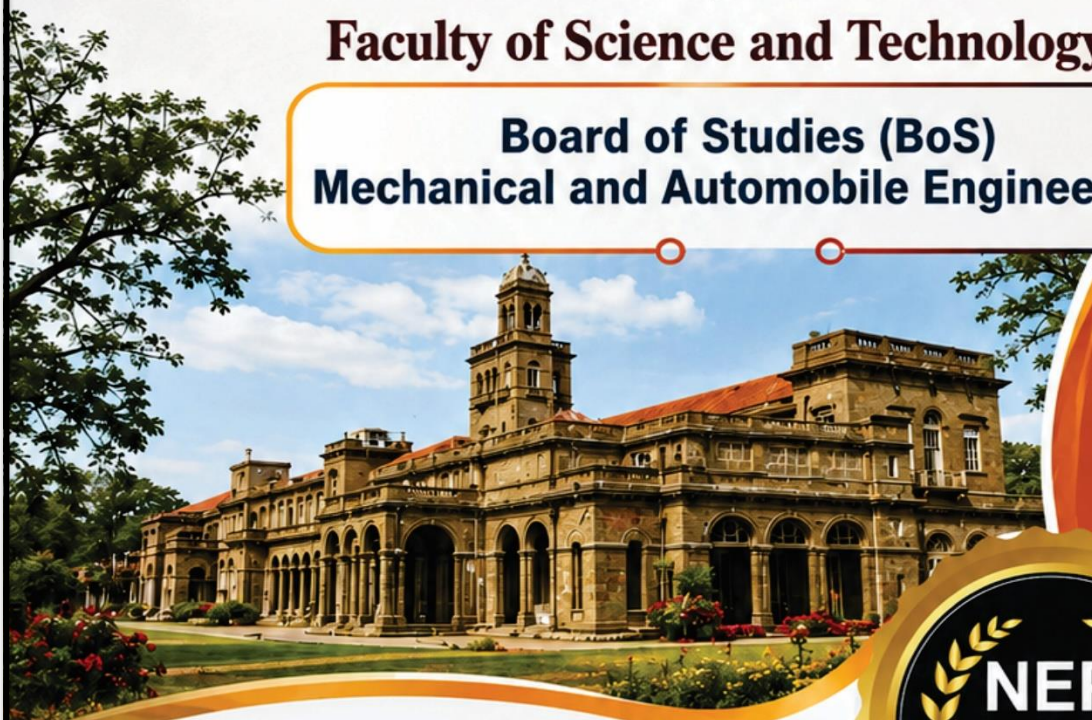
Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

Board of Studies (BoS)
Mechanical and Automobile Engineering



RESEARCH METHODOLOGY

- Identify Problem
- Review Literature
- Formulate Hypothesis
- Design Research
- Data Collection
- Data Analysis
- Conclusion

NEP 2020

Honors with Research Program

(18 Credits)

2024 PATTERN

(w.e.f. Academic Year: 2026-27)

Website: https://www.unipune.ac.in/

Contents

Semester: V, VI, VII & VIII Courses

NOMENCLATURE

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

PREFACE BY BOARD OF STUDIES

Dear Students and Teachers,

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

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

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

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

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

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

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

PROGRAM SPECIFIC OUTCOMES

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

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

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

PROGRAM EDUCATIONAL OBJECTIVES

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

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

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

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

PROGRAM OUTCOMES

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

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

KNOWLEDGE AND ATTITUDE PROFILE (WK)

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

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

GENERAL RULES AND GUIDELINES

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

ASSESSMENT AND EVALUATION:

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

Component	Description	Marks
Comprehensive Continuous Evaluation (CCE)	Conducted at institute level, covering all Units of the syllabus. The design and mark allocation follow the Continuous Assessment Sheet structure.	30
End-Semester Examination (ESE)	Conducted at university level, typically covering the entire syllabus through summative examination.	70
	Total Marks per Subject	**100**

A) Comprehensive Continuous Evaluation (CCE) :

CCE to be conducted either on the basis of Mode 1 or Mode 2.

