they have the potential to explore on their own right.

CO2- EXPLORE the human being as the coexistence of self and body to see their real needs / basic aspirations clearly

CO3- EXPLAIN relationship between one self and the other self as the essential part of relationship and harmony in the family

CO4- INTERPRET the interconnectedness, harmony and mutual fulfilment inherent in the nature and the entire existence

CO5- DRAW ethical conclusions in the light of Right understanding facilitating the development of holistic technologies production systems and management models

Course Contents

Unit I	**Introduction to Value Education**	**(03 Hours)**

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

Exemplars / Practical Applications

Explore real life applications using Practical No. 1, 2, 3, 4

Unit II	Harmony in the Human Being	(03 Hours)

- Understanding Human being as the Co-existence of the Self and the Body
- Distinguishing between the Needs of the Self and the Body
- The Body as an Instrument of the Self
- Understanding Harmony in the Self
- Harmony of the Self with the Body
- Programme to Ensure self-regulation and Health

Exemplars / Practical Applications

Explore real life applications using Practical No. 5, 6.

Unit III	Harmony in the Family and Society	(03 Hours)

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

Exemplars / Practical Applications

Explore real life applications using Practical No. 7, 8

Unit IV	Harmony in the Nature (Existence)	(03 Hours)

- Understanding Harmony in the Nature
- Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
- Realizing Existence as Co-existence at All Levels
- The Holistic Perception of Harmony in Existence

Exemplars / Practical Applications

Explore real life applications using Practical No. 9,10,11

Unit V	Implications of the Holistic Understanding - Professional Ethics Look	(03 Hours)

- Basis for Universal Human Values
- Definitiveness of (Ethical) Human Conduct
- Professional Ethics in the light of Right Understanding
- A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
- Holistic Technologies, Production Systems and Management Models Typical Case Studies
- Strategies for Transition towards Value-based Life and Profession

Exemplars / Practical Applications

Explore real life applications using Practical No. 12,13,14

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 Automobile Engineering (2024 Pattern)				
CEP-241-ABE: Community Engagement Project				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**NA**	**2**	**Termwork**	**25 Marks**
Practical	**4 Hours/Week**		**Oral**	**25 Marks**

Prerequisite Courses:

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 - Automobile Engineering (2024 Pattern) Revised

Semester IV Courses

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

PCC-251-ABE: Fluid Statics and Dynamics

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

Prerequisite Courses:

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

Course Objectives:

To understand basic fluid mechanics principles and properties.

1. To comprehend fluid flow types, visualization and governing equations.
2. To perceive Bernoulli's equation, momentum principles and energy concepts in fluid systems
3. To study dimensional analysis, similarity laws and flow characteristics in pipes.
4. To explore boundary layer theory, drag and lift concepts and compressible flow principles.

Course Outcomes:

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

CO1: To **APPLY** fluid statics and buoyancy concepts in analysis.
CO2: To **ANALYZE** flow behavior using continuity and momentum principles.
CO3: To **ANALYZE** flow behavior, measure flow rates, and **EVALUATE** energy losses in real-world fluid systems
CO4: To **ANALYZE** and model fluid flow using dimensionless numbers and determine losses in pipe systems.
CO5: To **ANALYZE** flow behavior, **EVALUATE** drag/lift for compressible flow phenomena.

Course Contents

Unit I	Fluid Properties and Fluid Statics	(07 Hours)

Introduction to fluid mechanics, classification of fluids and flows, properties of fluids – density, specific weight, specific gravity, viscosity, surface tension, vapor pressure, capillarity, pressure and its measurement, barometers, manometers, hydrostatic pressure, Pascal's law, forces on plane and curved surfaces, buoyancy and stability of floating bodies.

Real World Assignment

1. **Water Storage Tank System**
   Analyse hydrostatic pressure and forces on tank walls; recommend material and shape based on fluid properties and pressure distribution.
2. **Manometer and Barometer Construction**
   Build a simple U-tube manometer and barometer using household items; measure atmospheric and fluid pressures, and compare with standard values.
3. **Buoyancy and Stability Test**
   Create floating models using different materials; observe buoyancy, stability, and center of gravity; validate using Archimedes' principle.
4. **Viscosity Measurement of Fluids**
   Determine viscosity of household fluids (e.g., oil, honey, water) using a falling sphere method and compare results.

