SAMARTH EDUCATIONAL TRUST

ARVIND GAVALI COLLEGE OF ENGINEERING, SATARA

(AN AUTONOMOUS INSTITUTE)

# Master of Technology

in

# Mechanical Engineering (Heat Power)

**First Year Syllabus**

2025-26

# LIST OF ABBREVIATIONS

| Sr. No. | Abbreviation | Description | Code |
|---|---|---|---|
| 1 | L | Lecture | |
| 2 | T | Tutorial | |
| 3 | P | Practical | |
| 4 | Cr | Credits | |
| 5 | BSC | Basic Science Course | BS |
| 6 | ESC | Engineering Science Course | ES |
| 7 | AEC | Ability Enhancement Course | AE |
| 8 | VSEC | Vocational and Skill Enhancement Course | VS |
| 9 | PCC | Program Core Course | PC |
| 10 | PEC | Professional Elective Course | PE |
| 11 | OEC | Open Elective Course | OE |
| 12 | IKS | Indian Knowledge System | IK |
| 13 | CC | Co-curricular Course | CC |

# SEMESTER – I

| Sr. No. | Category | Course Code | Course Name | Teaching Scheme L | T | P | Hrs./Week | Cr | Evaluation Scheme Components | Max | Min for Passing | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PCC | 25MHP1101 | Thermodynamics and Combustion | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 2 | PCC | 25MHP1102 | Advanced Fluid Dynamics | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 3 | PCC | 25MHP1103 | Advanced Heat Transfer | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 4 | PCC | 25MHP1101 L | Thermodynamics and Combustion Laboratory | 0 | 0 | 2 | 2 | 1 | CA1 | 25 | | 40 |
| | | | | | | | | | CA2 | 25 | | |
| | | | | | | | | | OE | 50 | 20 | |
| 5 | PCC | 25MHP1102 L | Advanced Fluid Dynamics Laboratory | 0 | 0 | 2 | 2 | 1 | CA1 | 25 | | 20 |
| | | | | | | | | | CA2 | 25 | | |
| | | | | | | | | | -- | -- | -- | |
| 6 | PCC | 25MHP1103 L | Advanced Heat Transfer Laboratory | 0 | 0 | 2 | 2 | 1 | CA1 | 25 | | 40 |
| | | | | | | | | | CA2 | 25 | | |
| | | | | | | | | | OE | 50 | 20 | |
| 7 | PEC | 25MHP1104 | Professional Elective Course- I | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 8 | PEC | 25MHP1105 | Professional Elective Course- II | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| | | | **Total** | **15** | **0** | **6** | **21** | **18** | | **750** | | |
| **Total Contact Hours – 21 Total Credits - 18** | | | | | | | | | | | | |

**Professional Elective Course List for F. Y. M. Tech (Heat Power) SEM – I:**

| Sr. No. | Track | Course Code | Course Name |
|---|---|---|---|
| **PROFESSIONAL ELECTIVE COURSE- I** | | | |
| 1 | Study and Design of Thermal Systems | 25MHP1104A | Nuclear Engineering |
| 2 | Pumps and Turbines | 25MHP1104B | Design of Thermal – Turbo Systems |
| 3 | Pumps and Turbines | 25MHP1104C | Gas Turbines |
| **PROFESSIONAL ELECTIVE COURSE- II** | | | |
| 1 | Study and Design of Thermal Systems | 25MHP1105A | Design of Hydro - Turbo Systems |
| 2 | Heating Ventilation and Air Conditioning | 25MHP1105B | Air Conditioning System Design |
| 3 | Energy Engineering | 25MHP1105C | Design of Solar and Wind System |

# SEMESTER – II

| Sr. No. | Category | Course Code | Course Name | Teaching Scheme | | | | | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Hrs./Week | Cr | Components | Max | Min for Passing | |
| 1 | PCC | 25MHP1201 | Steam Engineering | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 2 | PCC | 25MHP1202 | Computational Techniques in Fluid Flow and Heat Transfer | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 3 | PCC | 25MHP1203 | Internal Combustion Engine Design | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 4 | PCC | 25MHP1201L | Steam Engineering and I.C. Engine Laboratory | 0 | 0 | 2 | 2 | 1 | CA1 | 25 | | 40 |
| | | | | | | | | | CA2 | 25 | | |
| | | | | | | | | | OE | 50 | 20 | |
| 5 | PCC | 25MHP1202L | CFD Laboratory | 0 | 0 | 2 | 2 | 1 | CA1 | 25 | | 20 |
| | | | | | | | | | CA2 | 25 | | |
| | | | | | | | | | -- | -- | -- | |
| 6 | PCC | 25MHP1204 | Seminar | 0 | 0 | 2 | 2 | 1 | CA1 | 25 | | 40 |
| | | | | | | | | | CA2 | 25 | | |
| | | | | | | | | | OE | 50 | 20 | |
| 7 | PEC | 25MHP1205 | Professional Elective Course- III | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 8 | PEC | 25MHP1206 | Professional Elective Course- IV | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| 9 | OEC | 25MHP1207 | Research Methodology | 3 | 0 | 0 | 3 | 3 | CA-1 | 10 | | 40 |
| | | | | | | | | | MSE | 30 | | |
| | | | | | | | | | CA-2 | 10 | | |
| | | | | | | | | | ESE | 50 | 20 | |
| | | | **Total** | **18** | **0** | **6** | **24** | **21** | | **850** | | |
| **Total Contact Hours – 24 Total Credits - 21** | | | | | | | | | | | | |

**Professional Elective Course List for F. Y. M. Tech (Heat Power) SEM – II:**

| Sr. No. | Track | Course Code | Course Name |
|---|---|---|---|
| **PROFESSIONAL ELECTIVE COURSE– III** | | | |
| 1 | Study and Design of Thermal Systems | 25MHP1205A | Design of Heat Exchanger |
| 2 | Refrigeration | 25MHP1205B | Industrial Refrigeration |
| 3 | Food Preservation | 25MHP1205C | Food Preservation and Cold Chain Management |
| 4 | Automotive and Power Systems | 25MHP1205D | Alternative fuels for I.C. Engines |
| **PROFESSIONAL ELECTIVE COURSE - IV** | | | |
| 1 | Refrigeration | 25MHP1206A | Cryogenics |
| 2 | Heating Ventilation and Air Conditioning | 25MHP1206B | Industrial Air Conditioning |
| 3 | Energy Engineering | 25MHP1206C | Energy Conservation and Management |
| 4 | Automotive and Power Systems | 25MHP1206D | Battery thermal management system |

| Title of the Course: Thermodynamics and combustion<br>Course Code: 25MHP1101 | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | - | - | 3 |

**Course Prerequisite:**

To ensure that the students can fully benefit from this course, they should have basic knowledge of Basic Mathematics and Chemistry.