CCE MODE 1:

To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 15 or 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)

Comprehensive Continous Evaluation (CCE) [30 Marks Distribution]

Class: TE- Mechanical Engineering — Subject: Refrigeration and Air Conditioning

Exam Seat No.	Roll No.	Name of Student	Unit 1		Unit 2		Unit 3		Unit 4		Unit 5		Cumulative Sum				30 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	Attendance	Field Activity	Quiz	Internal Test	Attendance	
			A	B	C	D	E	F	G	H	I	J	SUM(A+C+E+G+I)	SUM(B+D+F+H+J)			P	Q	R	S	SUM(P:S)
			10	10	10	10	10	10	10	10	10	10	50	50	100	100	15	5	5	5	30
T9028246474	2020	MAAN PANCHAL	8	8	8	8	8	8	8	8	8	8	40	40	60	75	12	4	3	3.8	22.75

Figure 1 Template Comprehensive Continuous Evaluation (CCE) ***Click*** *here to download .*

Field Activities / Home Assignments

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

1. **Course Projects**

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

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

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

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

2. **Industrial Visit**

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

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

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

3. **Guest Lectures**

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

Assessment methods for guest lectures may include:

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

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

4. Quiz

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

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

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

5. Internal Tests

Two major internal tests should be conducted as follows:

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

CCE MODE 2:

Comprehensive Continuous Evaluation scheme in this mode for a theory subject of **30 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	12 Marks	Unit 1 & Unit 2 (6 Marks/Unit)
2	Assignments/Case Study	12 Marks	Unit 3 & Unit 4 (6 Marks/Unit)
3	Seminar Presentation/ Open Book Test/ Quiz	06 Marks	Unit 5

- **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].

- **Assignments / Case Study:** Students should submit one assignment or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.

  – ***Format*****:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.

  – ***Implementation:*** Distribute the assignments or case study after covering Units 3 and 4. Provide clear guidelines and a rubric for evaluation.

- **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 interest 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 (08 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 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.
e) **Evaluating**: Justifying a decision or course of action.
f) **Creating**: Producing new or original work (if applicable).

Curriculum Structure
Honor Courses (2024 Pattern)
NEP 2020 Compliant Curriculum Structure

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Third and Final Year Mechanical Engineering (2024 pattern)

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			L	T	P	CCE	ESE	TW	OR	PR	TOTAL	L	T	P	TOTAL
Semester-V															
HRES301MEC		Research Orientation & Proposal Development	7					100			100				03
Semester-VI															
HRES302MEC		Literature Review & Publication	7					100			100				03
Semester-VII															
HRES351MEC		Research planning, preliminary investigation and execution	18					100			100				06
Semester-VIII															
HRES321MEC		Research Analysis, Discussion and Dissertation	18					100			100				06
		Total	**26**					**400**			**400**				**18**

Savitribai Phule Pune University, Pune

Maharashtra, India

TE - Mechanical Engineering (2024 Pattern)

SEMESTER- V

Honor Courses

[Honors with Research]

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

HRES351MEC: Research Orientation & Proposal Development

Teaching Scheme		Credit	Examination Scheme	
Theory	7 Hours/Week	3	CCE	NA
Practical	NA		TW	100 Marks

- **Prerequisites:**
  Students should have:
  - Basic understanding of their engineering discipline.
  - Basic awareness of research and innovation.
  - Fundamental knowledge of technical communication.
  - Basic ability to search scholarly information and use digital resources.

Course Objectives:
The course aims to enable students to:

1. Understand the fundamentals, types, scope and significance of engineering research and distinguish research from innovation, invention and product development.
2. Explore a broad research domain and identify a meaningful engineering problem based on emerging trends and real-world needs.
3. Develop the ability to formulate a research problem, research questions, objectives and scope through preliminary exploration of existing knowledge.
4. Develop a feasible preliminary research methodology, resource plan, timeline and implementation strategy for the identified research problem.
5. Prepare, present and defend a structured research proposal while demonstrating awareness of research ethics, academic integrity and IPR.

Course Outcomes: On completion of the course, Student will be able to
After successful completion of the course, learner will be able to:
After successful completion of the course, the learner will be able to:

CO1: Explain the fundamentals, types and significance of engineering research and distinguish research from innovation and product development.