Unit II	Fluid Kinematics and Dynamics	(07 Hours)

Types of flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, flow visualization – streamlines, path lines, streak lines, acceleration of fluid particles, rotational and irrotational flows, stream function and velocity potential, continuity equation in Cartesian coordinates, concept of system and control volume, Reynolds transport theorem, conservation of mass and momentum.

Real World Assignment

1. **Flow Pattern Visualization Experiment.**
   Use dye or coloured particles in water to observe and distinguish between streamlines, path lines, and streak lines in steady and unsteady flows.
2. **Laminar vs. Turbulent Flow Analysis.**
   Conduct a pipe flow experiment at different velocities to observe transition from laminar to turbulent flow and calculate the Reynolds number.
3. **Continuity Equation Application in Pipe Network.**
   Analyse a simple pipe junction or household plumbing to verify mass conservation using flow rates and the continuity equation.
4. **Control Volume and Momentum Conservation Study.**
   Evaluate the forces on a bend in a water jet or nozzle using control volume analysis and apply Reynolds Transport Theorem for momentum conservation.

Unit III	Energy Analysis and Applications	(07 Hours)

Bernoulli's equation, derivation, assumptions, and limitations, applications, venturimeter, orifice meter, pitot tube, linear momentum equation – applications to pipe bends, nozzles, and jets, energy grade line and hydraulic grade line, head loss concepts, total energy and power concepts in fluid motion, microfluidics, smart fluid systems.

Real World Assignment

1. **Bernoulli's Principle Demonstration**
   Conduct an experiment (e.g., blowing over a paper strip or using a spray bottle) to demonstrate Bernoulli's effect and explain assumptions and limitations.
2. **Flow Measurement Using Venturimeter or Orifice Meter**
   Simulate or analyse flow rate in a pipeline using venturimeter/orifice meter data and apply Bernoulli's equation.
3. **Force Analysis on Pipe Bends**
   Calculate the force exerted by fluid flow on a pipe bend using the linear momentum equation and compare with real pipe systems.
4. **Energy and Head Loss Evaluation in Pipelines**
   Measure or estimate head losses in a piping system and plot the energy grade line (EGL) and hydraulic grade line (HGL).

Unit IV	Dimensional analysis and internal flows	(07 Hours)

Dimensional homogeneity, Buckingham π theorem, important dimensionless numbers, Reynolds, Froude, Weber, Mach, Euler, similarity laws and model testing, laminar and turbulent flow through pipes, Hagen–Poiseuille equation, Darcy–Weisbach equation, friction factor and Moody chart, major and minor losses in pipe systems, series and parallel pipe networks, introduction to computational fluid dynamics (CFD).

Real World Assignment

1. **Model testing with π Theorem** – Apply dimensional analysis and similarity laws for scaling a physical model.
2. **Reynolds Number Calculation** – Determine flow type (laminar/turbulent) in a pipe using Reynolds number.
3. **Pipe Flow Losses** – Calculate head losses using Darcy-Weisbach and compare with the Moody chart.
4. **Flow Experiment** – Observe laminar/turbulent flow and apply Hagen-Poiseuille for laminar and Darcy-Weisbach for turbulent.

Unit V	Boundary layer and external flows	(07 Hours)

Boundary layer concept – thickness, separation, laminar and turbulent boundary layers, drag and lift – skin friction and pressure drag, flow over immersed bodies – streamlined and bluff bodies, lift on airfoils – circulation theory basics, introduction to compressible flow – Mach number, isentropic flow concepts, shock waves (qualitative), area–velocity relation in nozzles (overview), energy-efficient nozzle and propulsion designs.

Real World Assignment

1. **Boundary Layer Analysis** – Study flow separation and boundary layer types over a flat plate or cylinder.
2. **Drag and Lift Measurement** – Measure drag and lift on streamlined and bluff bodies in a wind tunnel.
3. **Airfoil Lift Calculation** – Apply circulation theory to calculate airfoil lift and compare with experimental data.
4. **Shock Wave and Mach number** – Observe shock waves and calculate Mach number in a nozzle or supersonic setup.