**Course Description:**

This course provides an in-depth study of thermodynamics and combustion principles with a focus on energy conversion in multi-component systems. Students will develop a strong foundation in the fundamental laws of thermodynamics, including zeroth, first, and second laws, and will explore advanced thermodynamic relations such as Maxwell's relations, Helmholtz and Gibbs free energies, and the Clapeyron equation. The course also emphasizes chemical thermodynamics and equilibrium, statistical interpretations of thermodynamic laws, and entropy concepts.

**Course Objectives:**

By the end of this course, the students will be able to:

1. Students will get Knowledge of energy, basic laws governing energy conversion in multi-component systems and application of chemical thermodynamics.
2. Student will be aware about advanced concepts in thermodynamics with emphasis on the thermodynamic relations, equilibrium and stability of multi phase multi-component systems.
3. Student will be acquiring the confidence in analyze the motion of combusting and no combusting fluids whilst accounting for variable specific heats, non-ideal gas properties, chemical no equilibrium and compressibility.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | Explain the concepts of thermodynamics and kinetics of combustion |
| CO2 | Apply the concepts of Thermodynamics and combustion phenomena in energy conversion devices. |
| CO3 | Analyze the combustion mechanisms of various fuels. |
| CO4 | Evaluate entropy change for flow and non-flow processes under steady and unsteady conditions |
| CO5 | Interpret the thermodynamic behavior of reacting systems using concepts of chemical equilibrium and statistical thermodynamics. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | P011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | | | | | | |
| **CO2** | 2 | | 2 | | 1 | | | | | | |
| **CO3** | | 3 | | 2 | | | | | | | 2 |
| **CO4** | 2 | 3 | | 2 | 2 | | | | | | |
| **CO5** | 2 | 2 | | | | | | | | | 2 |

**Assessment Scheme:**
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| MSE | 30 |
| CA2 | 10 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions/presentation, etc.

**MSE** is based on 50% of course content.

**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

**Course Contents:**

| Unit No. | Unit Title and Contents | Hours |
|---|---|---|
| 1 | **Laws of Thermodynamics**<br>Zeroth and First Law of Thermodynamics applied to macroscopic systems.<br>Second Law analysis applied to macroscopic systems. Concept & Evaluation of entropy, Clausius inequality, Principle of increase of entropy. | **08** |
| 2 | **Second Law Analysis of Thermodynamic Systems**<br>Introduction, Thermodynamic availability, Second Law Analysis of | **08** |

| | | |
|---|---|---|
| | Closed Systems and Open Systems. | |
| 3 | **Generalized Thermodynamic Relationship**<br>Thermodynamic Relations Mathematical theorems, Helmholtz and Gibb's function, T-ds equations, Maxwell's relations, energy equations, variation in heat capacities, Clapeyron relation. | **08** |
| 4 | Combustion and Thermo-chemistry, Second law analysis of reacting mixture, Availability analysis of reacting mixture, Chemical equilibrium. | **08** |
| 5 | Statistical thermodynamics, statistical interpretations of first and second law and Entropy. | **08** |

| **Textbooks** | | | |
|---|---|---|---|
| **Sr. No.** | **Title** | **Author** | **Publisher** |
| 1 | An Introduction to Thermodynamics | Y.V.C. Rao | University Press (India) Private Limited (Revised Edition, 2004) |
| 2 | Thermodynamics: An Engineering Approach | Y.A. Cengal and M.A. Boles | McGraw Hill (Fifth edition) |
| 3 | Fundamentals of Classical Thermodynamics | G. Van Wylen, R. Sonntag and C. Borgnakke | John Willey & Sons (Fourth edition) |

| **Reference Books** | | | |
|---|---|---|---|
| **Sr. No.** | **Title** | **Author** | **Publisher** |
| 1 | Thermodynamics | Cengel | Tata McGraw Hill Co., New Delhi, 1980 |
| 2 | Fundamentals of Engineering Thermodynamics | Howell and Dedcius | McGraw Hill Inc., U.S. A |
| 3 | Engineering Thermodynamics | Jones and Hawkings | John Wiley and Sons Inc., U.S.A, 2004 |
| 4 | Thermodynamics | Holman | McGraw Hill Inc., New York, 2002 |
| 5 | Postulational and Statistical Thermodynamics | Rao Y.V.C | Allied Publishers Inc, 1994 |

| Title of the Course: Advanced Fluid Dynamics<br>Course Code: 25MHP1102 | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | - | - | 3 |

**Course Prerequisite:**
To ensure that the students can fully benefit from this course, they should have basic knowledge of Fluid Mechanics.

**Course Description:**
This course delves into advanced concepts of fluid dynamics, focusing on the mathematical modelling and analysis of fluid flow problems. Students will build on their foundational knowledge of fluid mechanics to study flow kinematics, potential flow theory, hydrodynamic stability, boundary layer phenomena, and turbulent flow characteristics. The course also covers the performance and operation of turbo machinery such as turbines, compressors, and pumps.