CO2: Explore a research domain and formulate a relevant engineering problem based on emerging trends, real-world needs and preliminary literature exploration.

CO3: Formulate research questions, objectives, scope and expected outcomes aligned with an identified research problem.

CO4: Develop a preliminary research methodology, feasibility analysis, resource plan and research timeline for the proposed research.

CO5: Prepare, present and defend a structured research proposal incorporating research ethics, IPR awareness, impact and implementation planning.

Course Contents		
Unit I	**Fundamentals of Engineering Research & Research Landscape**	**(20 Hours)**

Introduction to engineering research and its role in technological development, Types of research (Fundamental and applied research, Experimental, analytical and computational research, Design-based and interdisciplinary research). Distinction between research, innovation, invention and product development. Research ecosystem and contemporary research trends.

Research ecosystem and contemporary research trends. Identification of broad research domains and emerging technologies. Research landscape and domain exploration. Identification of real-world engineering challenges. Industry, societal, environmental and technological problem contexts. Introduction to scholarly information sources: Research papers, Review papers, Conference papers, Patents, Standards, Technical reports. Basic research search strategies and keyword development. Preliminary exploration of literature for research-domain identification. Identification of potential research areas and application domains.

Unit II	**Research Problem Identification & Preliminary Literature Exploration**	**(08 Hours)**

Understanding the characteristics of a good research problem. **Problem identification from:** Industry, Society, Campus, Environment, Emerging technologies. Preliminary literature exploration for understanding the existing problem context. Identification of major research approaches and existing solutions. Basic comparison of selected research studies. Identification of broad limitations and unexplored areas. **Distinguishing a research problem from (**Engineering design problem, Product development problem, Routine improvement problem). Problem scoping and narrowing. Stakeholder identification. Application context and relevance. Societal, industrial, environmental and economic significance. Mapping the proposed problem with relevant **Sustainable Development Goals (SDGs)**. Preparation of preliminary problem statement.

Unit III	**Research Questions, Objectives, Ethics & IPR Awareness**	**(25 Hours)**

Research problem versus research gap. Formulation of research questions. Development of research objectives. Characteristics of effective and measurable research objectives. Alignment: **Problem → Research Question → Objective → Expected Outcome**.

Definition of: Scope, Limitations, Assumptions, Constraints. Preliminary formulation of research hypothesis, wherever applicable. Expected research contribution and outcomes. Introduction to research ethics and responsible conduct of research. Academic integrity and responsible research practices. Introduction to: Plagiarism, Self-plagiarism, Fabrication, Falsification. Basic awareness of plagiarism detection tools. Responsible use of AI-assisted research tools. Introduction to Intellectual Property Rights: Patent, Copyright, Industrial design. Basic awareness of novelty and patentable components. Preliminary consideration of IPR in research planning.

Unit IV	**Research Methodology, Planning & Proposal Development**	**(35 Hours)**

Introduction to research methodology. Selection of preliminary research approach: Experimental, Analytical, Computational, Design-based, Mixed/interdisciplinary, wherever applicable. Development of preliminary methodology. Identification of: Variables, Parameters, Inputs and outputs, Assumptions, Constraints. Experimental/computational planning. Validation strategy at preliminary level. Resource identification: Equipment, Software, Materials, Data, Infrastructure, Expertise.

Feasibility analysis: Technical, Resource, Time, Data/material availability. Risk identification and preliminary mitigation. Development of research workflow. Research roadmap and Gantt chart.

- **Research proposal structure:**
  - Title.
  - Background and motivation.
  - Problem statement.
  - Preliminary literature context.
  - Research questions.
  - Objectives.
  - Scope and limitations.
  - Proposed methodology.
  - Expected outcomes.
  - Applications and impact.
  - Resources.
  - Timeline.
  - References.

Preparation of a **5–7 page structured research proposal**. Preparation of preliminary abstract and introduction.

Unit V	**Research Proposal Presentation, Review & Readiness**	**(30 Hours)**

Principles of technical and research communication. Preparation of research proposal presentation. Presentation of: Research background, Problem statement, Preliminary literature context, Research questions, Objectives, Proposed methodology, Expected outcomes, Impact and applications. Research proposal presentation before mentor/faculty panel. Technical questioning and defense. Peer and mentor review. Incorporation of feedback. Finalization of research proposal. Research readiness assessment. Maintenance of Research Logbook documenting: Weekly activities, Mentor interactions, Decisions, Modifications, Challenges, Learning, Next steps..