Learning Resources

Text Books:

1. **Mukesh Bansal**, Fluid Mechanics, Laxmi Publications
2. **R. K. Bansal**, Fluid Mechanics & Hydraulic Machines, Laxmi Publications
3. **P. N. Modi, S. M. Seth**, Hydraulics and Fluid Mechanics, Standard Book House
4. **Sukumar Pati**, Fluid Mechanics and Hydraulic Machines, TATA McGraw-Hill

Reference Books:

1. **Victor L. Streeter, E. Benjamin Wylie, Keith W. Bedford**, Mechanics of Fluids, McGraw-Hill Education, 10th Edition (2005)
2. **Kundu, Cohen, Dowling**, Fluid Mechanics, Elsevier India
3. **Chaim Gutfinger, David Pnueli**, Fluid Mechanics, Cambridge University Press
4. **S.S. Bhavikatti**, Experiments in Fluid Mechanics, New Age International, 2009
5. **Cengel & Cimbala**, Fluid Mechanics: Fundamentals and Applications (with Lab Manual), McGraw-Hill Education, 2013
6. **M.S. Raju**, Experimental Fluid Mechanics, I.K. International Publishing House, 2016
7. **C. Tropea, A.L. Yarin, J.F. Foss (Eds.)**, Springer Handbook of Experimental Fluid Mechanics, Springer, 2007
8. **N. T. Ouellette, G. A. Voth**, Experiments in Fluid Mechanics, Springer, 2022

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/105/103/105103095/
2. https://archive.nptel.ac.in/courses/105/101/105101082/
3. https://archive.nptel.ac.in/courses/103/104/103104043/
5. https://archive.nptel.ac.in/courses/112/105/112105171/
6. https://archive.nptel.ac.in/courses/112/105/112105269/
7. https://archive.nptel.ac.in/courses/105/103/105103192/
8. https://archive.nptel.ac.in/courses/103/106/103106158/

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

PCC-252-ABE: Manufacturing Technology

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

Prerequisite Courses:

- Material science and Metallurgy

Course Objectives:

1. To introduce casting processes, materials, and sustainable design practices.
2. To understand plastic deformation and metal forming processes.
3. To learn sheet metal operations, die design, and force estimation in automotive manufacturing.
4. To introduce key welding and joining processes, equipment, and inspection methods.
5. To study types, properties, and processing of polymers and composites

Course Outcomes:

After successful completion of the course, learner will be able to:
CO1: To **DESIGN** and analyze cast components and select appropriate casting methods
CO2. To **ANALYZE** and optimize metal forming processes for efficient automotive component production
CO3. To **DESIGN** efficient dies for formability in automotive production.
CO4. To **SELECT** appropriate joining processes and **EVALUATE** weld quality and common defects.
CO5. To **APPLY** suitable polymers and processing methods for engineering applications.

Course Contents

Unit I	Foundry Technology and Modern Casting Processes	(07 Hours)

Overview of casting processes including pattern types, materials, design, and allowances. Study of moulding sands, their properties, and sustainable alternatives. Core making techniques, melting furnaces, and gating system design. Numerical methods for mold filling and riser placement. Principles of cooling, directional and progressive solidification, and solidification rate estimation. Casting finishing, defect analysis, and remedies. Introduction to permanent mould, investment, centrifugal, and continuous casting methods.

Real World Assignment

1. Design a Pattern and Calculate Allowances for a Real-Life Object
   (Apply concepts of pattern design and dimensional allowances)
2. Comparative Study of Industrial Furnaces
   (Understand industrial melting techniques and energy efficiency)
3. Eco-Friendly Molding Sand Alternatives
   (Explore sustainable alternatives to conventional molding sands)
4. Casting Defect Analysis in Automotive Parts
   (Study casting defects in a real-world automotive casting (e.g., piston, clutch plate, or gearbox housing).

Unit II	Techniques in Metal Forming Processes	(07 Hours)

Plastic deformation. Stress-strain diagram for different types of material, Hot and Cold working, Factors affecting plastic deformation, Yield criteria, Concept of flow stress, Forming Limit diagram Rolling Process: Rolling terminology, Friction in rolling, Calculation of rolling load. Smart rolling mills with adaptive control and digital twins. Forging: Open and closed die forging, Forging operations Extrusion: Types, Process parameter Wire and Tube Drawing: Wire and tube drawing process, Die profile Friction and lubrication in metal forming, Forming defects, causes and remedies for all forming processes.