**Course Objectives:**
By the end of this course, the students will be able to:
1. To enable the students to analyse and solve fluid related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfil industrial needs related to fluid dynamics.
3. To train students with effective communication skill to demonstrate fluid dynamics theories.
4. To develop skills in the analysis of fluid systems with mathematical modeling for applications of fluid dynamics in research or design.
5. To develop a professional approach for lifelong learning in the fluid dynamics to include the awareness of social and environment issues associated with engineering practices.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| **CO1** | Describe and define the fluid flow problems along with range of governing parameters |
| **CO2** | Devise the experiments in the field of fluid mechanics. |
| **CO3** | Analyze the flow patterns and differentiate between the flow regimes and its effects. |
| **CO4** | Evaluate the performance of turbomachinery. |
| **CO5** | Interpret the characteristics of compressible fluid flow and analyze the effects of shock waves and area variation in nozzles and diffusers. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | P011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | |
| **CO2** | 2 | 3 | 2 | 3 | 2 | | | | | | |
| **CO3** | 3 | 3 | | 3 | 2 | | | | | | 2 |
| **CO4** | 2 | 3 | | 2 | 2 | | | | | | |
| **CO5** | 3 | 3 | | 2 | 2 | | | | | | 2 |

**Assessment Scheme:**
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| MSE | 30 |
| CA2 | 10 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions/presentation, etc.
**MSE** is based on 50% of course content.
**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

**Course Contents:**

| Unit No. | Unit Title and Contents | Hours |
|---|---|---|
| 1 | **Basic equations of flow**<br>Kinematics of flow, Control volume approach, Continuity equation, Momentum equation Linear momentum equation and angular momentum equation, Energy equation, Bernoulli equation. | **08** |
| 2 | **Theory of Potential Flow and Hydrodynamic Stability**<br>Kelvin's theorem, Stream function and Velocity potential, Irrational flow, Laplace equation and various flow fields, Combined flows and super positions, Examples of transition, Theoretical determination of Critical Reynolds Number. | **08** |

| | | |
|---|---|---|
| 3 | **Flow over immersed bodies and boundary layer flow**<br>Boundary layer equations, flow over flat plate, Boundary layers with non- zero pressure gradient, Approximate methods for boundary layer equations, separation and vortex shedding. | **08** |
| 4 | **Turbulent flow**<br>Characteristics of Turbulent flow, Laminar turbulent transition, Governing equations for turbulent flow, turbulent boundary layer equations, measurement of turbulent quantities, shear stress models, universal velocity distribution and friction factor, fully developed turbulent flow, Dynamics of turbulence. | **08** |
| 5 | **Turbo machinery**<br>Equations of turbomachinery, Axial flow turbines, compressors, pumps and fans, Radial flow turbines, compressors, pumps and fans, Power absorbing vs. power producing devices, Performance characteristics of centrifugal pumps, Performance characteristics of hydraulic turbines. | **08** |

| **Textbooks** | | | |
|---|---|---|---|
| **Sr. No.** | **Title** | **Author** | **Publisher** |
| 1 | Advanced Engineering Fluid Mechanics | Muralidhar and Biswas | Alpha Science International, 2005 |
| 2 | Mechanics of Fluids | Irwin Shames | McGraw Hill, 2003 |

| **Reference Books** | | | |
|---|---|---|---|
| **Sr. No.** | **Title** | **Author** | **Publisher** |
| 1 | Introduction to Fluid Mechanics | Fox R.W., McDonald A. T. | John Wiley and Sons Inc., 1985 |
| 2 | Fluid Mechanics | Pijush K. Kundu, Ira M Kohen and David R. Dawaling | McGraw Hill Inc., U.S. A |

| Title of the Course: Advanced Heat Transfer<br>Course Code: 25MHP1103 | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | - | - | 3 |

**Course Prerequisite:**
To ensure that the students can fully benefit from this course, they should have basic knowledge of heat transfer.

**Course Description:**
This course covers the fundamentals and advanced concepts of heat transfer through conduction (1D & 2D), convection (natural and forced), and radiation. It includes special topics such as fins, heat sources, unsteady conduction, boiling, condensation, and two-phase flow. Applications like heat pipes, transpiration cooling, ablation, and radiation network analysis are also addressed.

**Course Objectives:**
By the end of this course, the students will be able to:
1. To provide the student with general techniques to formulate, model and mathematically solve advanced heat transfer problems.
2. To provide the student with a detailed, but not exhaustive, presentation of selected advanced topics in convective heat transfer that are representative of "real world" engineering problems.
3. To introduce basic numerical methods and software tools for solving heat transfer problems.
4. To use appropriate analytical and computational tools to investigate heat and mass transport Phenomena.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | Explain the physical modelling aspects of heat transfer and an ability to make the appropriate choice between exact and approximate calculations in solving problems of heat transfer in complex systems. |
| CO2 | Identify the analogy of flow and momentum diffusion to heat and mass transfer and identify the interdisciplinary character of real- life thermal engineering. |
| CO3 | Analyze heat transfer in complex internal flow systems and in boundary layers and external flow configurations. |
| CO4 | Evaluate radiation heat transfer between black body and gray body surfaces & Gas radiation. |
| CO5 | Assess and apply advanced heat transfer techniques including phase change, transpiration cooling, and heat pipe technology in engineering systems. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | | | | | | 2 |
| **CO2** | 2 | 3 | 2 | 3 | 2 | | | | | | 2 |
| **CO3** | 3 | 3 | | 3 | 2 | | | | | | 2 |
| **CO4** | 3 | 3 | | 2 | | | | | | | 2 |
| **CO5** | 3 | 2 | | 2 | 3 | | | | | | 2 |