Learning Resources

Text Books

1. C.R. Kothari, Gaurav Garg, *Research Methodology: Methods and Techniques*, New Age International, 2019
2. Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, 4th Ed.,2024.
3. Ramakrishna B and Anil Kumar H S., *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers*, Notion Press, 2024

Reference Books

1. Stuart Melville and Wayne Goddard, *Research methodology: An Introduction for Science and Engineering students*, Juta Academic; 2nd Ed., 2014
2. Wayne C. Booth et al., *The Craft of Research*, University of Chicago Press, 2016.
3. S.D. Sharma, *Operational Research*, Kedar Nath and Co., 2012.
4. Virendra Kumar Ahuja, *Intellectual Property Rights in India*, Lexis Nexis, 2017.

Web References

MOOC / NPTEL/YouTube Links: -

1. https://nptel.ac.in/courses/109103153
2. https://onlinecourses.swayam2.ac.in/ini25_ed05/preview

Assignments

Assignment 1: Research Domain Identification & Problem Scoping

Assignment 2: Preliminary Literature Exploration & Problem Formulation

Assignment 3: Research Ethics & IPR Awareness

Assignment 4: Research Methodology & Planning

Assignment 5: Research Proposal Development

Savitribai Phule Pune University, Pune

Maharashtra, India

TE - Mechanical Engineering (2024 Pattern)

SEMESTER- VI

Honor Courses

[Honors with Research]

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

HRESM351MEC: Literature Review & Publication

Teaching Scheme		Credit	Examination Scheme	
Theory	7 Hours/Week	3	CCE	NA
Practical	NA		TW	100 Marks

- **Prerequisites:**

Students should have:

- Basic understanding of their engineering discipline.
- Basic awareness of research and innovation.
- Fundamental knowledge of technical communication.
- Basic ability to search scholarly information and use digital resources.

Course Objectives:

The course aims to enable students to:

1. Conduct a systematic and comprehensive literature review to establish the state-of-the-art in the approved research domain.
2. Critically synthesize and benchmark existing research to validate the research gap and establish the novelty and contribution of the proposed work.
3. Develop advanced scientific writing skills for preparing literature reviews and research manuscripts.
4. Understand scholarly publishing, publication ethics, journal/conference selection, peer review and research dissemination practices.
5. Prepare, present and refine a publication-ready manuscript based on systematic literature analysis and mentor/peer feedback.

Course Outcomes:

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

CO1: Conduct a systematic literature search and organize scholarly sources using appropriate databases and bibliographic tools.

CO2: Critically synthesize, compare and benchmark published research to validate research gaps, limitations and potential contributions.

CO3: Prepare a structured and technically sound research manuscript using appropriate scientific writing, citation and referencing practices.

CO4: Evaluate publication venues and apply publication ethics, journal-selection criteria, peer-review practices and IPR-publication considerations.

CO5: Present, defend and refine a research manuscript and demonstrate publication readiness.
research proposal incorporating research ethics, IPR awareness, impact and implementation planning.

Course Contents

Unit I	**Systematic Literature Review & Research Framework**	**(25 Hours)**

Purpose and role of systematic literature review. Review of literature specifically related to the **approved research proposal**. Systematic search strategy. Selection of **25–30 quality research papers/patents**. Scholarly databases and advanced search techniques. Keywords, Boolean operators and citation chaining. Source-quality assessment. Classification of literature according to: Methodology, Materials, Tools, Datasets, Application, Performance parameters, Outcomes. Bibliographic/reference management. Annotated bibliography. Literature database development. State-of-the-art mapping. Research trend analysis. Development of literature synthesis matrix.