Real World Assignment

1. Stress-Strain Analysis of Engineering Materials
   (Develop fundamental understanding of material behavior under load)
2. Smart Rolling Mills: A Report on Industry 4.0 in Rolling Operations
   (Digital technologies in manufacturing)
3. Design and Calculation of a Simple Forging or Rolling Operation
   (Apply basic mechanical equations to metal forming problems)
4. Forging and Extrusion in Automotive Parts Production
   (Examine the use of forging and extrusion processes in producing critical automotive components such as engine blocks or suspension parts)

Unit III	Sheet Metal Forming Processes	(07 Hours)

Types of sheet metal operations, Press working equipment and terminology, Types of dies, Clearance analysis, Estimation of cutting forces, Centre of pressure and blank size determination, Hybrid dies. Design of strip lay-out, Blanking die design, Introduction to Drawing, Bending dies, Methods of reducing forces, Formability and forming limit diagrams.

Real World Assignment

1. Design a Blanking Die for a Simple Component
   (Die design fundamentals and calculations)
2. Strip Layout Design for Minimum Material Wastage
   (Material optimization through proper strip layout design)
3. Sheet Metal Forming Defects and Force Reduction Techniques
   (Analyze failure modes and explore energy-efficient forming)
4. Blanking Die Design for Automotive Components
   (Design a blanking die for an automotive part)

Unit IV	Welding and Joining Processes	(07 Hours)

Classification of joining processes; welding terminology and types of joints. Arc welding processes: Principles and equipment of single carbon arc welding, FCAW, TIG, MIG, SAW, hybrid laser welding. Resistance welding: Spot, seam, and projection welding; heat balance. Gas welding and cutting. Soldering, brazing, and braze welding. Welding metallurgy and heat-affected zone. Weld inspection, defects in joints, and their remedies.

Real World Assignment

1. Welding Process Selector for Real-World Applications
   (Match different welding processes with industrial use cases)
2. Weld Defects and Inspection Techniques – Case Study Report
   (Build understanding of welding quality control and root cause analysis)
3. Welding Metallurgy and Heat-Affected Zone Simulation
   (Thermal effects and material changes due to welding)
4. Study of Brazing and Welding in Automotive Exhaust Systems

Unit V	Polymers and Composites	(07 Hours)

Polymers: Thermoplastics, Thermosetting, Processing methods, Thermoforming (Pressure, Vacuum), Extrusion (Film, Pipe, Sheet), Composite Processing: Hand lay-up, Spray lay-up, Filament winding, Resin transfer moulding, Pultrusion. Advanced Composites: MMCs, CMCs, Carbon-carbon, Polymer matrix, Nanocomposites. Bio-based and biodegradable polymers (e.g., PLA, PHA).

Real World Assignment

1. Comparative Study of Thermoplastics vs Thermosetting Polymers in Real-Life Products (Build material identification and application skills)
2. Design and Process Flow of a Thermoformed Product (Understand forming operations with real-world product focus)
3. Bio-Based and Biodegradable Polymers: A Sustainability Report (Encourage environmental awareness and future-oriented thinking)
4. Application of Plastic and Composite Materials in Car Bumpers:
5. Arrange an industrial visit to manufacturing industry.

Learning Resources

Text Books:

1. P. C. Sharma, "Production Engineering", Khanna Publishers
2. P.N. Rao, Manufacturing Technology – Vol. 1 & 2, Tata McGraw-Hill
3. R.K. Rajput, Manufacturing Technology, Laxmi Publications
4. O.P. Khanna, Production Technology, Dhanpat Rai Publications
5. S.K. Hajra Choudhury, Elements of Workshop Technology – Vol. 1 & 2, Media Promoters & Publishers

Reference Books:

1. Brent Strong, Fundamentals of Composites Manufacturing: Materials, Methods, SME Book Series
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Education
3. Mikell P. Groover, Fundamentals of Modern Manufacturing, Wiley India
4. E.P. DeGarmo, J.T. Black, Ronald A. Kohser, Materials and Processes in Manufacturing, Wiley
5. David A. Stephenson and John S. Agapiou, Metal Cutting Theory and Practice, CRC Press

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/112/107/112107219/
2. https://archive.nptel.ac.in/courses/112/104/112104204/
3. https://archive.nptel.ac.in/courses/112/104/112104195/
4. https://archive.nptel.ac.in/courses/112/107/112107078/
5. https://archive.nptel.ac.in/courses/113/106/113106087/
6. https://archive.nptel.ac.in/courses/112/104/112104229/
7. https://archive.nptel.ac.in/courses/112/107/112107250/

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

PCC-253-ABE: Applied Thermodynamics and Heat Transfer

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

Prerequisite Courses:

- Engineering Chemistry, Thermal Science.