**Course Contents:**

| Unit No. | Unit Title and Contents | Hours |
|---|---|---|
| 1 | Conduction- One and Two Dimensions. | **08** |
| 2 | Fins, conduction with heat source, unsteady state heat transfer. | **08** |
| 3 | Natural and forced convection, integral equation, analysis and analogies. | **08** |
| 4 | Transpiration cooling, ablation heat transfer, boiling, condensation and two-phase flow mass transfer, cooling, fluidized bed combustion. | **08** |
| 5 | Heat pipes, Radiation, shape factor, analogy, shields. Radiation of gases, vapors and flames, Network method of analysis for Radiation Problem. | **08** |

| **Textbooks** | | | |
|---|---|---|---|
| **Sr. No.** | **Title** | **Author** | **Publisher** |
| 1 | A Textbook on Heat Transfer | S. P. Sukhatme | Universities Press, 4th Edition,2006 |
| 2 | Heat Transfer – A Practical Approach | Yunus. A. Cengel | Tata McGraw Hill, 3rd Edition, 2006 |
| 3 | Fundamentals of Heat and Mass Transfer | Incropera and Dewitt | Wiley publications, 2nd Edition, 2007 |
| 4 | Heat and Mass transfer | P. K Nag | Tata McGraw Hill, 2nd Edition |

| Reference Books | | | |
|---|---|---|---|
| **Sr. No.** | **Title** | **Author** | **Publisher** |
| 1 | Analysis of Heat and Mass Transfer | Eckert and Drabe | McGraw Hill Higher Education, 2003 |
| 2 | Boundary Layer Theory | H. Schlichting, K. Gersten | Springer, 8$^{th}$ edition, 2000 |
| 3 | Heat Transfer | J. P. Holman | McGraw Hill Book Company, New York, 1990 |
| 4 | Principles of Heat Transfer | Frank Kreith | Harper and Row Publishers, New York, 1973 |
| 5 | Process Heat Transfer | Donald Q. Kern | Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975 |
| 6 | Fundamentals of Engineering Heat and Mass Transfer | R. C. Sachdeva | Wiley Eastern Ltd., India |
| 7 | Heat Conduction | Latif M. Jiji | Springer, 3$^{rd}$ edition, 2009 |

| Title of the Course: Thermodynamics and combustion Laboratory<br>Course Code: 25MHP1101L | L | T | P | Credit |
|---|---|---|---|---|
| | - | - | 2 | 1 |

**Course Prerequisite:** Requisite Courses: Basic Mathematics, Chemistry.

**Course Description:**

This laboratory course is designed to provide hands-on experience in the principles of thermodynamics and combustion processes through a series of practical experiments and data analysis. Students will conduct experiments related to energy conversion, heat engines, calorimetry, fuel properties, and combustion analysis. Emphasis is placed on experimental design, measurement techniques, error analysis, and interpretation of results in the context of real-world energy systems.

**Course Objectives:**

By the end of this course, the students will be able to:

1. To learn about work and heat interactions, and balance of energy between system and its surroundings.
2. To learn about application of law to various energy conversion devices.
3. To evaluate the changes in properties of substances in various processes.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | Describe the experimental procedure of experiments in thermodynamics lab. |
| CO2 | Solve field problems in Thermodynamics and Combustion by using different techniques. |
| CO3 | Verify the concepts related to Thermodynamics and Combustion.. |
| CO4 | Prepare and present a detailed technical report based on experiment /mini project work. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | | 1 | | | | 2 | | 3 |
| **CO2** | 2 | | 2 | | 2 | | | | 2 | | 3 |
| **CO3** | 3 | 3 | 3 | | 2 | | | | 2 | | 3 |
| **CO4** | 2 | 2 | 1 | | 2 | | | | 1 | | 3 |

**Assessment Scheme:**

Two components of Continuous Assessment (CA-1, CA-2), having 25% weightage for each component respectively and 50% weightage is for OE.

| Assessment Component | Marks |
|---|---|
| CA1 | 25 |
| CA2 | 25 |
| OE | 50 |
| -- | - |

**CA1** OE based on 50% of course content, attendance, lab overall performance.
**CA2** OE based on 100% of course content, attendance, lab overall performance.

**Course Contents**

| Unit No. | Course Contents | Hours |
|---|---|---|
| 1 | Test on Grease dropping point apparatus. | **02** |
| 2 | Test on Redwood Viscometer . | **02** |
| 3 | Determination of flash and fire point of a lubricating oil | **02** |
| 4 | A test on Bomb calorimeter. | **02** |
| 5 | Mini steam power plant. | **02** |
| 6 | Cooling Tower | **04** |
| 7 | Reciprocating compressor unit | **04** |

| Text Book | | | |
|---|---|---|---|
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | Thermodynamics | P. K. Nag | Tata McGraw Hill Publication |
| 2 | Thermodynamics an engineering Approach | Cengel and Boles | Tata McGraw-Hill . |

| Reference Books | | | |
|---|---|---|---|
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | Fundamentals of Thermodynamics | Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J | John Wiley and Sons |
| 2 | Engineering Thermodynamics | Jones, J. B. and Duggan, R. E | Prentice-Hall of India |
| 3 | Fundamentals of Engineering Thermodynamics | Moran, M. J. and Shapiro, H. N., | John Wiley and Sons. |

| Useful Links |
|---|
| https://archive.nptel.ac.in/courses/112/105/112105123/ |

| Title of the Course: Advanced Fluid Dynamics Laboratory<br>Course Code: 25MHP1102L | L | T | P | Credit |
|---|---|---|---|---|
| | - | - | 2 | 1 |

**Course Prerequisite:** Requisite Courses: Basic Mathematics, Chemistry.

**Course Description:**

This laboratory course offers an in-depth, hands-on exploration of advanced concepts in fluid dynamics through experimental investigation. Students will design, perform, and analyze experiments involving internal and external flows, turbulence, boundary layers, compressible flow, and flow visualization techniques. Emphasis is placed on modern instrumentation, data acquisition, uncertainty analysis, and comparing experimental results with theoretical and computational models.

**Course Objectives:**

1. To provide hands-on experience with advanced experimental techniques used in fluid dynamics research and applications.
2. To develop skills in various flow visualization techniques to study fluid flow patterns and behaviors.
3. To enhance students' ability to use statistical and computational tools for analyzing fluid flow data.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | Explain the working principles of various flow measurement instruments. |
| CO2 | Use flow visualization techniques to observe and analyze fluid flow patterns. |
| CO3 | Compare experimental results with theoretical predictions to identify discrepancies and understand their causes. |
| CO4 | Evaluate the accuracy and reliability of experimental data and measurement techniques. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | | 1 | | | | 2 | | 2 |
| **CO2** | 2 | | 1 | | 2 | | | | 1 | | 1 |
| **CO3** | 2 | 2 | 2 | | 2 | | | | 2 | | 3 |
| **CO4** | 2 | 2 | 1 | | 2 | | | | 1 | | 3 |

**Assessment Scheme:**

Two components of Continuous Assessment (CA-1, CA-2), having 50% weightage for each component respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 25 |
| CA2 | 25 |
| OE | - |
| ESE | - |

**CA1** OE based on 50% of course content, attendance, lab overall performance.
**CA2** OE based on 100% of course content, attendance, lab overall performance.