Unit II	**Critical Literature Synthesis, Benchmarking & Research Gap Validation**	**(25 Hours)**

Critical reading of research papers. Literature synthesis versus descriptive literature summary. Comparative analysis of: Methodologies, Experimental conditions, Computational approaches, Materials, Tools, Datasets, Performance parameters. Quantitative comparison and benchmarking. Identification of: Limitations, Inconsistencies, Contradictory findings, Unexplored parameters, Methodological gaps, Performance gaps, Application gaps. Evidence-based research-gap identification. Validation of the gap against the approved research proposal. Refinement of research questions/objectives, if require. Establishing novelty and potential contribution. Development of research contribution statement.

Preparation of **8–10 page Critical Literature Review Report**.

Unit III	**Scientific Writing & Research Manuscript Development**	**(25 Hours)**

Principles of scientific writing. Developing a coherent research narrative.

Structure of a research manuscript:

- Title.
- Abstract.
- Keywords.
- Introduction.
- Literature Review.
- Research Gap.
- Objectives.
- Methodology.
- Results/expected results.
- Discussion.
- Conclusion.
- References.

Advanced literature synthesis writing. Writing a strong introduction based on evidence. Integrating research gap and contribution. Citation and referencing practices. Reference-management tools. Tables and figures for literature synthesis. Conceptual diagrams and graphical representation. Journal/conference manuscript templates. Technical language and scientific style. Peer review of manuscripts. Revision and editing based on feedback.

Unit IV	Publication Ethics, Journal Selection & Research Dissemination	(30 Hours)

Scholarly publishing ecosystem. **Types of research publications:** Research article, Review article, Conference paper, Short communication, Technical note. **Publication ethics:** Authorship, Contributor responsibility, Conflict of interest, Duplicate/redundant publication, Plagiarism, Self-plagiarism, Fabrication, Falsification. Responsible use of AI-assisted research and writing tools. Similarity-checking and interpretation. **Journal/conference selection:** Scope, Relevance, Quality, Indexing, Journal metrics, Publication model, Review process, Author guidelines. Identification and avoidance of predatory journals/conferences. Manuscript submission requirements. Cover letter. Peer-review process. Reviewer comments and response-to-reviewer process. **IPR and publication:** Novelty, Prior art, Patent versus publication decision, Publication timing and IPR considerations. Research dissemination and societal/industrial impact.

Unit V	Manuscript Finalization, Presentation & Publication Readiness	(30 Hours)

Integration of literature findings into the manuscript. Final manuscript structuring and editing. Formatting according to selected publication venue. Citation and reference verification. Final similarity/plagiarism check. **Preparation of:** Final manuscript, Cover letter, Highlights, Graphical abstract, wherever applicable. Preparation of publication submission checklist. Research seminar. **Technical presentation of:** State-of-the-art, Research gap, Contribution, Proposed/ongoing research, Publication potential. Technical defense before mentor/faculty panel. Incorporation of reviewer/mentor feedback. Final publication-readiness assessment. Preparation of next-step research plan. **Research Logbook focused on:** Literature reviewed, Analysis performed, Writing, Feedback, Revisions.
Publication decisions.

Learning Resources

Text Books

1. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International, 2019
2. Creswell, J.W., Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 6th Ed. SAGE, 2022.

Reference Books

1. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 4th Ed., 2024.
2. Mark Saunders, Philip Lewis, Research Methods for Business Students, 7th Ed., Pearson, 2015.
3. Robert A. Day, Barbara Gastel, How to Write and Publish a Scientific Paper, 7th Ed., Cambridge University Press, 2011.

Web References

MOOC / NPTEL/YouTube Links: -

https://onlinecourses.nptel.ac.in/noc26_ge43/preview

https://nptel.ac.in/courses/110105091

Assignments

Assignment 1: Systematic Literature Review & Research Landscape Mapping

Assignment 2: Critical Literature Analysis & Research Gap Validation

Assignment 3: Research Manuscript / Review Article Development

Assignment 4: Publication Strategy, Ethics, Journal Selection & IPR

Assignment 5: Final Manuscript & Publication Readiness

Savitribai Phule Pune University, Pune

Maharashtra, India

BE - Mechanical Engineering (2024 Pattern)

SEMESTER- VII

Honor Courses

[Honors with Research]

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

HRES401MEC: Honours Dissertation – Phase I: Research Planning, Preliminary Investigation and Execution

Teaching Scheme		Credit	Examination Scheme	
Theory	18 Hours/Week	06	CCE	NA
Practical	NA		TW	100 Marks

- **Prerequisites:**

Successful completion of:

- Research Orientation & Proposal Development
- Literature Review & Publication

Students shall enter this course with an approved research proposal, validated research gap, defined objectives, preliminary methodology and literature review.

