Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

Curriculum Structure and Syllabus

Master of Engineering (2025 Pattern) in

ME- Mechanical Engineering (Heat Power Engineering)

(With effect from Academic Year 2025-26)

Curriculum Structure

Master of Engineering (2025 Pattern) – Mechanical Engineering (Heat Power Engineering)

Level 6.0

Semester I

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Practical	Total
PCC-501-HPO	Program Core Course	Advanced Numerical Methods for Thermal & Fluid Engineering	4	-	50	50	-	-	-	100	4	-	4
PCC-502- HPO	Program Core Course	Advanced Thermodynamics	4	-	50	50	-	-	-	100	4	-	4
PCC-503- HPO	Program Core Course	Advanced Fluid Mechanics	4	-	50	50	-	-	-	100	4	-	4
PCC-504- HPO	Program Core Course	Advanced Refrigeration Technology	4	-	50	50	-	-	-	100	4	-	4
PCC-505- HPO	Program Core Course	Laboratory Practice-I	-	4	-	-	25	-	25-	50	-	2	2
PEC-520- HPO	Program Elective Course	Program Elective Course I	3	-	50	50	-	-	-	100	4	-	4
PEC-521- HPO	Program Elective Course	Program Elective Course I: Field Work	-	2	-	-	25	-	25	50	-	1	1
Total			**19**	**6**	**250**	**250**	**50**	**-**	**50**	**600**	**19**	**3**	**22**

List of Program Elective Course I

PEC-520A- HPO	Energy Conservation and Management
PEC-520B- HPO	Gas Dynamics

Curriculum Structure

Master of Engineering (2025 Pattern) – Mechanical Engineering (Heat Power Engineering)

Level 6.0

Semester II

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Practical	Total
PCC -551- HPO	Program Core Course	Advanced Heat Transfer	4	-	50	50	-	-	-	100	4	-	4
PCC-552- HPO	Program Core Course	Computational Fluid Dynamics	4	-	50	50	-	-	-	100	4	-	4
PCC-553- HPO	Program Core Course	Design of Heat Exchangers	4	-	50	50	-	-	-	100	4	-	4
PCC-554- HPO	Program Core Course	Laboratory Practice-II	-	4	-	-	25	-	25	50	-	2	2
PEC-570-HPO	Program Elective Course	Program Elective Course –II	3	-	50	50	-	-		100	4	-	4
PEC-571-HPO	Program Elective Course	Program Elective Course –III	3	-	50	50	-	-		100	4	-	4
SEM-580- HPO	Seminar	Technical Seminar-I	-	4	-	-	25	-	25	50	-	2	2
Total			**18**	**8**	**250**	**250**	**50**	**-**	**50**	**600**	**18**	**4**	**22**

List of Program Elective Course II

PEC-570A- HPO	Advances in Power Generation Technology
PEC-570B- HPO	Advances in Engine Technology

List of Program Elective Course III

PEC-571A- HPO	Renewable Energy Systems
PEC-571B- HPO	Nuclear Engineering

Curriculum Structure

Master of Engineering (2025 Pattern) – Mechanical Engineering (Heat Power Engineering)

Level 6.0

Semester III

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Practical	Total
RM-600- MECH	Research Methodology	Research Methodology	4	-	50	50	-	-	-	100	4	-	4
OJT-601- HPO	Internship/ OJT	Internship/ On Job Training	-	10	-	-	100	-	-	100	-	5	5
SEM-602- HPO	Seminar	Technical Seminar II	-	8	-	-	25	-	25	50	-	4	4
RPR-603- HPO	Research Project	Research Project Stage -I	-	18	-	-	25	-	25	-	-	9	9
Total			**4**	**36**	**50**	**50**	**150**	**-**	**50**	**300**	**4**	**18**	**22**

Curriculum Structure

Master of Engineering (2025 Pattern) – Mechanical Engineering (Heat Power Engineering)

Level 6.0

Semester IV

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Practical	Total
RPR-651- HPO	Research Project	Seminar on Project Stage II	-	8	-	-	50	-	50	100	-	4	4
RPR-652- HPO	Research Project	Research Project - Stage II	-	36	-	-	150	-	50	200	-	18	18
Total			**-**	**44**	**-**	**-**	**200**	**-**	**100**	**300**	**-**	**22**	**22**

Programme Outcomes (PO)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability, attitude, and behavior that students acquire through the program. The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of a graduate of the PG Engineering Program.

The National Board of Accreditation (NBA) has defined the following three POs for a graduate of the PG Engineering Program:

PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Savitribai Phule Pune University, Pune

Maharashtra, India

ME - Mechanical Engineering (Heat Power Engineering)

(2025 Pattern)

Semester I

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-501-HPO - Advanced Numerical Methods for Thermal & Fluid Engineering		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Engineering Mathematics, Numerical Methods

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Formulate linear equations by simplifying them using basic concepts of linear algebra
- CO2: Apply numerical methods of interpolation, integration to obtain approximate solutions to the problem
- CO3. Develop the mathematical models of thermal systems using ODEs
- CO4: Develop the mathematical models of thermal systems using PDEs
- CO5: Identify and use proper optimization, numerical methods of curve fitting to solve problems of thermal engineering

Course Contents

Unit I	**Linear Algebraic Equations**	**(08 Hours)**

Solution of algebraic and transcendental equations: - Bisection Method, False position method, Newton–Raphson Method, Muller's method, Bairstow's Method, Convergence and stability

Solution of simultaneous equations: Gauss–Elimination, Gauss-Jordan, Gauss–Seidel, LU Decomposition,

Eigenvalue problem- Power Method

Unit II	**Interpolation & Integration**	**(08 Hours)**

Interpolation- Newton's backward and forward, Lagrange's, Newton-divided difference, Gauss's forward and backward interpolation, Lagrange's Inverse, Spline, Hermite Interpolation

Integration- Trapezoidal, Simpson's 1/3 and 3/8 rules, Boole's rule, Weddle's rule. Romberg integration, Gauss quadrature two-point and three-point, Double integration (Trapezoidal rule, Simpson's 1/3rdRule)

Unit III	**Ordinary Differential Equations (ODE)**	**(08 Hours)**

Euler's method, Heun's method, Modified Euler's method, Runge – Kutta methods, Adams – Bashforth technique, Boundary value problems, Finite difference method, Higher order ODE – Shooting method.

Unit IV	**Partial Differential Equations (PDE)**	**(08 Hours)**

Solution of Elliptic Equation, Laplace Equations, Poisson's Equations, Solution of Parabolic equations, Solution of 2-D Heat equation, and Hyperbolic equations –Implicit & Explicit Schemes

Unit V	**Curve fitting and optimization**	**(08 Hours)**

Curve fitting: Least square method, nonlinear, exponential curve fitting, method of group average, laws with three constraints

Optimization: Introduction to optimization, Classification, Constrained optimization (maximum two constrains): Graphical and Simplex method, One Dimensional unconstrained optimization: Newton's Method. Modern Optimization Techniques: Genetic Algorithm (GA), Simulated Annealing (SA).

Learning Resources

Text Books:

1.	**Numerical methods in Engineering and Science,** Dr. B.S. Grewal, Khanna Publishers.
2.	**Numerical Methods for Engineers,** Steven C Chapra & Raymond P Canale, TMH, Fifth Edition

Reference Books:

1.	**Applied Numerical Methods,** Alkis Constantinides, McGraw Hill
2.	**Numerical Solution of Differential Equations,** M.K. Jain, 2nd Edition, Wiley Eastern
3.	**Numerical methods for scientific and engineering computation,** Jain, Iyangar Jain, New Age International Publishers
4.	**Applied Numerical Methods using MATLAB,** Won Y. Yang, Wenwu Cao, Tae-Sang Chung, John Morris, Wiley.

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-502-HPO - Advanced Thermodynamics		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Engineering Thermodynamics

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Recognize the properties of pure substances and use property tables to estimate the physical properties of the substance.
- CO2: Apply laws of thermodynamics to model and solve problems of engineering applications
- CO3. Analyze thermal systems using principles of exergy, thermodynamic relations
- CO4: Apply the knowledge of chemical thermodynamics to evaluate problems involving gas mixtures and chemical reactions
- CO5: Recognize the concepts of statistical and biological thermodynamics

Course Contents

Unit I	**Properties of Pure Substances**	**(08 Hours)**

Concept, Phase change process of pure substances, Property diagrams for phase change processes: T-v diagram, P-v diagram, P- T diagrams and PVT surface, Use of steam tables and charts in common use, Ideal gas equation, compressibility factor, principle of corresponding states, use of generalized compressibility chart, Van der Waals equation of state, Beattie-Bridgeman equation of state, Benedict-Webb-Rubin Equation of State

Unit II	**Applications of laws of thermodynamics**	**(08 Hours)**

Repopulation of the 2nd law of thermodynamics, 2nd law Analysis for Engineering Systems

Entropy: Concept, Increase of entropy principle, Entropy generation, entropy change of pure sub, T-ds relations, Isentropic efficiency,

Thermo-electricity, Onsager equation, Third law of thermodynamics, Nerst heat theorem, and thermal death of the universe.