Course Objectives:

1. To introduce the classification, operation, and performance analysis of IC engines and various thermodynamic cycles.
2. To impart knowledge of combustion mechanisms, ignition systems, and emission phenomena in SI and CI engines.
3. To enable evaluation of performance parameters and systems influencing IC engine efficiency and emissions.
4. To provide familiarity with basic heat transfer modes and conduction analysis in various geometries.
5. To provide comprehensive understanding of convection and radiation heat transfer along with heat exchanger analysis.

Course Outcomes:

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

CO1: **APPLY** thermodynamic principles to **COMPARE** fuel-air, air-standard and actual cycles and ASSESS their impact on IC engine performance.

CO2: **ANALYZE** the combustion process, knocking characteristics, and emission behaviour in SI and CI engines under various conditions.

CO3: **EVALUATE** the performance of IC engines using diagnostic tools and **INTERPRET** engine behaviour under different operating conditions.

CO4: **EXPLAIN** the modes of heat transfer and **ANALYZE** conduction problems in plane, cylindrical and spherical geometries.

CO5: **APPLY** empirical and analytical methods to **ANALYZE** convection and radiation heat transfer problems and **EVALUATE** heat exchanger performance.

Course Contents

Unit I	Introduction to Internal Combustion Engines and Thermodynamic Cycles	(07 Hours)

Definitions and Classifications of Engines: Conventional IC engines (SI, CI), hybrid engines, and alternative fuel engines (CNG, LPG, hydrogen engines).

Basic Engine Components and Nomenclature: Advanced materials in engine components (lightweight alloys, ceramic coatings), and integration of sensors for real-time performance monitoring.

Air-Standard Cycles: Otto, Diesel, and Dual cycles, developments in cycle optimization for fuel efficiency.

Fuel-Air Cycles and Their Analysis: Advanced fuel injection systems (direct injection, multi-point injection) and their impact on fuel efficiency.

Actual Cycles and Their Deviations from Ideal Cycles: Analysis of real-world deviations due to friction, heat losses, and the role of new technologies (e.g., variable valve timing, turbocharging).

Real World Assignment

1. Engine Type Comparison Report
   Task: Compare SI, CI, hybrid, and alternative fuel engines based on performance, emissions and applications.
   Outcome: IDENTIFY and CLASSIFY various engine types for appropriate usage.

2. Component Material Study
   Task: Visit a workshop or online database to analyze materials used in engine components.
   Outcome: EXAMINE materials based on properties like strength, weight, and thermal resistance.
3. Cycle Efficiency Analysis
   Task: Solve and COMPARE Otto, Diesel, and Dual cycles for efficiency under varied compression ratios.
   Outcome: CALCULATE and INTERPRET thermodynamic efficiency trends.
4. Deviation Impact Case Study
   Task: Investigate real engine performance losses due to friction, heat loss, etc., and explore tech solutions (e.g., turbocharging).
   Outcome: ANALYZE causes of deviation and RECOMMEND efficiency improvements..

Unit II	Combustion in Internal Combustion Engines	(07 Hours)

Combustion in Spark Ignition (SI) Engines: Advanced ignition technologies (e.g., spark plugless engines), lean burn combustion and their impact on emissions

Combustion in Compression Ignition (CI) Engines: Low-temperature combustion (LTC) and homogeneous charge compression ignition (HCCI) for improved efficiency and reduced emissions.

Ignition Systems and Flame Propagation: Developments in electronic control and piezoelectric ignition systems.

Knocking Phenomena in SI and CI Engines: Advanced knock detection systems, impact of biofuels on knock resistance, and active combustion control technologies (e.g., real-time monitoring with sensors).