Course Objectives:

The course aims to enable students to:

1. Translate the approved research proposal into a detailed and executable research implementation plan.
2. Establish the required experimental, computational, simulation or prototype-development environment and conduct preliminary investigations.
3. Execute the proposed research methodology systematically and generate reliable research data/evidence.
4. Develop and evaluate a novel design, concept or technical solution with potential for **Design/Idea Patent** protection.
5. Document research progress, evaluate preliminary findings and communicate the progress and innovation through technical reports and seminars.

Course Outcomes:

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

CO1: Develop and implement a detailed research execution plan using appropriate tools, resources, methods and timelines.

CO2: Conduct experiments, simulations, computational studies or prototype development according to the approved research methodology.

CO3: Generate, organize and perform preliminary analysis of reliable research data and evaluate the feasibility of the proposed research approach.

CO4: Develop and document a novel design/concept with potential for **Design or Idea Patent** protection.

CO5: Communicate and document research progress, preliminary findings, challenges and future execution plans through technical reports, seminars and research logbooks.

Course Contents

Unit I	**Research Execution Planning & Experimental/Computational Setup**	**(40 Hours)**

Review of approved research proposal and research objectives. Translation of research objectives into measurable research tasks. Detailed research execution roadmap. Refinement of research methodology based on feasibility considerations. Identification and procurement/access of: Materials, Equipment, Software, Computational resources, Datasets, Measurement systems. Experimental setup/system architecture. Simulation/model development environment. Data acquisition and storage plan. Identification of variables and control parameters. Establishment of baseline/reference conditions. Safety, ethical and operational considerations. Pilot study and feasibility investigation. Troubleshooting and risk mitigation. Preparation of detailed semester-wise execution schedule.

Unit II	**Research Problem Identification & Preliminary Literature Exploration**	**(40 Hours)**

Preliminary experiments/simulations/prototype development. Verification of experimental or computational setup. Calibration and measurement-system verification. Selection of operating parameters and boundary conditions. Baseline experimentation/simulation. Initial data collection. Repeatability and reproducibility considerations. Identification of experimental/computational errors. Sensitivity to important parameters. Preliminary comparison with stablished/reference results. Refinement of methodology based on preliminary findings. Documentation of challenges, deviations and corrective actions.

Unit III	**Research Execution & Data Generation**	**(50 Hours)**

Full-scale execution of approved research methodology. Experimental investigation. Numerical/computational simulation. Algorithm/model development. Prototype development and testing. Parametric studies. Design iterations. Data collection and systematic documentation. Experimental repeatability and reliability. Data organization and metadata documentation. Troubleshooting and iterative improvement. Comparison with baseline/reference cases. Documentation of research decisions and modifications. Periodic mentor review.

Unit IV	**Design/Idea Patent Development**	**(90 Hours)**

A. Innovation and Novelty Identification

- Identification of novel design/concept emerging from the research.
- Problem–solution mapping.
- Identification of innovative features.
- Functional and technical advantages.
- Novelty and inventive contribution.

B. Prior-Art and Patent Landscape

- Introduction to patent databases.
- Patent search strategy.
- Keyword and classification-based search.
- Identification of relevant prior art.
- Comparison with existing patents/designs.
- Identification of distinguishing features.

C. Design/Idea Development

- Development of innovative concept/design.
- Functional architecture.
- Design specifications.
- Engineering drawings/CAD models, wherever applicable.
- Prototype/concept validation.
- Technical advantages and applications.
- Industrial applicability.

D. Patent/Design Documentation

- Title of invention/design.
- Field of invention.
- Background.
- Problem addressed.
- Novelty.
- Description of design/concept.
- Figures/drawings.
- Key features.
- Advantages.
- Applications.
- Inventor contribution statement.
- Preparation of draft patent/design documentation in consultation with the institute's IPR support system.