Unit III	Exergy and Thermodynamic Property Relations	(08 Hours)

Exergy: Concept, Second-Law Efficiency, Exergy Destruction, Exergy Balance

Thermodynamic Property Relations: Partial Differentials, Maxwell relations, Clapeyron equation, general relations for du, dh, ds, and Cv and Cp, Joule Thomson Coefficient, Δh, Δu, Δs of real gases

Unit IV	Chemical Thermodynamics	(08 Hours)

Gas Mixtures: Mass & mole fractions, Dalton's law of partial pressure, Amagat's law, Kay's rule

Combustion: Fuels and Combustion, Enthalpy of Formation and Enthalpy of Combustion, adiabatic flame temperature

Chemical and Phase Equilibrium: Criterion for chemical equilibrium, Equilibrium constant KP, importance of KP, Variation of Kp with temperature, Phase equilibrium, Gibbs phase rule, fugacity and activity

Unit V	Biological and Statistical Thermodynamics	(08 Hours)

Biological Thermodynamics: Living systems, Thermodynamics of Biological cells, Energy conversion efficiency of Biological systems, Thermodynamics of Nutrition and Exercise, Thermodynamics of Aging and Death

Statistical Thermodynamics: Fundamentals, equilibrium distribution, Significance of Lagrangian multipliers, Partition function for Canonical Ensemble, partition function for an ideal monatomic gas, equipartition of energy, Bose Einstein statistics, Fermi- Dirac statistics

Learning Resources

Text Books:

1.	**Advanced Thermodynamics,** S.S.Thipse, Narosa Publications
2.	**Thermodynamics –** An Engineering Approach, Yunus Cengel and Michael Boles,7th Ed., Tata McGraw Hill

Reference Books:

1.	**Basic and applied thermodynamics,** P.K. Nag, McGraw Hill
2.	**Advanced Thermodynamics for Engineers,** Kenneth Wark, McGraw Hill, 1997.
3.	**Modern Engineering Thermodynamics,** Robert Balmer, Elseveir
4.	**Advanced Thermodynamics for Engineers,** Winterbone, John Wiley
5.	**Thermodynamics for Engineers, Mathur, Gupta, Metropolitan Book Co. Pvt. Ltd.**

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-503-HPO - Advanced Fluid Mechanics		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Fluid Mechanics

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Apply the concept of continuity and momentum equations in practical applications
- CO2: Formulate and apply the Navier–Stokes Equation to practical fluid flow conditions
- CO3. Evaluate the problem on the Potential and Turbulent Shear flow
- CO4: Evaluate the problem on the boundary layer and fluid flow over solid bodies
- CO5: Formulate and solve one-dimensional compressible low problems

Course Contents

Unit I	**Fluid Kinematics and Differential Analysis**	**(08 Hours)**

Fluid Kinematics: Lagrangian and Eulerian Descriptions, Acceleration Field, Material Derivative, Fundamentals of Flow Visualization, Deformation of Fluid Elements, Vorticity and Rationality, Reynolds transport theorem (RTT), Relationship between material derivative and RTT, Body and surface forces, stress tensor,

Differential analysis: Conservation of Mass-The Continuity Equation, Stream Function, Conservation of Linear Momentum—Cauchy's Equation,

Unit II	**Navier–Stokes Equation**	**(08 Hours)**

Generalized form, exact solutions, Calculation of the pressure field, Couette flow (with and without pressure gradient), Viscous fluid falling along a vertical wall, Poiseuille flow, Stokes' first problem (unsteady flow)

Approximate solutions: Creeping Flow

Unit III	Potential and Turbulent Shear flow	(08 Hours)

Potential flow: Elementary planar irrotational flows (Uniform Stream, singularity, circulation, Doublet), Planar flow over a circular cylinder

Turbulent Shear Flows: Equations for free shear layers: mixing layer, plane and axisymmetric jet, wake. Turbulent energy equation, two-equation model(k-epsilon), Large Eddy Simulation, Various Turbulent Models

Unit IV	Boundary layer , Drag and Lift	(08 Hours)

Boundary layer: Boundary layer equations, Flow over a flat plate, Displacement thickness, momentum thickness, Turbulent flat plate boundary layer.

Drag and Lift: Concept, Drag/lift coefficient, Flow separation, friction coefficient (flow over flat plate), flow past airfoils, Magnus effect, Kutta-Joukowski lift theorem.

Unit V	Compressible Flow	(08 Hours)

Stagnation Properties, Mach Number, Variable cross-section flow, Converging-diverging nozzle, Introduction to normal and oblique shocks, Fanno and Rayleigh curve, Prandtl–Meyer expansion waves. 2-dimensional flows (subsonic and supersonic) past slender bodies, compressible boundary layers

Learning Resources

Text Books:

1.	**Fluid Mechanics,** Yunus A. Cengel, Tata McGraw Hill
2.	**Fluid Mechanics,** F.M. White, Tata McGraw Hill Int.

Reference Books:

1.	**Advanced Fluid Mechanics,** G. Biswas and K. Muralidhar, Narosa Publisher
2.	**Boundary Layer Theory,** H. Schlichting, Springer
3.	**Viscous Fluid Flow,** F. M. White, Tata McGraw Hill
4.	**Fundamentals of Fluid Mechanics,** Bruce R. Munson, Donald F. Young, Wiley**.**
5.	**Fluid Mechanics,** Robert W. Fox, Alan T. McDonald, P.J.Pritchard, J.W.Mitchell, Wiley

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-504-HPO - Advanced Refrigeration Technology		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Refrigeration & Air Conditioning

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Describe insights into Vapor absorption refrigeration
- CO2: Express non-conventional refrigeration system and refrigeration
- CO3. Describe the fundamentals of Cryogenics Engineering
- CO4: Describe various methods for the Storage of cryogenic liquids
- CO5: Describe the basics of the Heating, Ventilation, and Air Conditioning System

Course Contents

Unit I	**Vapour absorption refrigeration**	**(08 Hours)**

Standard cycle and actual cycle, thermodynamic analysis, Li-Br-water, NH_3-water systems, three fluid absorption systems, half effect, single effect, single-double effect, double effect, and electro-lux refrigerator, comparison between VCC and VAC

Unit II	**Non-conventional refrigeration system**	**(08 Hours)**

Refrigerants: Designation of refrigerants, Desirable properties of refrigerants, Ozone depletion and global warming, ODP, GWP & LCCP, selection of environment-friendly refrigerants, secondary refrigerants, anti-freeze solutions, Zeotropes and Azeotropes

Non-conventional refrigeration system: Thermoelectric refrigeration, thermo-acoustic refrigeration, adsorption refrigeration, steam jet refrigeration, vortex tube refrigeration, and magnetic refrigeration (Principle and thermodynamic analysis only)

Unit III	**Cryogenics**	**(08 Hours**

Refrigeration and liquefaction principles: Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison.

Properties of cryogenic fluids: Properties of solids at cryogenic temperatures; Superconductivity.

Gas liquefaction systems: Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.

Unit IV	**Storage of cryogenic liquids**	**(08 Hours)**

Storage of cryogenic liquids; Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two-phase flow in Transfer system; Cool-down of storage and transfer systems

Cryogenic instrumentation: Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

Unit V	**Heating Ventilation and Air Conditioning Systems**	**(08 Hours)**

Local (Window, Split, multi-split, Chilled water fan coil unit) and Central Air Conditioning system (All air and All water system, VRF/VRV systems) Scope of HVAC Industry with overview of Consulting & Construction industry, Concepts of Air conditioning systems,

PMV and PPD. ASHRAE comfort chart Infiltration and ventilation, Indoor Air Quality (IAQ), Sources of indoor air pollution, methods of control of IAQ, Fresh air requirements for IAQ

Learning Resources

Text Books:

1.	**Refrigeration and Air conditioning,** C P Arora, Tata McGraw Hill Publication
2.	**Cryogenics: Applications and Progress,** A. Bose and P. Sengupta, Tata McGraw Hill.
3.	**Refrigeration & Air Conditioning,** Arora and Domkundwar Dhanpatrai & Company, New Delhi

Reference Books:

1.	**Cryogenic Engineering,** T.M. Flynn, Marcel Dekker
2.	**Handbook of Cryogenic Engineering**, Editor – J.G. Weisend II, Taylor and Francis
3.	**Refrigeration and Air conditioning,** ARI Prentice Hall, New Delhi.
4.	**Dossat Ray J, Principles of refrigeration,** S.I. version, Willey Eastern Ltd, 2000

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-505-MECH - Laboratory Practice-I		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 00 Hours/Week **Practical:** 04 Hours/Week	00 02	**Term Work**: 25 Marks **Oral**: 25 Marks ,
Comprehensive Continuous Evaluation	**--**	

Guidelines for Laboratory Practice – I

- Lab work or Assignments have to be carried out at the respective labs as mentioned below.
- It is to be submitted as term work at the end of the semester after continuous assessment by the course teacher.
- Oral examination will be conducted at the end of the semester based on the contents of the courses as well as the Term work (Part I to Part IV)

List Experiments/ Assignments

Part I	**Advanced Numerical Methods for Thermal & Fluid Engineering**

- **Conduction of <u>Any Four</u> from the list given below**
  1. Analytical solution for **Two** Thermal engineering-based problems for the **Solution of algebraic and transcendental equations** and their validation through a program in C/C++/MATLAB
  2. Analytical solution for **Two** Thermal engineering-based problems for the Solution **of simultaneous equations** and its validation through a program in C/C++/MATLAB
  3. Analytical solution for **Two** Thermal engineering-based problems for **Interpolation** and its validation through a program in C/C++/MATLAB
  4. Analytical solution for Two Thermal engineering-based problems for **Integration** and its validation through a program in C/C++/MATLAB
  5. Analytical solution for Two Thermal engineering-based problems for **Ordinary Differential Equations** and their validation through a program in C/C++/MATLAB
  6. Analytical solution for Two Thermal engineering-based problems for **Partial Differential Equations** and its validation through a program in C/C++/MATLAB
  7. Analytical solution for Two Thermal engineering-based problems for **curve fitting** and its validation through a program in C/C++/MATLAB
  8. Analytical solution for Two Thermal engineering-based problems for **optimization** and their validation through a program in C/C++/MATLAB

Part II	Advanced Thermodynamics

- **Conduction of <u>Any Three</u> from the list given below**

1. Analysis of an ideal gas system using statistical thermodynamic techniques.
2. Exergy Analysis of real devices (Heat Exchangers, Vapor Compression cycle, Compressors, Power plants, etc.)
3. Study of mixture of gases, gas and vapour, estimation of properties and preparation of charts.
4. Determination of HCV of solid or gaseous fuel using Bomb or Junker's calorimeter respectively.
5. Thermodynamic Analysis of any System / Model by using any Computer Software.
6. Study of behavior of pure substance with change in pressure and temperature.
7. Study the effect of percentage of constituents on adiabatic flame temperature and equilibrium composition for a hydrocarbon fuel

Part III	Advanced Fluid Mechanics

- **Conduction of <u>Any Three</u> from list given below**

1. Flow through a converging-diverging nozzle: subsonic and supersonic flows
2. Laminar/Turbulent boundary layer over a flat plate.
3. Flow past an aero foil: Pressure measurements, calculation of lift
4. Case study on real world problem for Navier–Stokes Equation
5. Case study on normal/oblique shock wave
6. Friction factor determination: incompressible flow through pipes/ducts of variable cross section