**Course Contents**

| Unit No. | Course Contents | Hours |
|---|---|---|
| 1 | Laminar and Turbulent Flow in Pipes. | **02** |
| 2 | Flow Visualization Using Dye Injection. | **02** |
| 3 | Measurement of Flow Rate Using Orifice and Venturi Meters | **02** |

| | | |
|---|---|---|
| 4 | Jet Impact on Vanes. | **02** |
| 5 | Cavitation in Fluid Flows. | **02** |
| 6 | Flow Through Open Channels | **04** |
| 7 | Trial on Pelton Wheels | **04** |

| **Text Book** | | | |
|---|---|---|---|
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | Advanced Engineering Fluid Mechanics | Muralidhar and Biswas | Alpha Science |
| 2 | Mechanics of Fluids | Irwin Shames | Tata McGraw-Hill . |

| **Reference Books** | | | |
|---|---|---|---|
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | Introduction to Fluid Mechanics | Fox R.W., McDonald A.T | John Wiley and Sons |
| 2 | Fluid Mechanics | Pijush K. Kundu, Ira M Kohen and David R | Prentice-Hall of India |

| **Useful Links** |
|---|
| https://youtu.be/H38vI93exns |

| Title of the Course: Advanced Heat Transfer Laboratory<br>Course Code: 25MHP1103L | L | T | P | Credit |
|---|---|---|---|---|
| | - | -- | 2 | 1 |

**Course Prerequisite:** Requisite Courses: Basic heat transfer.

**Course Description:**

Thermal conductivity of solids defines how well a material conducts heat, with metals being good conductors and insulators being poor. Natural convection relies on buoyancy-driven fluid movement due to temperature differences, while forced convection in a pipe uses external means like pumps to enhance heat transfer. Boiling heat transfer involves rapid heat exchange during liquid-to-vapor phase change. A double pipe heat exchanger uses concentric pipes for fluid-to-fluid heat transfer, while a shell and tube heat exchanger involves multiple tubes inside a shell for efficient large-scale heat exchange.

**Course Objectives:**

1. To provide hands-on experience with advanced experimental techniques used in heat transfer research and applications.
2. To investigate the fundamental mechanisms of heat transfer, including conduction, convection, and radiation.
3. To train students in the analysis and interpretation of experimental data in heat transfer.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | Explain the theoretical background behind heat transfer measurements and calculations. |
| CO2 | Conduct experiments to measure various heat transfer properties using appropriate instruments. |
| CO3 | Analyze experimental data to extract meaningful information about heat transfer characteristics. |
| CO4 | Evaluate the performance and accuracy of different heat transfer measurement instruments and techniques. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | | 1 | | | | 2 | | 2 |
| **CO2** | 2 | | 1 | | 2 | | | | 1 | | 1 |
| **CO3** | 2 | 2 | 2 | | 2 | | | | 2 | | 3 |
| **CO4** | 2 | 2 | 1 | | 2 | | | | 1 | | 3 |

**Assessment Scheme:**

Two components of Continuous Assessment (CA-1, CA-2), having 25% weightage for each component respectively and 50% weightage is for OE.

| Assessment Component | Marks |
|---|---|
| CA1 | 25 |
| CA2 | 25 |
| OE | 50 |
| ESE | - |

**CA1** OE based on 50% of course content, attendance, lab overall performance.
**CA2** OE based on 100% of course content, attendance, lab overall performance.

**Course Contents**

| Unit No. | Course Contents | Hours |
|---|---|---|
| 1 | Thermal Conductivity of Solids | **02** |
| 2 | Natural Convection | **02** |
| 3 | Forced Convection in a Pipe | **02** |
| 4 | Boiling Heat Transfer: | **02** |
| 5 | Double pipe heat exchanger | **02** |
| 6 | Shell and Tube Heat Exchanger | **04** |

| **Text Book** | | | |
|---|---|---|---|
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | A Textbook on Heat Transfer | S. P. Sukhatme | Universities Press |
| 2 | Heat Transfer – A Practical Approach | Yunus A. Cengel | Tata McGraw Hill |

| **Reference Books** | | | |
|---|---|---|---|
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | A Textbook on Heat Transfer | S. P. Sukhatme | Universities Press |
| 2 | Heat Transfer – A Practical Approach | Yunus A. Cengel | Tata McGraw Hill |
| 3 | Analysis of Heat and Mass Transfer | Eckert and Drabe | McGraw Hill Higher Education |
| 4 | Boundary Layer Theory | H. Schlichting, K. Gersten | Springer |

| **Useful Links** |
|---|
| https://nptel.ac.in/courses/112/105/112105271/ |

| Title of the Course: Nuclear Engineering<br>Course Code: 25MHP1104A | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | -- | - | 3 |

**Course Prerequisite:** Heat and Mass Transfer

**Course Description:**

This course introduces the fundamental principles and applications of nuclear engineering. Topics include nuclear reactions, radioactivity, neutron interactions, nuclear fission and fusion, reactor physics, and the design and operation of nuclear reactors. The course also covers key aspects of nuclear fuel cycles, radiation shielding, safety analysis, and nuclear waste management.

**Course Objectives:**

1. Demonstrate the basic concepts and processes taking place inside a nuclear reactor, such as nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.
2. The student will also be familiar with concepts of reactor criticality, the relationship.
3. The student will also be familiar with Time dependent (transient) behavior of power reactor in non-steady state operation and the means to control the reactor.
4. The student will also be familiar with concepts of heat removal from reactor core, reactor safety and radiation protection.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | Understand the fundamentals of nuclear fission, radioactivity, nuclear reactions, and power generation in reactors. |
| CO2 | Apply neutron transport and diffusion theories to evaluate neutron behavior in various reactor systems. |
| CO3 | Analyze multi-group and multiregional diffusion equations and assess reactor criticality conditions. |
| CO4 | Interpret reactor kinetics and control concepts to study time-dependent behavior of reactors under transient conditions. |
| CO5 | Evaluate heat transfer from reactor core, critical heat flux, reactor safety, and radiation protection strategies. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | | | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | | | | | | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | | | | | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 2 | 3 | | | | 2 |

**Assessment Scheme:**

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%,30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| CA2 | 10 |
| MSE | 30 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.