E. Patent/Design Presentation

- Innovation pitch.
- Technical defense before mentor/IPR panel.
- Feedback incorporation.
- Finalization of patent/design documentation.

This unit is specifically dedicated to the **2-credit Design/Idea Patent component**.

Two Credit Assessment is done for:

- Patent/Design Search Report.
- Novelty Assessment.
- Innovation/Design Concept.
- CAD/technical drawings/prototype, where applicable.
- **Draft Design/Idea Patent Application.**
- Patent/Design Presentation.
- IPR Mentor/Panel Evaluation.

Unit V	Research Consolidation	(50 Hours)

Consolidation of research execution activities. Preliminary data organization and visualization. Initial interpretation of research observations. Comparison with expected outcomes. Identification of deviations and limitations. Preparation of preliminary research findings. Preparation of research article framework based on emerging results. Research progress presentation. Technical defense before faculty/mentor panel. Incorporation of review feedback. Preparation of Semester VIII execution plan. Continuous research documentation.

Learning Resources
Text Books 1. C.R. Kothari, Gaurav Garg, *Research Methodology: Methods and Techniques*, New Age International, 2019 2. Robert A. Day, Barbara Gastel, *How to Write and Publish a Scientific Paper*, 7th Ed., Cambridge University Press, 2011.
Reference Books 1. Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, 4th Ed., 2024. 2. Creswell, J.W., *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 6th Ed. SAGE, 2022.
Web References
MOOC / NPTEL/YouTube Links: - 1. Shodhganga 2. Research publication database like ScienceDirect (Elsevier), IEEE Xplore Digital Library, SpringerLink, or open access database, etc.
Assignments Assignment 1: Detailed Research Execution Plan Assignment 2: Pilot Investigation & Method Validation Assignment 3: Research Execution & Preliminary Data Generation Assignment 4: Design/Idea Patent Development Assignment 5: Research Progress Seminar

Savitribai Phule Pune University, Pune

Maharashtra, India

BE - Mechanical Engineering (2024 Pattern)

SEMESTER- VIII

Honor Courses

[Honors with Research]

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

HRES401MEC: Honours Dissertation – Phase II: Research Analysis, Discussion and Dissertation

Teaching Scheme		Credit	Examination Scheme	
Theory	18 Hours/Week	06	CCE	NA
Practical	NA		TW	100 Marks

- **Prerequisites:**

Successful completion of:

- Research Orientation & Proposal Development
- Literature Review & Publication
- Honours Dissertation – Phase I: Research Planning, Preliminary Investigation and Execution

Students shall enter this course with completed/preliminary research implementation, datasets/prototypes/models, preliminary findings and a Semester VII progress report.

Course Objectives:

The course aims to enable students to:

1. Complete the research implementation and consolidate reliable research data/evidence generated during the research project.
2. Apply appropriate analytical, statistical, computational and comparative techniques to interpret research results.
3. Critically discuss research findings with respect to objectives, literature, novelty, limitations and practical implications.
4. Develop and communicate scholarly research through a **journal/Scopus-indexed publication** and appropriate research communication.
5. Compile, present and defend a comprehensive research dissertation demonstrating originality, technical competence and research contribution

Course Outcomes:

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

CO1: Complete and consolidate the research work and generate validated research evidence aligned with the approved objectives.

CO2: Analyze and interpret research data using appropriate analytical, statistical, computational and visualization techniques.

CO3: Critically discuss research findings with respect to existing literature, novelty, limitations, applications and research contributions. **CO4:** Prepare and communicate scholarly research through a quality journal/Scopus-indexed publication and appropriate academic communication.

CO5: Prepare, present and defend a comprehensive dissertation demonstrating originality, technical competence and research contribution.

Course Contents		
Unit I	**Completion of Research & Data Consolidation**	**(40 Hours)**

Review of research objectives and work completed in Semester VII. Identification of pending research activities. Completion of experiments/simulations/prototype testing. Final data generation. Data quality assessment. Data cleaning and organization. Repeatability and reproducibility assessment. Verification and validation. Finalization of datasets. Documentation of experimental/computational conditions. Establishment of final research evidence.