Part IV	Advanced Refrigeration Technology

- **Conduction of <u>Any Three</u> from list given below**

1. Trial on VCC- Effect of condensing and evaporator temperature on Performance
2. Design of Vapor Absorption System 100 kW or 200 kW or 300 kW etc.
3. Study of Codes & Standards (ASHRAE, ISHRAE, SMACNA, CIBSE, NFPA & IPC design standards).
4. Case study on Desiccant Dehumidification OR Two Stage Evaporative cooling
5. Case study on Magneto-caloric refrigerator OR Cryogenic instrumentation
6. Visit report on Cold Storage/ Ice Plant/ Dairy/ Pharmaceutical

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PEC-520A- HPO Energy Conservation and Management		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week **Practical:** 00 Hours/Week	03 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Heat Transfer, Power Plant Engineering/Energy Engineering

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Describe the energy scenario and the need for energy conservation
- CO2: Interpret the methodology of the energy audit
- CO3. Analyze the energy conservation in thermal Utilities
- CO4: Recognize the opportunity for waste heat recovery of various thermal systems
- CO5: Analyze the energy conservation in Electrical Utilities

Course Contents

Unit I	**Energy Scenario and Conservation**	**(06 Hours)**

Commercial and Non-Commercial Energy, Primary Energy Resources, Indian Energy Scenario, Energy Needs of a Growing Economy, Energy Intensity on Purchasing Power Parity (PPP), Long-Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features.

Unit II	**Energy Management and Audit**	**(06 Hours)**

Energy Management & Audit: Definition, Energy audit-need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments, Bureau of Energy Efficiency Regulations 2008

Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts, and role of ESCOs.

Unit III	Energy Efficiencies in Thermal Utilities (06 Hours)

Functions and types of steam traps, types of furnaces, Functions and types of insulations, refractories, Economic thickness of insulation,

Energy saving opportunities in Boilers, Steam distribution system, Furnace, HVAC and Refrigeration System, Pumps and pumping system, Cooling tower, DG sets, Buildings and ECBC

Unit IV	Waste Heat recovery & Cogeneration (06 Hours)

Waste Heat recovery: Classification, Advantages and applications, Commercial Waste Heat Recovery Devices- Recuperators, Regenerator, Heat Wheels

Cogeneration: Definition, Need, cogeneration cycles, Selection of cogeneration system, Operating strategies for cogeneration system, Advantages, Cogeneration system in Steam power plant (Numerical treatment), Introduction to Tri-generation

Unit V	Energy Efficiencies in Electrical Utilities (06 Hours)

Cascade Efficiency, Electricity billing, Need for Electrical Load Management, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses.

Electric Motor efficiency, Energy efficient motors, Energy saving opportunities with energy efficient motors

Lighting systems: Lighting designs for interior, Energy Efficient lighting control

Learning Resources

Text Books:

1.	Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.

Reference Books:

1.	**Guide to Energy Management:** Barney L. Capehart, Wayne C. Turner and William J. Kennedy, ", Seventh Edition, The Fairmont Press Inc., 2012.
2.	**Energy Management Principles:** Craig B. Smith, Pergamon Press, 2015.
3.	**Energy Management Handbook:** Wayne C. Turner, The Fairmont Press Inc., , Georgia
4.	**Energy Engineering and Management:** Amlan Chakrabarti, Prentice Hall, India 2011
5.	**Energy Hand Book:** Robert L. Loftness, , Second edition, Von Nostrand Reinhold Company

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PEC-520B- HPO Gas Dynamics		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week **Practical:** 00 Hours/Week	03 00	**CCE** : 50 Marks **End-Semester**: 50 Marks ,
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Fluid Mechanics

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Apply the fundamentals of Compressible Flow and Isentropic flow
- CO2: Develop fluid flow equations for Variable area flow
- CO3. Recognize concepts of flow with normal shock waves
- CO4: Recognize concepts of flow with moving and oblique shock waves
- CO5: Develop equations for flow in a constant area with heat transfer

Course Contents

Unit I	**Introduction to Compressible and Isentropic Flow**	**(06 Hours)**

Flow Dimensionality and Average Velocity, Pressure-Energy Equation, The Stagnation Concept, Stagnation Pressure-Energy Equation, Consequences of Constant Density.

Fundamental equations of steady flow: Definition of Compressible Flow, Flow Regimes, Continuity and momentum equation, and energy equation. Isentropic flow: Acoustic velocity, Mach number, Mach cone, and Mach angle. Flow parameters, stagnation temperature, pressure, and density.

Unit II	**Variable area flow**	**(06 Hours)**

Velocity variation with Isentropic flow, Criteria for acceleration and deceleration. Flow through nozzle, Effect of pressure ratio on Nozzle operation. Convergent nozzle and convergent-divergent nozzle. Effect of back pressure on nozzle flow. Isothermal flow functions and Flow Generalized one-dimensional flows

Unit III	Flow with normal waves (06 Hours)

Development of shock wave, Rarefaction wave, governing equations, Prandtl-Meyer relation, Mach number downstream, Static pressure rise, Density ratio, Temperature ratio, Tables and charts for normal shock.

Fundamental relations, Prandtl's equation, Rankine-Hugoniot equation, Variation of flow parameters and Gas tables for oblique shocks. Over-expanded and under-expanded flows.

Unit IV	Moving and Oblique Shocks (06 Hours)

Normal velocity superposition: Moving normal shocks, tangential velocity superposition: Oblique shocks, oblique shock analysis of perfect gas, oblique shock table and charts, Boundary condition of flow direction, Boundary condition of pressure equilibrium, Conical shocks

Unit V	Flow in constant area with heat transfer (06 Hours)

Stagnation temperature change. Rayleigh line, Pressure ratio and temperature ratio, Entropy considerations and maximum heat transfer. Flow in constant area with friction: Fanno curves, The fanning equation, Friction factor and friction parameter, Fanno line and Fanno flow equations.

Learning Resources

Text Books:

1.	**Gas Dynamics,** E Radhakrishnan PHI-2006
2.	**Fundamentals of Compressible flow:** Yahya, 2nd Edn. 1991; Wieley Eastern**.**

Reference Books:

1.	**Introduction to Gas Dynamics:** Rolty, wiley 1998
2.	**Elements of Gas Dynamics:** Liepmann and roshko, Wiley 1994
3.	**The dynamics and thermodynamics of compressible fluid flow:** Shapiro Ronold press. 1994**.**
4.	**Modern Compressible Flow,** Anderson John.D, McGraw Hill Publication, 1990

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PEC-521- HPO – Program Elective Course I: Field Work		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 00 Hours/Week **Practical:** 02 Hours/Week	00 01	**Term Work**: 25 Marks **Oral**: 25 Marks ,
Comprehensive Continuous Evaluation	**--**	

Guidelines for Program Elective Course I: Field Work

- Lab work or Assignments have to be carried out at the respective labs as per the selection of Elective (Part I OR Part II) as mentioned below.
- It is to be submitted as term work at the end of the semester after continuous assessment by the course teacher.
- Oral examination will be conducted at the end of the semester based on the contents of the courses as well as the Term work (Part I OR Part II)

List Experiments/ Assignments

Part I	**PEC-520A- HPO Energy Conservation and Management**

- **Conduction of <u>Any Six</u> from the list given below**
  1. Case study on Energy Audit of Institute/MSMEs/Organization
  2. Guidelines for the Energy Manager and Energy Auditor examination conducted by BEE.
  3. Assignment on the financial management of an organization
  4. Case study on Buildings and ECBC
  5. Case study on cogeneration in Sugrmill/ cement mill
  6. Case study on the impact installation of a Waste Heat recovery device on the performance of the plant
  7. Energy saving opportunity in HVAC and Refrigeration System/ pumps and pumping system/ Cooling tower/ DG sets
  8. Analysis of HT/LT electricity bill and recommendations for energy saving opportunities

Part II	**PEC-520B- HPO Gas Dynamics**

- **Conduction of <u>Any Six</u> from list given below**
  1. Assignment on stagnation properties
  2. Case study on normal shock wave

3. Assignment on Effect of back pressure on nozzle flow
4. Case study on normal shock wave
5. Case study on moving and oblique shock wave
6. Flow through a converging-diverging nozzle: subsonic and supersonic flows
7. Assignment on Fanno line and Fanno flow equation
8. Assignment on. Rayleigh line

Savitribai Phule Pune University, Pune

Maharashtra, India

ME - Mechanical Engineering (Heat Power Engineering)

(2025 Pattern)

Semester II

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-551-HPO - Advanced Heat Transfer		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Heat Transfer

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Formulate the heat transfer equations to solve engineering problems involving heat conduction
- CO2: Apply concepts of forced convective heat transfer to real-life problems
- CO3. Apply the fundamentals of natural and two-phase convective heat transfer for modelling of problems
- CO4: Apply concepts of radiative heat transfer to real-world problems
- CO5: Evaluate sizing of multi-pass and cross-flow heat exchangers.

Course Contents

Unit I	**Heat Conduction**	**(08 Hours)**

Recapitulation of fundamentals of heat transfer, general heat conduction equation

Boundary and Initial Conditions, Solution of steady one/two-dimensional heat conduction problems, Variable thermal conductivity,

Transient Heat Conduction: Lumped system analysis, Transient heat conduction in large plane walls, long cylinders, and spheres with spatial effects, Transient heat conduction in semi-infinite solids, multidimensional systems

Numerical Methods: Finite difference formulation of differential equations, 1-D steady heat conduction, 2-D steady heat conduction

Unit II	**Forced Convective Heat Transfer**	**(08 Hours)**

Principles: Velocity and thermal boundary layers, Derivation of differential convection equations, Solutions of convection equations for a flat plate, Non-dimensionalized convection equations and similarity, Friction and convection coefficients, Analogies between momentum and heat transfer

External forced convection: Parallel flow over flat plates, flow across cylinders and spheres

Internal forced convection: The entrance region, thermal analysis, Laminar and turbulent flow in tubes

Unit III	Natural and Two Phase Convective Heat Transfer (08 Hours)

Natural Convective Heat Transfer: Mechanism, Natural convection over Vertical/horizontal/inclined Plates, Vertical/ horizontal cylinders, cooling of finned surfaces, vertical PCBs Combined natural and forced convection

Boiling and condensation: Pool and flow boiling, Film and drop condensation, Heat transfer correlations for pool boiling and film condensation

Unit IV	Radiation Heat Transfer (08 Hours)

Radiation Heat Transfer: Recapitulations of fundamentals of radiation heat transfer, laws of radiations, Concept of shape factor, laws of shape factor, Electrical analogy, Radiation heat transfer in two-surface enclosures, Radiation shields, Emissivity and absorptivity of gases and gas mixture, Multimode heat transfer.