**MSE** is based on 50% of course content.

**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

**Course Contents**

| Unit No. | Unit Title and Contents | Hours |
|---|---|---|
| 1 | **Basics of nuclear fission and power from fission**<br>Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding. | **08** |
| 2 | **Neutron transport and diffusion**<br>Neutron transport equation, diffusion theory approximation, Fick's law, solutions to diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down. | **08** |

| | | |
|---|---|---|
| 3 | **Reactor**<br>Multigrain, multiregional diffusion equation, concept of criticality Solution of multigrain diffusion equations in one region and multiregional reactors, concept of criticality of thermal reactors. | **08** |
| 4 | **Reactor kinetics and control**<br>Derivation of point kinetics equations, in hour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients. | **08** |
| 5 | **Reactor kinetics and control**<br>Derivation of point kinetics equations, in hour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients. | **08** |

**Text Book**

| Sr.No. | Title | Author | Publisher |
|---|---|---|---|
| 1 | Introduction to Nuclear Engineering | John R. Lamarsh, Anthony J. Barrata | Prentice Hall |

**Reference Books**

| Sr.No. | Title | Author | Publisher |
|---|---|---|---|
| 1 | Introduction to Nuclear Reactor Theory | John R. Lamarsh | Addison-Wesley |
| 2 | Nuclear Reactor Analysis | Dr. Meherwan P. Boyce, P.E | Wiley |

| Useful Links |
|---|
| https://nptel.ac.in/courses/112/103/112103243/ |
| https://nptel.ac.in/courses/112/101/112101007/ |

| Title of the Course: Design of Thermal Turbo Systems<br>Course Code: 25MHP1104B | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | -- | - | 3 |

**Course Prerequisite:** Thermodynamics, Fluid Mechanics, Heat Transfer, Mechanical Design

**Course Description:**
This course provides a comprehensive study of the design, analysis, and performance optimization of thermal turbo systems, including gas turbines, steam turbines, turbochargers, and jet engines. Emphasis is placed on thermodynamic cycle analysis, component-level performance (compressors, turbines, combustion chambers, and nozzles), and system integration for various applications such as aerospace, power generation, and automotive industries.

**Course Objectives:**

1. Recognize typical designs of turbo machines and Explain the working principles of turbomachines and apply it to various types of machines.
2. Determine the velocity triangles in turbomachinery stages operating at design and off-design conditions.
3. Perform the preliminary design of turbomachines ( Fans compressors ) on a 1-D basis.
4. Use design parameters for characterizing turbomachinery stages and determine the off-design behavior of turbines and compressors and relate it to changes in the velocity triangles • Explain and understand how the flow varies downstream of a turbomachinery blade row.
5. Recognize relations between choices made early in the turbomachinery design process and the final components and operability.
6. Explain the limits of safe operation of compressors.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | Describe types and working principles of turbomachines. |
| CO2 | Explain fluid dynamic principles and flow through turbomachines. |
| CO3 | Apply dimensional analysis and performance relations to turbomachines. |
| CO4 | Analyze the design and performance of axial and centrifugal compressors. |
| CO5 | Evaluate performance of axial fans and propellers for industrial applications |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | 1 |
| **CO2** | 3 | 3 | | | 2 | | | | | | 1 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | | | | | | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | | | | | 2 |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 2 | | | | | 2 |

**Assessment Scheme:**
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%,30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| CA2 | 10 |
| MSE | 30 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.
**MSE** is based on 50% of course content.
**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

**Course Contents**

| Unit No. | Unit Title and Contents | Hours |
|---|---|---|
| 1 | **Introduction to Turbomachines:** Turbines Pumps and Compressors Fans and Blowers Compressible Flow Machines Incompressible Flow Machines Turbine, Compressor and Fan Stages Extended Turbomachines Axial Stages Radial Stages Mixed Flow Stages Impulse Stages Reaction Stages Variable Reaction Stages Multistage Machines Stage Velocity Triangles Design Conditions Off-design Conditions Applications. | **08** |

| | | |
|---|---|---|
| 2 | **Fluid Dynamic Principles:**<br>Equations of Motion (in Cartesian, Cylindrical and Natural Coordinate system) Further notes on Energy Equation, Isentropic Flow through Blade passages, High speed flows, Aero foil Blades. | **08** |
| 3 | **Dimensional Analysis and Performance Parameters**:<br>Units and Dimensions, Buckingham's Pi theorem, Principle of similarity, Incompressible flow machines, Compressible flow machines, Performance of Compressors, Fans and Blowers. | **08** |
| 4 | **Compressor:**<br>Axial and Centrifugal compressor, Elements of centrifugal compressor stage, stage velocity triangles, Enthalpy – Entropy diagram, Stage losses and Efficiency, Performance characteristics. | **08** |
| 5 | **Axial Fans and Propellers:**<br>Fan Applications, Axial fans, Fan stage parameters, types of Axial fan stages, Propellers, Performance of Axial Fans. | **08** |

| **Text Book** | | | |
|---|---|---|---|
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | Turbines, Compressors and Fans | S M Yahya | McGraw Hill Publication |
| 2 | Principles of Turbomachinery | Shepherd, D.G | Macmillan |
| | | | |
| **Reference Books** | | | |
| **Sr.No.** | **Title** | **Author** | **Publisher** |
| 1 | Fans | J Bruneck | Pergamom Press |
| 2 | Handbook of Turbomachinery | Earl Logan, Jr | Marcel Dekker Inc |
| 3 | Fluid Mechanics and Thermodynamics of Turbomachinery | Dixon, S.I | Pergamon Press |

| Title of the Course: Gas Turbines<br>Course Code: 25MHP1104C | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | -- | - | 3 |

**Course Prerequisite:** Thermodynamics, Fluid Mechanics

**Course Description:**
This course offers an in-depth exploration of gas turbine engines, covering their thermodynamic principles, design considerations, and performance characteristics. It focuses on the application of gas turbines in aerospace propulsion, power generation, and industrial processes. Students will study the ideal and real thermodynamic cycles, component-level analysis (compressors, combustion chambers, turbines, and nozzles), and the integration of these components into efficient and high-performance systems.