Real World Assignment

1. Ignition Technology Survey
   Task: Research spark plugless and advanced ignition systems in modern engines.
   Outcome: IDENTIFY ignition advancements and their role in emission reduction.
2. Biofuel Knock Analysis
   Task: Study the effect of biofuels on knocking in SI and CI engines using data from research articles.
   Outcome: ANALYZE knock resistance properties of alternative fuels.
3. Flame Propagation Demo
   Task: Simulate or observe flame front propagation in SI engines under lean/rich conditions.
   Outcome: INTERPRET the influence of mixture strength on combustion speed and stability.
4. Combustion Strategy Comparison
   Task: Compare LTC and HCCI strategies for CI engines through a case study or journal review.
   Outcome: COMPARE advanced combustion modes for performance and emission characteristics

Unit III	Engine Performance and Systems	(07 Hours)

Cooling and Lubrication Systems: Innovations in thermal management (e.g., electric water pumps, advanced radiators), low-friction coatings, and integrated cooling technologies in hybrid engines

Supercharging and Turbocharging Mechanisms: Electric turbocharging, hybrid turbochargers, and advancements in turbo-lag reduction technologies

Scavenging in Two-Stroke Engines: New developments in two-stroke engine technology, including direct fuel injection and improved scavenging methods for higher power output and lower emissions

Engine Performance Parameters: Real-time monitoring and diagnostics using IoT (Internet of Things), and predictive maintenance through data analytics

Heat Balance and Energy Flow in Engines: Research on waste heat recovery technologies (e.g., thermoelectric generators, organic Rankine cycle) for improving overall efficiency

Variable Compression Ratio (VCR) Engines: Latest advancements in VCR technology and its role in improving engine efficiency across varying loads and driving conditions.

Real World Assignment

1. Cooling System Innovation Review
   Task: Study modern cooling methods (e.g., electric pumps, low-friction coatings) in hybrid engines.
   Outcome: EVALUATE thermal management techniques for efficiency improvement.

2. Boosting Technology Analysis
   Task: Compare electric turbochargers and traditional setups in terms of lag and performance.
   Outcome: ANALYZE the impact of supercharging technologies on engine response.
3. IoT-based Engine Monitoring Project
   Task: Use a simulation tool or data set to demonstrate real-time engine diagnostics via IoT.
   Outcome: INTERPRET engine data for fault detection and maintenance planning.
4. Heat Recovery Feasibility Study
   Task: Investigate thermoelectric or Rankine-based waste heat recovery systems in engines.
   Outcome: ASSESS the potential of energy recovery systems in enhancing engine efficiency

Unit IV	Introduction to Heat Transfer & Conduction Heat Transfer	(07 Hours)

Introduction to Heat Transfer: Basic concepts and definitions, Modes of heat transfer: conduction, convection, and radiation, Thermal conductivity and its measurement.

Conduction Heat Transfer: Fourier's law of heat conduction, Steady-state conduction in one dimension, Conduction in cylindrical and spherical geometries, Transient heat conduction and lumped capacitance method, Numerical methods for solving conduction problems.

Real World Assignment

1. Thermal Conductivity Material Survey
   Task: Collect data on thermal conductivity of metals, insulators, and composites used in industry.
   Outcome: COMPARE materials based on their heat transfer characteristics.
2. One-Dimensional Heat Flow Experiment
   Task: Perform or simulate a steady-state conduction experiment through a flat wall.
   Outcome: EVALUATE heat transfer rate using Fourier's law.
3. Geometric Conduction Case Study
   Task: ANALYSE heat loss through cylindrical and spherical systems (e.g., pipes, tanks).
   Outcome: SOLVE conduction problems for different geometries.
4. Transient Heat Transfer Simulation
   Task: Use lumped capacitance or numerical methods to simulate transient conduction in small objects.
   Outcome: INTERPRET temperature variation with time under changing conditions.

Unit V	Convection and Radiation	(07 Hours)

Convection Heat Transfer: Boundary layer theory, Forced convection in ducts and pipes, Natural convection and free convection, Empirical correlations for heat transfer coefficients, Heat transfer in turbulent flow

Heat Exchangers: Types of heat exchangers, Log mean temperature difference (LMTD) method, Effectiveness-NTU method, Design considerations and fouling factors, Compact heat exchangers.

Phase Change Heat Transfer: Boiling heat transfer, Condensation heat transfer, Heat transfer during phase change processes.

Radiation Heat Transfer: Basic principles of thermal radiation, Emissivity and absorptivity, Blackbody radiation and Stefan-Boltzmann law, Shape factors and view factors, Radiation exchange between surfaces

Real World Assignment

1. Convection Case Study in HVAC
   Task: Analyse natural vs. forced convection in real applications like cooling of electronic devices or HVAC ducts.
   Outcome: COMPARE convection types and APPLY empirical correlations for heat transfer estimation.
2. Heat Exchanger Design Exercise
   Task: Select a heat exchanger for a given industrial application and analyze it using LMTD or NTU methods.
   Outcome: CALCULATE performance metrics and EVALUATE design suitability.
3. Boiling and Condensation Observation
   Task: Perform or watch a demo of boiling/condensation processes and record influencing parameters.
   Outcome: IDENTIFY phase change heat transfer characteristics and EXPLAIN their significance.