Unit V	Heat Exchangers and Thermal management of Electronic Equipment's (08 Hours)

Heat exchangers: Classification, application of LMTD, Effectiveness-NTU methods, Multipass and cross-flow heat exchangers, Selection of heat exchangers

Thermal management of Electronic Equipment: Manufacturing, Chip carrier, PCB's, the enclosure, cooling load of electronic equipment, thermal environment, electronics cooling in different applications. Conduction cooling, conduction in chip carriers and PCB's. Heat frames, Air cooling, Cooling of PC's, Liquid cooling, Immersion cooling. Ablative , transpiration and high speed cooling

Learning Resources

Text Books:

1.	**Heat and Mass Transfer,** Yunus Cengel, Afshin Ghajar, Tata Mc Graw Hill
2.	**Fundamentals of Heat and Mass Transfer,** Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Wiley

Reference Books:

1.	**Heat & Mass Transfer**, P.K. Nag, McGraw Hill Education Private Limited
2.	**Convective Heat transfer,** A Bejan, John Wiley and sons, 2013
3.	**Heat transfer - A basic approach,** M.N. Ozisik, Mc Graw Hill Int
4.	**Heat transfer,** J.P. Holman, Mc Graw Hill
5.	**Heat transfer,** S.P. Sukhatme, University Press

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-552--HPO - Computational Fluid Dynamics		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Heat Transfer, Fluid Mechanics

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Recognize the fundamentals of Computational Fluid Dynamics
- CO2: Express FDM and FVM technique
- CO3. Recognize Structured and unstructured grid generation techniques
- CO4: Analyze the real-world problem for heat conduction, convection
- CO5: Identify the necessity of turbulence modeling

Course Contents

Unit I	**Fundamentals of CFD**	**(08 Hours)**

Introduction to CFD: Concept, need for CFD, and Elements in CFD: development, application, and analysis.

Essentials of Fluid-Mechanics and Heat-Transfer: Conservation and subsidiary laws, transport mechanisms, and differential formulation from the conservation laws, convective forms of the equations, and general description.

Classification and Overview of governing equations: Classification of partial differential equations, physical examples of elliptic, parabolic, and hyperbolic equations. Mathematical nature of the flow equations & their boundary conditions.

Unit II	**Discretization and Essentials of Numerical Methods**	**(08 Hours)**

Finite Difference Method (FDM): Taylor series expansion, FDM-based formulation for 1D and 2D steady state heat conduction, and accuracy of the finite difference method.

Finite Volume Methods (FVM): Finite volume methods, approximation of surface and volume integrals, central, upwind, and hybrid formulations.

Analysis of numerical schemes: concept of consistency, accuracy, stability, and convergence; Error and stability analysis; some applications

Unit III	**Curvilinear Coordinates and Numerical Grid Generation**	**(08 Hours)**

Introduction to Structured and Unstructured mesh generation techniques, generalized curvilinear scheme, Reciprocal or dual base vectors, geometric interpretation of metrics, Orthogonal grid system, generalized grid transformation.

Structured grid generation: i) Algebraic method, ii) Elliptic generation systems.

Unstructured grid generation: i) Voronoi diagram and Delaunay triangulation, ii) Advancing front grid generation

Unit IV	**Computational Heat-Transfer & Solution to Navier-Stokes Equations**	**(08 Hours)**

Computational Heat-Transfer: Heat conduction, advection, and convection: Finite Volume Method (FVM) based algebraic formulation, and explicit as well as implicit method based methodology

Solution to Navier-Stokes Equations: Formulations of Euler equations, Waves and Space-Time dependence in computing, Discretization methods for Euler equations. High resolution schemes and TVD, Spectral Analysis: Nyquist criterion, spectral analysis of fourth-order central differencing scheme.

Unit V	**Turbulence Modeling**	**(08 Hours)**

Introduction, Statistical representation of turbulent flows, Characteristics of turbulence, Closure problem: Necessity of turbulence modeling, Reynolds Average Navier Stokes (RANS) equation,

Different types of turbulence models: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, Two-equation models: κ-ε model and κ-ω model, Reynolds stress equation model (RSM).

Learning Resources

Text Books:

1.	**Computational Fluid Dynamics,** J. D. Anderson, McGraw Hill, 1995.
2.	**Introduction to Computational Fluid Dynamics:** Development, Application and Analysis, Atul Sharma, Wiley
3.	**Introduction to Computational Fluid Dynamics:** The Finite Volume Method, H. K.Versteeg, and W.Malalasekara, Longman Scientific & Technical, Harlow

Reference Books:

1.	**Numerical Heat Transfer and Fluid Flow,** S.V. Patankar, Hemisphere Publishing Corporation.
2.	**Computational Fluid Dynamics**, T. J. Chung, Cambridge University Press.
3.	**Computational Fluid Flow and Heat Transfer,** K. Muralidhar, and T. Sundarajan, (Editors), 2nd Ed., IIT Kanpur Series, Narosa Publishing House, New Delhi.
4.	**Computational Methods for Fluid Dynamics,** J.H.Ferziger, and M. Peric, Springer Verlag, Berlin**.**
5.	**Turbulence Modeling for CFD,** David C. Wilcox, Publisher: D C W Industries, 2006**.**

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PCC-553- HPO Design of Heat Exchangers		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Heat Transfer

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Calculate Thermal and hydraulic Design parameters of Heat Exchangers
- CO2: Analyze the pressure drop in the heat exchangers
- CO3. Analyze Heat Transfer Characteristics of Heat Exchangers
- CO4: Recognize fundamentals of Regenerators, Heat Pipe, and Microscale Heat Exchangers
- CO5: Comprehend basic design principles of compact heat exchangers

Course Contents

Unit I	**Sizing and Rating of Heat Exchangers**	**(08 Hours)**

Introduction, Classification, Overview of Heat Exchanger Design Methodology, Thermal and Hydraulic Design, Mechanical Design, Assumptions, Basic Definitions, ε - NTU Method, The P-NTU Method, TEMA, Multi-pass Exchangers, LMTD, Heat Exchanger Arrays and Multi-passing, Sizing and Rating Problems, Kern Method, Bell Delaware Method, Numerical on Shell and tube HEX

Unit II	**Heat Exchanger Pressure Drop Analysis**	**(08 Hours)**

Importance of Pressure Drop, Devices, Extended Surface Heat Exchanger Pressure Drop, Tubular Heat Exchanger Pressure Drop, Tube Banks, Shell-and-Tube Exchangers, Plate Heat Exchanger Pressure Drop, Pipe Losses, Non- dimensional Presentation of Pressure drop Data

Unit III	**Heat Transfer Characteristics of Heat Exchangers**	**(08 Hours)**

Dimensionless Surface Characteristics, Experimental Techniques for Determining Surface Characteristics, Steady-State Kays and London Technique, Wilson Plot Technique, Friction Factor Determination, Hydrodynamically Developing Flows, Thermally Developing Flows, Extended Reynolds Analogy, Heat Exchanger Surface Geometrical Characteristics, Selection of Heat Exchangers and Their Components, Temperature Difference Distributions

Unit IV	Regenerators, Heat Pipe and Microscale Heat Exchangers	(08 Hours)

Regenerators: types of regenerators, construction, and application. Theory of Regenerator, -NTU and - method.

Heat pipes: construction, working principle, application, analysis. Special heat pipes.

Microscale Heat Exchangers and heat sinks: heat transfer and fluid flow through narrow conduits, special design considerations

Unit V	Compact heat exchangers	(08 Hours)

Compact heat exchangers: enhancement of heat transfer, extended surface or Fin, fundamental of extended surface heat transfer, Fin tube heat exchanger

Plate Fin Heat Exchangers (PFHE): types, construction, fabrication, design, application. Multistream PFHE.

Direct contact heat exchangers: types, application, simple analysis.

Learning Resources

Text Books:

1.	**Fundamentals of Heat Exchanger Design** by R. K. Shah, Dusan P. Sekulic, John Wiley & Sons, 11-Aug-2003.
2.	**Heat Exchangers: Selection, Rating, and Thermal Design**, Third Edition by Sadik Kakac, Hongtan Liu, CRC-Press, 01-Feb-1998.

Reference Books:

1.	**Heat Exchanger Design Handbook** by Kuppan Thulukkanam, Taylor & Francis, 23-Feb-2000.
2.	**Cryogenic Heat Transfer**, Second Edition by Randall F. Barron, Gregory F. Nellis, CRC Press, May 23, 2016.
3.	**Heat Pipes Theory,** Design & Applications – D.A. Reay, P.D.Dunn, Pergamon
4.	**Process Heat Transfer –** Donald Q. Kern, Tata McGraw-Hill

Savitribai Phule Pune University

First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)

PCC-554-HPO - Laboratory Practice-II

Teaching /scheme	Credits	Examination Scheme
Theory: 00 Hours/Week **Practical:** 04 Hours/Week	00 02	**Term Work**: 25 Marks **Oral**: 25 Marks
Comprehensive Continuous Evaluation	--	

Guidelines for PCC-554-HPO - Laboratory Practice-II

- Lab work or Assignments have to be carried out at the respective labs as mentioned below.
- It is to be submitted as term work at the end of the semester after continuous assessment by the

course teacher.