**Course Objectives:**

1. To enable the students to analyze and solve gas turbine related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to gas turbine systems.
3. To train students with effective communication skills to demonstrate gas turbine theories.
4. To develop skills in the analysis of gas turbine systems in research or design.
5. Recognize relations between choices made early in the turbomachinery design process and the final components and operability.
6. To develop a professional approach to lifelong learning in the gas turbine to include the awareness of social and environment issues associated with engineering practices.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| **CO1** | Explain the role of key components such as the compressor, combustor, and turbine in a gas turbine engine. |
| **CO2** | Apply knowledge of mathematics, science, and engineering for designing gas turbine systems. |
| **CO3** | Analyze different gas turbine systems and their characteristics. |
| **CO4** | Evaluate the performance of gas turbine systems under various operating conditions. |
| **CO5** | Design the configuration and operation of axial and centrifugal compressors in turbomachinery applications. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | - | - | - | - | - | - | 1 |
| **CO2** | 3 | 3 | 3 | - | 2 | - | - | - | - | - | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | - | - | - | - | - | 2 |

**Assessment Scheme:**

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%,30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| CA2 | 10 |
| MSE | 30 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.

**MSE** is based on 50% of course content.

**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

| Course Contents | | |
|---|---|---|
| **Unit No.** | **Unit Title and Contents** | **Hours** |
| 1 | **Gas Turbine Plant:**<br>Historical review. Thermodynamic analysis of practical gas turbine cycles. The turboprop engine. The compressor, combustor, turbine and exhaust nozzle characteristics. Performance characteristics of the stationary and turboprop and turbojet engine. The turbojet engine components. Specific thrust and overall efficiency. Static and flight performance at the design point. Fundamentals of rotating machines. Impulse and reaction machines. The centrifugal compressor: Works done and pressure rise. Design of centrifugal compressor, surge & stall. | **08** |

| | | |
|---|---|---|
| 2 | **Centrifugal Compressors:**<br>Principal of operation, work done and pressure rise. Vane-less space, slip factor, power input factor and Mach number at intake to impeller. | **08** |
| 3 | **Axial Flow Compressor:**<br>Principle of operation, velocity triangles. Design procedure for single and multistage compressors. Three dimensional effect compressor performance. Description and problems of transonic and supersonic compressors. | **08** |
| 4 | **Combustion in Gas Turbine:**<br>Problem to be faced in the design of gas turbine combustion systems. Fuel injection system. Combustion chamber designs. Pressure loss. Temperature distribution, Reaction time, Flame stabilization. | **08** |
| 5 | **Turbine Characteristics:**<br>Off design performance of gas turbine plant, matching of the engine components, equilibrium running diagram. Specific thrust and specific fuel consumption in such cases for stationary turbojet and turboprop units. | **08** |

**Text Book**

| **Sr.No.** | **Title** | **Author** | **Publisher** |
|---|---|---|---|
| 1 | Gas Turbine | V. Ganesan | Tata McGraw-Hill Education |

**Reference Books**

| **Sr.No.** | **Title** | **Author** | **Publisher** |
|---|---|---|---|
| 1 | Gas Turbine | Cohan, Rogers | Person |
| 2 | Gas Turbine Engineering | Dr. Meherwan P. Boyce, P.E | CRC press |
| 3 | Handbook of Turbomachinery | Earl Logan | CRC press |

**Useful Links**

https://nptel.ac.in/courses/112/103/112103262

| Title of the Course: **Design of Hydro Turbo machines**<br>**Course Code: 25MHP1105A** | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | -- | - | 3 |

**Course Prerequisite:** Preliminary knowledge of **Fluid Mechanics**, **Engineering Thermodynamics**, and **Machine Design.**

**Course Description:**
This course introduces the fundamental principles and advanced design concepts of **hydrodynamic machines**, including both **pumps and turbines**. It covers the classification, theory, and performance of impulse and reaction turbines, centrifugal and axial flow pumps, and cavitation phenomena. Detailed procedures for the **hydraulic and mechanical design** of pump impellers, volutes, diffusers, turbine runners, and guide vanes are presented. Emphasis is placed on velocity triangles, blade geometry on various flow surfaces, and practical design guidelines for **Francis** and **Kaplan turbines**, as well as mixed and axial flow pumps.

**Course Objectives:**

1. To enable the students to analyze and solve hydrodynamic machine related problems by applying principles of mathematics, science and engineering.
2. To prepare students to handle various strategic issues related to hydrodynamic machines such as turbines, pumps etc.
3. To train students with effective communication skills to demonstrate hydrodynamic theories.
4. To develop skills in designing the hydrodynamic machine component.
5. To develop a professional approach to lifelong learning in the hydrodynamic machine to include the awareness of social and environment issues associated with engineering practices.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| **CO1** | **Describe** different types of hydrodynamic machines and their components. |
| **CO2** | **Apply** knowledge of mathematics, science, and engineering to design hydrodynamic machines. |
| **CO3** | **Carry** out analysis and interpret the performance of turbines and pumps using appropriate techniques. |
| **CO4** | **Evaluate** the performance of hydrodynamic machines and justify design choices. |
| **CO5** | **Design** blade geometries and flow surfaces for centrifugal and axial flow machines using appropriate velocity and flow analysis. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | 1 |
| **CO2** | 3 | 3 | 3 | | 2 | | | | | | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | | | | | | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 2 | | | | | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | | | | | 2 |

**Assessment Scheme:**

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%,30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| CA2 | 10 |
| MSE | 30 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.