4. Radiation Heat Transfer Simulation
   Task: Use software or spreadsheet to simulate radiation between surfaces with varying emissivity and geometry.
   Outcome: SOLVE radiation exchange problems using shape factors and Stefan-Boltzmann law.

Learning Resources

Text Books:

1. **R.K. Rajput,** Internal Combustion Engines, Laxmi Publications.
2. **V. Ganesan**, Internal Combustion Engines, McGraw Hill Education.
3. **Yunus A. Çengel & Afshin J. Ghajar,** Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill Education
4. **John B. Heywood,** Internal Combustion Engine Fundamentals, McGraw Hill Education.
5. **M.L. Mathur and R.P. Sharma**, A Textbook of Internal Combustion Engines, Dhanpat Rai Publications.
6. **R.C. Sachdeva,** Fundamentals of Engineering Heat and Mass Transfer, New Age International
7. **P.K. Nag,** Heat and Mass Transfer, McGraw Hill Education
8. **D.S. Kumar,** Heat and Mass Transfer, S.K. Kataria & Sons

Reference Books:

1. **Colin R. Ferguson and Allan T. Kirkpatrick,** Internal Combustion Engines, Wiley India in its 3rd edition in 2015.
2. **H.N. Gupta,** Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd.
3. **J.P. Holman,** Heat Transfer, McGraw Hill Education
4. **Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne S. Lavine,** Fundamentals of Heat and Mass Transfer, Wiley

MOOC / NPTEL/ YouTube Links: -

1. https://archive.nptel.ac.in/courses/112/103/112103307/
2. https://archive.nptel.ac.in/courses/112/106/112106310/
3. https://archive.nptel.ac.in/courses/103/105/103105140/
4. https://archive.nptel.ac.in/courses/103/101/103101137/
5. https://archive.nptel.ac.in/courses/112/108/112108246/
6. https://archive.nptel.ac.in/courses/103/108/103108123/
7. https://archive.nptel.ac.in/courses/112/108/112108212/
8. https://archive.nptel.ac.in/courses/112/105/112105271/
9. https://archive.nptel.ac.in/courses/119/108/119108004/

Savitribai Phule Pune University Second Year of Automobile Engineering (2024 Pattern)				
PCC-254-ABE: Thermo-Fluid Engineering Lab				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**NA**	**2**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses:

- Thermal Science, Fluid Statics and Dynamics.

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

Laboratory Practical/ Real World Assignments

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.

Real World Assignment

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.

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

Real World Assignment
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

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

Real World Assignment
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

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.

Real World Assignment
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

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

Real World Assignment
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.

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
Real World Assignment 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.
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.
Real World Assignment Bernoulli's Theorem Demonstration: Assignment: Create a video or presentation showing real-life application of Bernoulli's principle in aircraft wing design or carburetors.
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.
Real World Assignment 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.
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.
Real World Assignment Viscosity Using Redwood Viscometer: Assignment: Collect samples of different lubricants used in automotive workshops and compare their viscosities and suitability for engine parts.
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.
Real World Assignment 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.
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

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 Automobile Engineering (2024 Pattern)

MDM-271-ABE: 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:

- 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

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

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

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

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 Automobile Engineering (2024 Pattern)				
VSE-281-ABE: Solid Modeling and Drafting				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses:

- Engineering Graphics, Solid Mechanics, Material Science 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

Laboratory Practical/ Real World Assignments

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

Real World Assignment

Simple sketching of any 5 objects by using the above mentioned commands

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

Real World Assignment

Creating any 2 simple machine parts by using 3D modeling software and calculation of mass properties by applying suitable material.