- Oral examination will be conducted at the end of the semester based on the contents of the courses, as well as the Term work (Part I to Part III)

List Experiments/ Assignments

Part I	**PCC-551-HPO Advanced Heat Transfer**

- **Conduction of <u>Any Four</u> from the list given below**

1. Transient Heat Conduction using Heisler and Grober charts
2. Determination of local and average heat transfer coefficient in Natural Convection
3. Determination of local and average heat transfer coefficient in Forced Convection at different Re.
4. Determination of temperature distribution, fin efficiency in Natural / Forced Convection.
5. Design of a heat exchanger for practical application.
6. Assignment on Numerical methods in heat conduction
7. Assignment on Combined Natural and Forced Convection Heat Transfer.
8. Case study on Heat transfer augmentation techniques

Part II	**PCC-552-HPO Computational Fluid Dynamics**

- **Conduction of <u>Any Four</u> from the list given below**

1. One-dimensional steady state conduction using the finite volume method.
2. One-dimensional unsteady state conduction using the finite volume method.
3. Two-dimensional steady state conduction using the finite volume method.
4. One-dimensional conduction convection problem using the finite volume method.
5. Solution of the Navier-Stokes equation using the SIMPLE algorithm for the Lid Driven Cavity flow problem.
6. Numerical simulation and analysis of boundary layer over a flat plate (Blasius Equation)
7. Numerical simulation and analysis of the boundary layer for a fully developed flow through a pipe.
8. CFD Analysis of external flow: Circular Cylinder or Airfoil (NACA 0012).

Part III	**PCC-553-HPO Design of Heat Exchangers**

- **Conduction of <u>Any Four</u> from list given below**

1. Design of regenerator/ Heat wheel
2. Case study on sizing of heat exchanger for Industrial applications
3. Case study on heat exchanger pressure drop for Industrial applications
4. Case study on Heat Pipe Heat Exchanger
5. Case study on Plate Fin Heat Exchangers (PFHE)
6. Case study on Microscale Heat Exchangers

7. Case study on phase change heat exchangers
8. Case study on cooling towers

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PEC-570A- HPO Advances in Power Generation Technology		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week **Practical:** 00 Hours/Week	03 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Power Plant Engineering, Applied Thermodynamics

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Describe advances in components of a thermal power plant
- CO2: Recognize recent trends in combined cycle power plants
- CO3. Explain the layout, component details of nuclear energy systems.
- CO4: Describe the arrangement, element details of hydel energy plants
- CO5: Explore the recent advances in diesel and gas power generation

Course Contents

Unit I	**Advances in Thermal Power Plant**	**(06 Hours)**

layout of modern thermal energy based plant with different circuits, high pressure boilers (LA Mont boiler; Benson Boiler; Loeffler Boiler; Schmidt- Hartman Boiler; Velox Boiler; Supercharged boiler; Supercritical boiler; Once through boiler), FBC systems (FBC, PFBC, BFBC, CFBC), Concept of distributed burner, multi-fuel burners (pulverized bed system), burner arrangements, energy conservation in boilers, super heaters, air preheater

Unit II	**Combined cycle power plants**	**(06 Hours)**

Improved gas power plant, Characteristics of ideal working fluid, Binary vapor power cycle, coupled cycles, GT-ST power plant (numerical), PFBC, combined cycle plant, Integrated Gasification Combined Cycle (IGCC) plant, Steam injection gas turbine (SIGT), Repowering, Advantages of combined cycle power plants.

Unit III	**Nuclear energy power plants**	**(06 Hours)**

Nuclear fission/fusion, Elements of NPP, Types of nuclear reactor (PWR, BWR, CANDU, LMCR, GCR, Fast Breeder) Nuclear fuels, moderators, coolants, control rod and shielding, Nuclear waste disposal, Nuclear power development program of India.

Unit IV	Hydel energy based plant (06 Hours)

Hydel energy: basics of hydrology, hydrograph, flow duration curve, mass curve (Numerical Treatment), hydel power plant (HPP)- site selection, classification of HPP (Based on head, nature of load, water quantity), criteria for turbine selection, components of HPP- dams; spillways; surge tank and forebay, advantages and disadvantages of HPP.

Unit V	Diesel and Gas Power Plant (06 Hours)

Diesel Power Plant: General Layout Diesel Power Plant, Duel Fuel Engines, Layout of High, Medium, Low Capacity Plants, Present Trends in Diesel Research, Applications

Gas Power Plant: Semi-closed cycle plant, Types of combustors: Swirl flow stabilizer, bluff body flame stabilizer, Free piston engine plants, merits, demerits

Learning Resources

Text Books:

1.	**Power Plant Engineering, P.K.Nag, McGraw Hill Publications New Delhi**
2.	**Power Plant Engineering, Domkundwar & Arora, Dhanpat Rai & Sons, New Delhi**

Reference Books:

1.	**Power Plant Engineering, E.I.Wakil, McGraw Hill Publications New Delhi**
2.	**Power Plant Engineering , G R Nagpal, Khanna Publication**
3.	**Combined cycle Gas and Steam Turbine Power Plants, Rolf H Kohlhofer, Penn Well Books, 1991**
4.	**An Introduction to Power plant engineering, G.D.Rai, Khanna Publishers, III edition,2001**

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PEC-570B- HPO Advances in Engine Technology		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week **Practical:** 00 Hours/Week	03 00	**CCE** : 50 Marks **End-Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Internal Combustion Engine

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Illustrate working and modeling of combustion systems
- CO2: Describe the Modeling of Injection Systems-CI and SI
- CO3. Use of CAE and simulation tools for various engine process modeling.
- CO4: Understand engine emissions and pollutants
- CO5: Explore the various emission control techniques

Course Contents

Unit I	**Combustion and gas Exchange modeling**	**(06 Hours)**

Modeling combustion processes: definition of in-cylinder heat release, Wiebe functions. Single-zone thermodynamic models. Modeling combustion processes: multi-zone thermodynamic models. Modeling combustion processes in SI engines: flame propagation models, Combustion chamber, and shape modeling. Effect of combustion on chamber parameters.

Unit II	**Modeling of Injection systems-CI and SI**	**(06 Hours)**

Overview of conventional and flexible valve actuation systems. 1-D gas exchange modeling of engine - Mean-Value Engine Models, including turbomachinery. Modeling the impact of valve train flexibility on engine gas exchange and in-cylinder processes, Modeling of fuel injection systems, and some basic concepts of control of fuel injection systems

Unit III	**Advances in Combustion Systems**	**(06 Hours)**

Introduction to commercial simulation tools (GT-Power), Computational fluid dynamics [CFD] in flow simulation, Advanced-mode combustion: HCCI, PCCI, AFCI, RCCI, etc. homogeneously charged compression ignition engine, controlled auto ignition engine. SI & CI engine simulation, CAD CAE Tools in Simulations.

Unit IV	Engine Emissions and Air-Pollution	(06 Hours)

Emissions and its Formation: Gaseous emissions: CO, CO2, HC, NOx (NO & NO2), SOx (SO2 & SO3); particulate matter (PM), Sources of emission formation; Emissions formation mechanisms of PM and NOx; volatile organic compounds(VOCs), poly aromatic hydrocarbons (PAH), soluble organic fraction (SOF); Mechanism of air pollution: Ozone depletion, Greenhouse effect, Photochemical smog, acid rain, Effect of air pollution on health and environment, Emission norms (passenger and commercial vehicles): National and International emission standards: BS-III and BS-IV & Euro III, IV, and V

Unit V	Emission Control Technologies	(06 Hours)

Emission Control Technologies and Emission Measurements: PM reduction technologies: Diesel oxidation catalysts (DOCs), Diesel particulate filters (DPFs), closed crankcase ventilation(CCV); NOx reduction technologies: Exhaust gas recirculation (EGR), Selective catalytic reduction (SCR), Lean NOx catalysts (LNCs), Lean NOx traps (LNTs), NOx adsorber catalysts, Exhaust gas recirculation (EGR), Diesel exhaust after treatment: diesel oxidation catalyst (DOC), diesel particulate filter (DPF), Soot suppression by fuel additives, relationship: soot, combustion chamber and swirl ratio, catalytic convertors: constructional features and types: 2-way and 3-way catalytic convertors. smoke (soot) measurement, application of microprocessor in emission control.

Learning Resources

Text Books:

3.	**Combustion Modeling in Reciprocating Engines**, by James N Mattavi and Charles A Amann, Plenum press, 1980
4.	**Automotive Emission Control** , Crouse William, Gregg division, McGraw-Hill,
5.	**Thermodynamic Analysis of Combustion Engines**, by Ashley S Campbell, John Wiley and Sons, 1980

Reference Books:

5.	**Modeling of Internal Combustion Engines Processes**, Ramoss A L, McGraw Hill Publishing Co.,1992
6.	**Computer Simulation of spark ignition engine process**, Ganesan V, Universities Press (I) Ltd, Hyderabad, 2001
7.	**Internal combustion engine modeling**, by J I Ramos, Hemisphere Publishing Corporation, 1989
8.	**Internal Combustion Engine Fundamentals**, John B. Heywood, Tata McGraw-Hill,1998

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PEC-571A- HPO Renewable Energy Systems		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week **Practical:** 00 Hours/Week	03 00	**CCE**: 50 Marks **End -Semester**: 50 Marks
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Heat Transfer

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Recognize the fundamentals of Solar Energy-based Systems
- CO2: Analyze aerodynamic characteristics of wind turbines
- CO3. Realize the working principle of Geothermal and Ocean Energy Sources
- CO4: Comprehend the construction and working of Emerging Renewable energy Technologies
- CO5: Analyze the Economics and Financial management of Renewable energy systems

Course Contents

Unit I	**Solar Energy Systems**	**(06 Hours)**

Fundamentals: Measurement of Solar Radiation, Solar Radiation Data, Solar Radiation Data, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length

Solar Thermal Systems: Solar Collectors, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Dryer, Solar Distillation (Desalination of Water), Solar Thermo-Mechanical System, Thermal Analysis of Liquid Flat Plate Collector

Solar Photovoltaic Systems: Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, and Array Construction, Solar PV Systems

Unit II	**Wind Energy Systems**	**(06 Hours)**

Wind Energy: Wind Turbine Aerodynamics, Wind Turbine Types and their Construction, Wind Energy Conversion Systems (WECS), Wind–Diesel Hybrid System, Effects of Wind Speed and Grid Condition (S