Unit II	**Research Data Analysis & Results**	**(40 Hours)**

Selection of appropriate analysis techniques. Statistical analysis. Error and uncertainty analysis, wherever applicable. Computational/numerical analysis. Comparative analysis. Parametric analysis. Sensitivity analysis. Optimization, where applicable. **Data visualization:** Graphs, Tables, Charts, Contour/field plots, Photographs/images, Identification of significant findings, Relationship between variables and outcomes, Comparison with baseline/reference cases. Benchmarking against published literature.

Unit III	**Discussion, Novelty, Impact & Research Contribution**	**(40 Hours)**

Interpretation of research findings. Linking results with research objectives. Comparison with previous literature. Explanation of agreements and deviations from existing studies. Identification of novel findings. Technical contribution. Scientific contribution. Industrial/application contribution. Societal and environmental implications. SDG impact. Limitations of the research. Assumptions and constraints. Scope for future work. Development of a coherent **Research Contribution Statement**. Preparation of dissertation results and discussion chapters.

Unit IV	**Scholarly Publication & Research Communication**	**(90 Hours)**

A. Manuscript Development

- Selection of appropriate research findings for publication.
- Development of research manuscript.
- Title, abstract and keywords.
- Introduction.
- Literature synthesis.
- Research gap.
- Methodology.
- Results.
- Discussion.
- Conclusion.
- References.

B. Journal/Scopus Publication Strategy

- Identification of suitable journals.
- Scope and relevance.
- Indexing verification.
- Journal quality assessment.
- Author guidelines.
- Publication model.
- Peer-review process.
- Publication ethics.
- Predatory journal awareness.

- Selection of target journal.

C. Manuscript Review and Submission

- Technical editing.
- Language editing.
- Reference verification.
- Similarity/plagiarism checking.
- Formatting according to journal requirements.
- Preparation of:
  - Cover letter.
  - Graphical abstract.
  - Highlights.
  - Supplementary information, wherever required.
- Mentor/peer review.
- Incorporation of reviewer comments.
- Final manuscript submission.

D. Scholarly Communication

Students shall communicate their research through at least one appropriate scholarly platform, such as:

- Journal manuscript submission.
- Scopus-indexed conference paper.
- Research conference presentation.
- Poster/oral presentation.
- Institutional research seminar.
- Technical research communication.

The **2-credit scholarly publication component**.
A manuscript **submitted to a relevant quality journal**, preferably Scopus-indexed.

Recommendation: Do not make *actual publication acceptance* the sole pass/fail requirement because the peer-review timeline is outside the student's control. The assessable requirement should be **quality manuscript + appropriate journal selection + documented submission**, with actual publication recognized as an additional achievement.

Unit V	Dissertation Writing, Seminar & Viva-Voce	(60 Hours)

Structure of the dissertation:

1. Introduction.
2. Literature Review.
3. Research Gap and Objectives.
4. Methodology.
5. Research Implementation.
6. Results.
7. Discussion.
8. Conclusions.
9. Contributions.
10. Limitations.
11. Future Scope.
12. References.
13. Appendices.

Integration of work conducted during Semesters VI–VIII. Preparation of dissertation figures, tables and diagrams. Technical editing and formatting. Citation and reference verification. Plagiarism/similarity checking. Incorporation of supervisor and review-panel comments. Dissertation submission. Final research seminar. Mock viva. Viva-voce preparation. Defense of: Problem, Methodology, Results, Novelty, Contribution, Limitations, Future work. Final Viva-Voce.

Task Force for Curriculum Design and Development

Advisors & the Chairmen - Board of Studies

Dr. Pradeep A. Patil	Dr. Prashant B. Kushare
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Dr. Amar P. Pandhare	Dr. Shiv Sai Dixit
Dr. Vishnu D. Wakchaure	Dr. Niranjan Kolhe
Dr. Sanjay B. Zope	Dr. Ajit A. Bhosale
Dr. Jitendra A. Hole	Dr. Narendra R. Deore
Dr. Mohan P. Khond	Dr. Vikas N. Chougule
Dr. Aishwarya B. Gawand	

Team Members for Course Design

Sr. No	Name of Faculty	Sr. No	Name of Faculty
1			
2			
3			
4			

Course Design By

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