Experiment 3	**Assembly Modeling**
Types of assemblies, significance and limitations, Inserting components into an assembly, mates and constraints, Assembly motion and interference checking	
Real World Assignment Creating assembly of model consisting of minimum 5 parts (Such as Knuckle joint, Flange coupling, C-Clamp, Vice etc.)	
Experiment 4	**Drafting from 3D Models**
Generating views from 3D parts and assemblies, Exploded views, Bill of Materials (BOM), GD&T symbols, dimensioning	
Real World Assignment Generation of 2D working drawings (minimum 2 views) of parts and assembly created in experiment 3 above	
Experiment 5	**Surface Modeling**
Introduction to surface modeling (patch, loft, and sweep), free form surfacing, creation of closed volume	
Real World Assignment Generation of 3D model by using surface parameters (Such as product casing design, automotive body panel design etc.)	

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 Automobile Engineering (2024 Pattern)				
VSE-282-ABE: Data Science and AIML				
Teaching Scheme		**Credit**	**Examination Scheme**	
Theory	**NA**	**1**	**CCE**	**NA**
Practical	**2 Hours/Week**		**Practical**	**50 Marks**

Prerequisite Courses:

- 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 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.

Laboratory Practical/ Real World Assignments

Experiment 01

Real World Assignment

To study supervised/unsupervised/reinforcement learning approach.

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

Experiment 02

Real World Assignment

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

Experiment 03

Real World Assignment

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

1. Extract color histograms from images
2. Extract word counts from news articles

Experiment 04

Real World Assignment

To select relevant features using suitable technique

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

OR

Experiment 05

Real World Assignment.

To use PCA for dimensionality reduction

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

Experiment 06

Real World Assignment

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

1. Classify different bank customers
2. Classify flower species

Experiment 07

Real World Assignment

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

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

Experiment 08

Real World Assignment

Markov process for modelling manufacturing processes.

1. Inventory Simulation
2. Machine Maintenance

OR

Experiment 09

Real World Assignment

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

1. Optimize energy consumption
2. Optimize robot movement

Experiment 10

Real World Assignment

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

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

OR

Experiment 11

Real World Assignment

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

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

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.

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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 Automobile Engineering (2024 Pattern)				
AEC-283-ABE: Modern Indian Language: 02				
Teaching Scheme		**Credit**	**Examination Scheme**	
Tutorial	**1 Hours/Week**	**2**	**Term work**	**50 Marks**
Practical	**2 Hours/Week**			

❖ अभ्यासक्रमाचे उद्दिष्ट :

१. प्रगत भाषिक कौशल्यांची क्षमता विकसित करणे.

२. प्रसारमाध्यमांतील संज्ञापनातील स्वरूप आणि स्थान स्पष्ट करणे.

३. व्यक्तिमत्व विकास आणि भाषा यांतील 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 व्यक्तिमत्व 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	१	१५

	२. नवमाध्यमे आणि समाजमाध्यमांचे प्रकार : ब्लॉग, फेसबुक, ट्विटर ३. नवमाध्यमे आणि समाजमाध्यमांमधील विषयक साक्षरता, दक्षता, वापर आणि परिणाम		
४.	१. वेबसाईट आणि ब्लॉग, ट्विटरसाठी लेखन २. व्यावसायिक पत्रव्यवहार	१	१५

Learning Resources

संदर्भ ग्रंथ :

१. **सायबर संस्कृती,** डॉ. रमेश वरखेडे

२. **उपयोगी मराठी,** संपादक डॉ. केतकी मोडक**,** संतोष शेंगई**,** सुजाता शेंगई

३. **ओळख माहिती तंत्रज्ञानाची,** टिमोथी जे. ओ. लिअरी

४. **संगणक,** अच्युत गोडबोले**,** मोज प्रकाशन**,** मुंबई

५. **इंटरनेट,** डॉ. प्रबोध चौबे**,** मनोरेमा प्रकाशन**,** मुंबई

६. **व्यवहारिक मराठी,** डॉ. ल. रा. नसीराबादकर**,** फडके प्रकाशन**,** कोल्हापूर

७. **आधुनिक माहिती तंत्रज्ञानाच्या विश्वात,** शिरगापुरकर 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 (Marathi/Hindi):

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 availle on YouTube and write a review.

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

HSSM-284-ABE: Engineering Economics and Financial Management

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

Prerequisite Courses:

- 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.

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

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.

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.

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.

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 Automobile Engineering (2024 Pattern)				
VEC-285-ABE: 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:

- Knowledge of Chemistry, Biology and Earth Science

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 UNDERSTAND the role of national and international policies in addressing environmental problems and promoting sustainability.
6. 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.

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 3. Composting of organic waste		
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		
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.		
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.		
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]