Aerodynamics of wind turbines: Aerofoil sections and lift and drag coefficients, relative wind velocity, Power extraction from the wind energy, Wind power generation curve, Maximum power and Betz coefficient, Power Coefficient of a wind turbine (Cp), Axial thrust and torque developed by the

turbine, Design tip speed ratio and solidity

Unit III	Geothermal and Ocean Energy Sources	(06 Hours)

Geothermal Energy: Origin and Distribution of Geothermal Energy, Types of Geothermal Resources

Ocean Energy: Tidal Energy- Origin and types, Wave Energy- fundamental and types, Ocean Thermal Energy- fundamental and types

Unit IV	Emerging Technologies	(06 Hours)

Biomass Energy: Biomass Conversion Technologies, Biomass Gasification, Biomass Liquefaction, Fuel Cell, Hydrogen as Energy Carrier, Magneto Hydrodynamic Power Conversion, Thermoelectric Power Conversion, Thermionic Power Conversion

Unit V	Financial and Economic Evaluation	(06 Hours)

Calculations for the Single payment and future value , Calculations for Uniform Series Compound Amount Factor, Sinking Fund Factor; present value; Capital Recovery Factor, Effect of Inflation on Cash Flows, Comparative Economic Evaluation of Alternatives- Payback Period, Net Present Value, NPV, IRR, Capital Recovery Cost, Effect of Depreciation and Tax on Cash Flow

Learning Resources

Text Books:

1.	**Solar Energy and Non-Conventional Sources of Energy**- Domkundwar & Domkundwar- , McGraw Hill Education (India) Private Limited, Chennai
2.	**Non-Conventional Energy Sources** G.D.Rai, , Khanna Publishers, Delhi

Reference Books:

1.	**Solar Energy**, G. N. Tiwari, Fundamentals, Design, Modeling and Applications, Narosa, 2002.
2.	**Solar Energy: Principles of Thermal Collection and Storage**, SP Sukhatme and J.K. Nayak, Tata Mc-Graw Hill Education Private Limited, 3rd Edition, 2010.
3.	**Wind Power Plants: Fundamentals, Design, Construction and Operation**, R. Gasch, J. Twele, , Springer, 2nd Edition, 2012.
4.	**Energy Economics Concepts, Issues, Markets and Governance**, S. C. Bhattacharyya, , springer, 2nd Edition, 2019.

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
PEC-571B- HPO Nuclear Engineering		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week **Practical:** 00 Hours/Week	03 00	**CCE** : 50 Marks **End-Semester**: 50 Marks ,
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Heat Transfer

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Recognize the basic physics of nuclear reactions
- CO2: Recognize the fundamentals of the Nuclear Fuel Cycle
- CO3. Realize the working principle of Nuclear Reactors
- CO4: Comprehend the construction and working of Nuclear Thermal Power Plants
- CO5: Describe the fundamentals of Fast Breeder Reactors

Course Contents

Unit I	**Introduction to Nuclear Physics**	**(06 Hours)**

Global nuclear energy scenario, Nuclear power plants in India, Nuclear power development program of India

Motivation for nuclear energy, Nuclear model of the atom, Equivalence of mass and energy, Binding energy, Mechanism of nuclear fission and fusion, Radioactivity, Half-life, Radiation interactions with matter, Cross sections, Principles of Radiation detection, Decay Heat.

Unit II	**Nuclear Fuel Cycle**	**(06 Hours)**

Uranium exploration, mining, Uranium production, fuel fabrication, Spent fuel handling, Reprocessing (Purex, Urex, Diamex), Pyroprocessing, Fuel transportation between facilities, Radioactive waste management: Types, treatment, compaction, Vitrification, etc., Materials: Fuel, Structural, Coolants, Control, Moderator, Shielding

Unit III	**Types of Nuclear Reactor**	**(06 Hours)**

Components of a nuclear reactor, Types of nuclear reactors, Pressurized Water Reactor, Boiling water Reactor, Pressurized Heavy Water Reactor, Gas Cooled reactor, Liquid Metal cooled fast breeder reactors, Gen IV Concepts

Unit IV	Nuclear Thermal Power Plant	(06 Hours)

Layout of nuclear power plant; Material selection for components, Operating environment. Zone control, regulating rods, Absorbers, and Shutdown systems. Fuel and Fuel transfer system; Primary heat Transport System; Emergency core cooling system; Moderator system; Auxiliary System.

Unit V	Fast Breeder Reactors	(06 Hours)

Breeding ratio, doubling time, Core design features - Static and Dynamic, control rod design, shielding principles, Fuel management, and safety. Core & important design parameters, Major primary and secondary system components. Choice of core materials, Engineering design of core, High temperature design methods. Decay heat removal system.

Learning Resources

Text Books:

1.	**Nuclear Reactor Engineering-Concepts & Principles** - G. Vaidyanathan, S. Chand co., Delhi, 2013.
2.	**Nuclear Reactor Engineering (3rd Edition)** - S. Glasstone and A.Sesonske, Von Nostrand, 1981

Reference Books:

1.	**Comprehensive Nuclear Materials**- Rudy J.M. Konings, vol. 1-5, Elsevier Ltd, 2012
2.	**Nuclear Power Plant Instrumentation and Control Systems for Safety and Security**- M.Yastrebenetsky, V. Kharchenko, , February 2014
3.	**Fast Breeder Reactor**- A.E.Walter and A.B.Reynolds, Pergamon Press, 1981
4.	**Fundamentals of Nuclear Reactor Physics**-E. Lewis, Academic Press, 2008

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
SEM-580- HPO – Technical Seminar I		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory: 00 Hours/Week **Practical:** 04 Hours/Week	00 02	**Term Work**: 25 Marks **Oral**: 25 Marks
Comprehensive Continuous Evaluation	**--**	

Technical Seminar I: shall be on state of a art topic of the student's own choice in the specialization (Thermal Engineering) approved by the authority. Students are advised to refer latest linked research papers from a reputable journal for preparation of the topic and report.
Guidelines for the preparation of the Technical Seminar I report are as below.

- The Technical Seminar I report is to be limited to 20-25 manuscript pages, preferably.
- Total number of Spiral Bound copies-02
- Page Size: Trimmed A4 (Plain white background and **strictly JK Bond papers**
- If colored Diagrams or Graphs are used in the report, take a color printout
- Top Margin: 1.00 Inches
- Bottom Margin: 1.25 Inches
- Left Margin: 1.5 Inches
- Right Margin: 1.0 Inches
- Para Text: Font: Times New Roman;12 points,
- Line Spacing: 1.5 lines
- Page Numbers: **Center aligned and in Footer** (Font: Times New Roman;10 points)
- The entire report shall be one chapter. No chapters for Seminars I, II, and III
- All section headings and subheadings should be numbered. For sections use numbers **1,2, 3, …..,** for subheadings **1.1**, **1.2**, **….** etc, and section subheadings **2.1.1**, **2.1.2, ….** etc.
- Certificate: All students should attach the Standard Format of Certificate as described by theDepartment
- Section Titles/ Headings: Times New Roman;14 points; Uppercase, **Bold, and Leftaligned.**
- Sub-Section headings should be aligned at the left with 12 pt, bold, and Title Case (thefirst letter of each word is to be capitalized).
- **Symbols** and **notations** if any should be included in the nomenclature section only
- **The main points in the seminar can be** Introduction, Historical Background, Literaturereview, summary of literature review, Scope of Seminar etc, Technical Session (Existing setup result and its discussion in detail), future scope, Summery or Conclusions, References
- Seminar I shall not have last section as Conclusions, it will be summary only
- If **figures** and **tables** are taken from any reference, then indicate source of it.
- References: Students should mention reference of Technical Paper, Handbooks, Books
- **Only** which are strictly referred by them, it should be in following format

For Reference paper

Author Names (Bold), Title of paper, Journal Publication or Conference details (name & Venue), Date or year of publication, page no

Eg

[1] **Ganesh Murali J**, **Subrahmanya S. Katte**, "Experimental Investigation of Heat transfer Enhancement in radiating Pin Fin", Jordan Journal of Mechanical and Industrial Engineering (JJMIE), 3rd Sep. 2008, Vol.2, pp. 163-167.

For Books/Handbooks

Author (Bold), Title of Book/Handbook, Publication, Edition

If you have any E references (Website links) mention it in Literature review should not mention website references under reference section.

Eg

[2] **Yunus A.Cengel. and Afshin J.Ghajar.**, „Heat and Mass Transfer", Tata McGraw Hill Education Pvt.Ltd., 4th Edition (2011)., pp.361- 363,

Seminar Report should be arranged in following Sequence

- Cover Page
- Certificate
- Acknowledgement
- Index/Contents
- Abstract
- List of Figures
- List of Tables
- Technical section
- References

About Power Point Presentation (PPT)

Total Time: 20 minutes of each student For
presentation: 15 minutes
For Question:5 minutes

- Slides should contain Bulleted points, Figures, Charts only
- Slides should have light background

Savitribai Phule Pune University, Pune

Maharashtra, India

ME - Mechanical Engineering (Heat Power Engineering)

(2025 Pattern)

Semester III

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
RM-600- MECH Research Methodology		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 04Hours/Week **Practical:** 00 Hours/Week	04 00	**CCE** : 50 Marks **End-Semester**: 50 Marks ,
Comprehensive Continuous Evaluation	**Closed book Test (CBT)**- 20 Marks **Open book Test (OBT)-** 10 **Marks Assignment/Presentation (A/P)**- 10 Marks **Research Papers /Survey Report (RPSR)** -10 Marks	

Prerequisite Courses: Fluid Mechanics

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: Descibe research and its essential characteristics with examples from engineering and science fields
- CO2: Apply different types of research (basic, applied, qualitative, quantitative, exploratory, descriptive, etc.) to specific problems.
- CO3. Analyze the outcomes of research such as publications, patents, and technological contri- butions, and their societal and industrial impacts.
- CO4: Apply ANOVA and ANCOVA techniques for effective experimental data analysis.
- CO5: Recognize Intellectual Property Rights (IPR) to safeguard innovative research and prevent unethical practices

Course Contents

Unit I	**Definition and Characteristics of Research**	**(08 Hours)**

Research — Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach

Unit II	**Types of Research**	**(08 Hours)**

Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative ap- proaches. Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design, Sample size

Unit III	**Analysis of Variance and Covariance**	**(08 Hours)**

Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation

of analysis, Preparation of the Report on conclusions reached, Testing validity of research outcomes, Suggestions and recommendations, identifying future scope

Unit IV	**Analysis of Variance and Covariance**	**(08 Hours)**

Basic principle of Analysis of Variance, ANOVA Technique, Setting up Analysis of Variance Table, short-cut method for oneway ANOVA, Coding method, Two-way ANOVA, ANOVA in Latin-square design, analysis of co-variance (ANCOVA), assumptions in ANCOVA. Academic Ethics: Plagiarism, exposure on anti-plagiarism tools.

Unit V	**Technical Writing and IPR**	**(08 Hours)**

Academic writing, sources of information, assessment of quality of journals and articles, writing scientific report, structure and component of research report, types of report – technical reports and thesis, SCOPUS Index, citations, search engines beyond google, impact factor, H-Index. IPR: What is IPR?, importance of patents, types of IPR, process of patent.

Learning Resources

Text Books:

1.	**Kothari, C.R.,1985, Research Methodology-Methods and Techniques,** New Delhi, Wiley Eastern Limited.
2.	**Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners,** (2nd.ed), Sin- gapore, Pearson Education.
3.	**Neeraj Pandey, Intellectual Property Rights ,**1st Edition, PHI

Reference Books:

1.	**Goode W J &Hatt P K, Methods in Social Research,** McGraw Hill
2.	**Shrivastava, Shenoy& Sharma, Quantitative Techniques for Managerial Decisions,** Wiley

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
OJT-601- HPO - Internship/ On Job Training		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 00 Hours/Week **Practical:** 10 Hours/Week	00 05	**Term Work**: 100 Marks **Oral**: -- Marks
Comprehensive Continuous Evaluation	**--**	

Guidelines for OJT-541- MECH - Internship/ On Job Training

- Internships/On job training are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales.
- Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.
- Engineering internships are intended to provide students with an opportunity to apply conceptual knowledge from academics to the realities of the field work/training.
- The following guidelines are proposed to give academic credit for the internship undergone as a part of the First Year Master of Engineering curriculum.
- Internship is to be completed after semester I and before commencement of semester II of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester II.
- Student may choose to undergo Internship at Industry/Govt. Organizations/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship.
- Students must get Internship proposals sanctioned from institute authority well in advance. Internship work identification process should be initiated in the 1st semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their 1st semester examination and before academic schedule of semester II.
- Student can take internship work in the form of following but not limited to
  1. Working for consultancy/ research project,
  2. Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute /
  3. Learning at Departmental Lab/Tinkering Lab/ Institutional workshop,
  4. Development of new product/ Business Plan/ registration of start-up,
  5. Industry / Government Organization Internship,
  6. Internship through Internshala

7. In-house product development, intercollegiate, inter department research internship under research lab/group, micro/small/medium enterprise/online internship,
8. Research internship under professors, IISC, IIT's, Research organizations,
9. NGOs or Social Internships, rural internship,
10. Participate in open source development.

- Every student is required to prepare and maintain documentary proofs of the activities done by him/her as internship diary or as workbook.

- The evaluation of these activities will be done by Program Head/Cell In-charge/ Project Head/ faculty mentor or Industry Supervisor based on- Overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

- Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External a supervisor from place of internship.

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
SEM-602- HPO – Technical Seminar II		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory: 00 Hours/Week **Practical:** 08 Hours/Week	00 04	**Term Work**: 25 Marks **Oral**: 25 Marks
Comprehensive Continuous Evaluation	**--**	

Technical Seminar II: shall be on state of the art topic of student's own choice in the domain of thermal engineering by authority. Students are advised to refer latest linked research papers from reputed referred journal for preparations of the topic and report.

Guidelines for preparations of Technical Seminar II report are as below

- Technical Seminar II report is to be limited to 25-30 manuscript pages preferably
- Total number of Spiral Bound copies-02
- Page Size: Trimmed A4 (Plain white background and **strictly JK Bond papers**
- If colored Diagrams or Graphs used in report take color printout
- Top Margin: 1.00 Inches
- Bottom Margin: 1.25 Inches
- Left Margin: 1.5 Inches
- Right Margin: 1.0 Inches
- Para Text: Font: Times New Roman;12 points,
- Line Spacing: 1.5 lines
- Page Numbers: **Center aligned and in Footer** (Font: Times New Roman;10 points)
- Entire report shall be one chapter. No chapters for Seminar I, II and III
- All section headings and subheadings should be numbered. For sections use numbers **1,2, 3, …. ,** for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.
- Certificate: All students should attach Standard Format of Certificate as Described by theDepartment
- Section Titles/ Headings: Times New Roman;14 points; Uppercase, **Bold and Leftaligned**
- Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (thefirst letter of each word is to be capitalized).
- **Symbols** and **notations** if any should be included in nomenclature section only
- **The main points in the seminar can be** Introduction, Historical Background, Literaturereview, summary of literature review, Scope of Seminar etc, Technical Session (Existing setup result and its discussion in detail), future scope, Summery or Conclusions, References
- If **figures** and **tables** are taken from any reference, then indicate source of it.
- References: Students should mention reference of Technical Paper, Handbooks, Books
- **Only** which are strictly referred by them, it should be in following format

For Reference paper

Author Names (Bold), Title of paper, Journal Publication or Conference details (name & Venue), Date or year of publication, page no

Eg

[3] **Ganesh Murali J**, **Subrahmanya S. Katte**, "Experimental Investigation of Heat transfer Enhancement in radiating Pin Fin", Jordan Journal of Mechanical and Industrial Engineering (JJMIE), 3rd Sep. 2008, Vol.2, pp. 163-167.

For Books/Handbooks

Author (Bold), Title of Book/Handbook, Publication, Edition

If you have any E references (Website links) mention it in Literature review should not mention website references under reference section.

Eg

[4] **Yunus A.Cengel. and Afshin J.Ghajar.**, „Heat and Mass Transfer", Tata McGraw Hill Education Pvt.Ltd., 4th Edition (2011)., pp.361- 363,

Seminar Report should be arranged in following Sequence

- Cover Page
- Certificate
- Acknowledgement
- Index/Contents
- Abstract
- List of Figures
- List of Tables
- Technical section
- References

About Power Point Presentation (PPT)

Total Time: 20 minutes of each student For
presentation: 15 minutes
For Question:5 minutes

- Slides should contain Bulleted points, Figures, Charts only
- Slides should have light background

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
RPR-603- HPO – Research Project Stage-I		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory: 00 Hours/Week **Practical:** 18 Hours/Week	00 09	**Term Work**: 25 Marks **Oral**: 25 Marks
Comprehensive Continuous Evaluation	**--**	

Research Project Phase I: shall be on state of the art topic of student's own choice in the domain of his/her Thermal Engineering approved by authority. In this, the student shall complete the partial work of the Research Project that will consist of problem statement, literature review, gap analysis, objectives, project scope, scheme of implementation (block diagram/ Test Matrix) and Layout & Design of the Set-up, details of simulation/ validation methodology. The candidate shall deliver a presentation as a part of the progress report of Research Project Phase-I.

The student shall submit the progress report of Research Project Phase-I in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

- Project Stage I shall not have last section as Conclusions, it will be summary only
- Details expected in chapters

1. **Abstract**

   A brief abstract of the entire project stage I report not more than 150 words and single paragraph. The heading of abstract i.e. word "Abstract" should be bold, Times New Roman, 12 pt and should be typed at the centre. The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on motive, method, key-results and summary in the Abstract.

1. **Chapter I- Introduction (about 7 pages)**
   - Maximum up to 5-6 pages with proper referencing w.r.t. references mentioned in Bibliography. Generalized arrangement as under
2. **Chapter 2- Literature Survey (about 10 pages)**
   - Survey of similar research work already available in (Specifications not needed)
   - Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.
   - Comparison with various other technologies available to implement the same.
   - Reference from journal paper is essential
   - Gap analysis
   - Summary of Literature Review
   - Problem statement (TNR – 12)

- Objectives of the project
- Scope of the project

3. **Chapter 3**- Design and Proposed Experimentation (you may divide this in two chapters if required)

- Basic Theory related to Topic with proper Block diagram & description
- Brief description of each diagrams
- Design related details
- Assumptions
- Detailed design of each component used
- Details of Experimentation to be performed
- Details of Test Matrix
- Proposed results and discussion
- Proposed method of validation experimentation
- Project Plan

3. In case of CFD simulation add separate chapter related to the same

 References: Students should mentio reference of Technical Paper, Handbooks, Books **Only** which are strictly referred by them, it should be in following format

Guidelines for preparations of Research Project Phase-I report are as below

- This report is to be limited to 30-35 pages preferably
- Total number of Spiral Bound copies-02
- Page Size: Trimmed A4 (Plain white background and **strictly JK Bond papers**
- If colored Diagrams or Graphs used in report take color printout
- Top Margin: 1.00 Inches
- Bottom Margin: 1.25 Inches
- Left Margin: 1.5 Inches
- Right Margin: 1.0 Inches
- Para Text: Font: Times New Roman;12 points,
- Line Spacing: 1.5 lines
- Page Numbers: **Center aligned and in Footer** (Font: Times New Roman;10 points)
- Entire report shall be one chapter. No chapters for Seminar I, II and III
- All section headings and subheadings should be numbered. For sections use numbers **1,2, 3, …. ,** for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.
- Certificate: All students should attach Standard Format of Certificate as Described by theDepartment
- Section Titles/ Headings: Times New Roman;14 points; Uppercase, **Bold and Leftaligned**
- Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (thefirst letter of each word is to be capitalized).
- **Symbols** and **notations** if any should be included in nomenclature section only
- **The main points in the seminar can be** Introduction, Historical Background, Literaturereview, summary of literature review, Scope of Seminar etc, Technical Session (Existing setup result and its discussion in detail), future scope, Summery or Conclusions, References

- Gap analysis section is to be added after literature review.
- Comparative analysis, extended simulation of each case study is expected.
- If **figures** and **tables** are taken from any reference then indicate source of it.
- References: Students should mention reference of Technical Paper, Handbooks, Books
- **Only** which are strictly referred by them, it should be in following format

For Reference paper

Author Names (Bold), Title of paper, Journal Publication or Conference details (name & Venue), Date or year of publication, page no

Eg

[5] **Ganesh Murali J**, **Subrahmanya S. Katte**, "Experimental Investigation of Heat transfer Enhancement in radiating Pin Fin", Jordan Journal of Mechanical and Industrial Engineering (JJMIE), 3rd Sep. 2008, Vol.2, pp. 163-167.

For Books/Handbooks

Author (Bold), Title of Book/Handbook, Publication, Edition

If you have any E references (Website links) mention it in Literature review should not mention website references under reference section.

Eg

[6] **Yunus A.Cengel. and Afshin J.Ghajar.**, „Heat and Mass Transfer", Tata McGraw Hill Education Pvt.Ltd., 4th Edition (2011)., pp.361- 363,

Research Project Phase I Report should be arranged in following Sequence

- Cover Page
- Certificate
- Acknowledgement
- Index/Contents
- Abstract
- List of Figures
- List of Tables
- Technical section
- References

About Power Point Presentation (PPT)

Total Time: 20 minutes of each student For
presentation: 15 minutes
For Question:5 minutes

- Slides should contain Bulleted points, Figures, Charts only.
- Slides should have light background

Savitribai Phule Pune University, Pune

Maharashtra, India

ME - Mechanical Engineering (Heat Power Engineering)

(2025 Pattern)

Semester IV

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
RPR-651- HPO –Seminar on Project Stage II		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory: 00 Hours/Week **Practical:** 08 Hours/Week	00 04	**Term Work**: 50 Marks **Oral**: 50 Marks
Comprehensive Continuous Evaluation	**--**	

Seminar on Project Stage II: shall be on state of the art topic of student's own choice in the specific domain of research project but not same contents as Research Project Stage I or II, approved by authority. Students are advised to refer latest linked research papers from reputed referred journal for preparations of the topic and report.

Guidelines for preparations of Seminar on Project Stage II report are as below

- Seminar on Project Stage II report is to be limited to 30-35 manuscript pages preferably
- Total number of Spiral Bound copies-02
- Page Size: Trimmed A4 (Plain white background and **strictly JK Bond papers**
- If colored Diagrams or Graphs used in report take color printout
- Top Margin: 1.00 Inches
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- Left Margin: 1.5 Inches
- Right Margin: 1.0 Inches
- Para Text: Font: Times New Roman;12 points,
- Line Spacing: 1.5 lines
- Page Numbers: **Center aligned and in Footer** (Font: Times New Roman;10 points)
- Entire report shall be one chapter. No chapters for Seminar I, II and III
- All section headings and subheadings should be numbered. For sections use numbers **1,2, 3, …. ,** for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.
- Certificate: All students should attach Standard Format of Certificate as Described by theDepartment
- Section Titles/ Headings: Times New Roman;14 points; Uppercase, **Bold and Leftaligned**
- Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (thefirst letter of each word is to be capitalized).
- **Symbols** and **notations** if any should be included in nomenclature section only
- **The main points in the seminar can be** Introduction, Historical Background, Literaturereview, summary of literature review, Scope of Seminar etc, Technical Session (Existing setup result and its discussion in detail), future scope, Summery or Conclusions, References
- Seminar I shall not have last section as Conclusions, it will be summary only
- If **figures** and **tables** are taken from any reference, then indicate source of it.

- References: Students should mention reference of Technical Paper, Handbooks, Books
- **Only** which are strictly referred by them, it should be in following format

For Reference paper

Author Names (Bold), Title of paper, Journal Publication or Conference details (name & Venue), Date or year of publication, page no

Eg

[7] **Ganesh Murali J**, **Subrahmanya S. Katte**, "Experimental Investigation of Heat transfer Enhancement in radiating Pin Fin", Jordan Journal of Mechanical and Industrial Engineering (JJMIE), 3rd Sep. 2008, Vol.2, pp. 163-167.

For Books/Handbooks

Author (Bold), Title of Book/Handbook, Publication, Edition

If you have any E references (Website links) mention it in Literature review should not mention website references under reference section.

Eg

[8] **Yunus A.Cengel. and Afshin J.Ghajar.**, „Heat and Mass Transfer", Tata McGraw Hill Education Pvt.Ltd., 4th Edition (2011)., pp.361- 363,

Seminar Report should be arranged in following Sequence

- Cover Page
- Certificate
- Acknowledgement
- Index/Contents
- Abstract
- List of Figures
- List of Tables
- Technical section
- References

About Power Point Presentation (PPT)

Total Time: 20 minutes of each student For
presentation: 15 minutes
For Question:5 minutes

- Slides should contain Bulleted points, Figures, Charts only
- Slides should have light background

Savitribai Phule Pune University First Year of ME - Mechanical Engineering (Heat Power Engineering) (2025 Course)		
RPR-652- HPO – Research Project Stage-II		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory: 00 Hours/Week **Practical:** 36 Hours/Week	00 18	**Term Work**: 150 Marks **Oral**: 50 Marks
Comprehensive Continuous Evaluation	**--**	

Research Project Phase II: shall be the final representation of his/her dissertation in field of Thermal Engineering approved by authority. It is a continuation of Research Project Phase I. In this report, the student shall complete the remaining work of the Research Project that will consist of problem statement, literature review, gap analysis, objectives, project scope, scheme of implementation (block diagram/ Test Matrix) and Layout & Design of the Set-up, detailed results of simulation/ validation, results and discussions, conclusions based on his/her research work, future scope of the work. The candidate shall deliver a presentation as a part of the progress report of Research Project Phase-II.

General Guidelines for Preparation of M.E. Dissertation (Research Project Phase II) Report

a) Report contents must be arranged as follows:

1. Cover Page – Black Hardbound with all details in gold embossing.
2. Blank Page
3. Title Page
4. Certificate signed by Guide, HOD and Principal
5. Certificate to be signed by examiners
6. Acknowledgment
7. Table of Contents
8. Abstract
9. List of Figures
10. List of Tables
11. List of Symbols, Abbreviations and Nomenclature
12. Introduction
13. Chapters (4 to 6 only)
14. References
15. Annexure (For property tables, charts, Photographs etc)

b) Page dimensions and Type:

A4- Executive bond Paper

Top Margin: 1.00 Inches
Bottom Margin: 1.25 Inches
Left Margin: 1.5 Inches
Right Margin: 1.0 Inches

c) For any figures/ graphs /block diagrams/photos/ tables add suitable caption i.e. Table No. 1/ Figure No. 1 etc.

d) Size of report should be min: 60 pages max: should not exceed 125 pages.

e) Font type and sizes:

Line spacing: 1.5 Lines

Section Titles/ Headings : Times New Roman;14 points; Uppercase, Bold All other details/ text : Times New Roman – 12 pt.

Table/Figure Caption : Times New Roman – 10 pt

- Page Numbers: **Right aligned and in Footer** (Font: Times New Roman;12 points)
- Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).
- All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, …. ,** for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.
- Certificate: All students should attach Standard Format of Certificate as Described by the Department
- **Symbols** and **notations** if any should be included in nomenclature section only

f) Details expected in chapters:

Abstract: A brief abstract of the entire report not more than **150 words and single pargraph**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **center.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in Abstract

I. Introduction (about 7 pages)

- Maximum up to 5 pages with proper referencing w.r.t. references mentioned in Bibliography. Generalized arrangement as under.
- Organization of Dissertation

II. Literature Survey (about 10 pages)

- Survey of similar research work already available in (Specifications not needed)
- Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.
- Comparison with various other technologies available to implement the same.
- Reference from journal paper is essential
- Gap analysis
- Summary of Literature Review
  - i. Problem statement (TNR – 12)
  - ii. Objectives
  - iii. Scope
  - iv. Methodology

III. Experimentation:

- Basic Thoery related to Topic with proper Block diagram & description
- Brief description of each diagrams
- Design related details
- Assumptions
- Detailed design of each component used
- Details of Experimentation performed
- Details of analysis of experiment

IV. Results and Discussions (about 20-25 pages)

- Results obtained at various stages of the implementation of the system, comparison with theoretical results & reasons for variation.
- Result tables and suitable graphs should be included.
- Problems encountered during testing, and design should be specified. Any remedial action taken or solution found must be specified and discussed
- Uncertainty analysis

V. Validation of Experimentation

- Specify in brief method/s used for validation of experimental results
- Explain the validation in brief

VI. Applications & Future modifications

- Specify detailed relevant applications of the system designed & implemented.
- Future modifications which could have been implemented if time & money are no constraints.

VII. Conclusions

- Write conclusions in point form
- List of paper/s published/ present
- References (In following format) : (Follow IEEE format)
  List and number all bibliographical references in 12-point Times, single-spaced. When referenced in the text, enclose the citation number in square brackets, for example [1]. Where appropriate, include the name(s) of editors of referenced books.
  [1] **A.B. Smith**, C.D. Jones, and E.F. Roberts, "Article Title", *Journal*, Publisher, Location, Date, pp. 1-10.
  [2] **Jones, C.D**., A.B. Smith, and E.F. Roberts, *Book Title*, Publisher, Location, Date.
- For Books/handbook Authors name, "*Title of book*", Publisher, Year of publication / Edition no. (Ex)
  [1] Yunus Cengel. , "Heat transfer - an practical application", McGraw Hills, 2006
- For Papers referred from journals / magazines.
  Ex.
  [1] **Ganesh Murali J**, Subrahmanya S. Katte, "Experimental Investigation of Heat transfer Enhancement in radiating Pin Fin", Jordan Journal of Mechanical and Industrial Engineering, Vol.2, PP. 163-167, 3,Sep. 2008
- Additional observation tables, calculations, results tables, certificates for calibration should be included in th **ANNEXURE (A, B…..)**

About Power Point Presentation (PPT)

Total Time: 60 minutes of each student for
presentation: 45 minutes
For Question:15 minutes

- Slides should contain Bulleted points, Figures, Charts only.
- Slides should have light background