**MSE** is based on 50% of course content.

**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

| **Course Contents** | | |
|---|---|---|
| **Unit No.** | **Unit Title and Contents** | **Hours** |
| 1 | **Introduction to Hydrodynamic Machines**<br>Classification of turbines and various forms of turbine runners, Impulse turbines; general theory of impulse machines; performance characteristics, Reaction turbines; general theory of reaction machines; performance characteristics, types; Francis and Kaplan turbines; theory of cavitation flows in hydrodynamic runners. Hydrodynamic pumps; classification of pumps and various forms of pump impellers; general theory of centrifugal pumps; performance characteristics. | **08** |

| | | |
|---|---|---|
| 2 | **Design of centrifugal pumps**<br>Selection of speed, determination of impeller inlet and outlet dimensions, meridional geometry inlet and exit blade angles, blade geometry, mixed flow pumps, elementary pump, design of twisted blade, design of volute, vane diffuser and return passage, suction spiral. | **08** |
| 3 | **Axial Flow Pump Design and Analysis**<br>Axial flow pumps, selection of speed, pump casing geometry hub diameter, number of blades and cascade solidity, selection of blade geometry on different flow surfaces, diffuser design. | **08** |
| 4 | **Hydraulic Design of Reaction Turbines (Francis & Kaplan)**<br>Introduction to hydraulic turbine design, Type series and diameter series, selection of type and diameter, Reaction turbine runner spaces, meridional velocity field, elementary turbines, Hydraulic design of Francis turbine, Choice of basic parameters, Inlet and Outlet edges of runner blade, blade profiles on flow surfaces, shape of blade duct-velocity diagrams on different flow surfaces, certain guide lines to finalize the runner design, Guide wheel, Vane geometry and torque on controlling mechanism, Discharge and circulation, spiral, speed ring, draft tube. | **08** |
| 5 | **Hydraulic Design of Axial Flow Turbine Runners**<br>Hydraulic design of axial turbine runners, characteristics of some aero foils, meridional flow field, blade geometry on each flow surface, procedure to finalize the runner design. | **08** |

**Text Book**

| Sr.No. | Title | Author | Publisher |
|---|---|---|---|
| 1 | Hydraulic Turbine their Design and Equipment's | Nechleba M. | Constable & Co., 1957 |
| 2 | Impeller Pumps | Lazarkieniz & Troskolanrkis | Pergamon Press, 1st edition, 1965 |
| 3 | Hydraulic Engineering | Robinson J.A. | Jaico Publishing House, Bombay, 2nd Edition, 1998 |

**Reference Books**

| Sr.No. | Title | Author | Publisher |
|---|---|---|---|
| 1 | Design and Performance of Centrifugal & Axial flow pumps & Compressors | Andre Kovats | Pergamon, 1st edition, 1964 |

| | | | |
|---|---|---|---|
| 2 | Centrifugal & Axial Flow Pumps | Stapanoff, A.J. | John Wiley, Rev ed, 1993 |
| 3 | Hydroelectric Engineering Practice, Vol-I & II | Editor Brown, J.G. | 1st edition, 1958 |

| **Useful Links:** | |
|---|---|
| 1 | https://nptel.ac.in/courses/112/105/112105206/ |

| Title of the Course: **Air-Conditioning System Design**<br>**Course Code: 25MHP1105B** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| | **3** | **--** | **-** | **3** |

**Course Prerequisite:** Preliminary knowledge of **Thermodynamics**, **Heat Transfer**, and **Fluid Mechanics.**

**Course Description:**
This course focuses on the principles and applications of air conditioning systems with an emphasis on psychrometrics, load estimation, and air distribution. It covers moist air properties, psychrometric processes, use of charts and tables, SHF, RSHF, ERSHF, and system analysis for summer and winter air conditioning. Students will learn heating and cooling load calculations, including internal, solar, and infiltration loads.

**Course Objectives:**
1. To enable the students to analyze and solve air conditioning related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfil industrial needs related to low temperature systems.
3. To train students with effective communication skills to demonstrate air conditioning theories.
4. To develop skills in the analysis of air conditioning systems in research or design.
5. To develop a professional approach to lifelong learning in the air conditioning to include the awareness of social and environment issues associated with engineering practices.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| **CO1** | **Describe** the principles behind psychrometrics and how they influence air-conditioning system design. |
| **CO2** | **Apply** knowledge of mathematics, science, and engineering for solving air-conditioning system problems. |
| **CO3** | **Analyze** different air-conditioning systems and their performance characteristics. |
| **CO4** | **Evaluate** the performance of air-conditioning systems and interpret technical reports effectively. |
| **CO5** | **Design** air distribution and handling systems considering system balancing, thermal insulation, and equipment selection. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | 1 |
| **CO2** | 3 | 3 | 3 | | 2 | | | | | | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | | | | | | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 2 | | | | | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | | | | | 2 |

**Assessment Scheme:**

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%,30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| CA2 | 10 |
| MSE | 30 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.
**MSE** is based on 50% of course content.
**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

**Course Contents**

| Unit No. | Unit Title and Contents | Hours |
|---|---|---|
| 1 | **Psychometric.**<br>Moist Air properties, use of Psychometric Chart, Various Psychometrics processes, Air Washer, Adiabatic Saturation. Fundamental properties of air and water vapor mixtures. - Definitions, equations and explanations, psychometric table and charts, Enthalpy deviation curve, psychometric processes and their analysis, SHF, effective surface temperature and bypass factor. Air quality required. Analysis of combination of processes psychometric system. Load Analysis: Inside design conditions, outside design conditions, sensible heat load and latent heat loads, heat gains from infiltration ventilation, solar radiation from walls, occupants and other | **08** |

| | | |
|---|---|---|
| | sources. Heating load, Load estimation chart. | |
| 2 | **Summer and Winter Air Conditioning**<br>Air conditioning processes-RSHF, summer Air conditioning, Winter Air conditioning, Applications with specified ventilation air quantity- Use of ERSHF,<br>Application with low latent heat loads and high latent heat loads, performance and selection. | **08** |
| 3 | **Heating & Cooling Load Calculations**<br>Introduction, Health & comfort criteria, thermal comfort, air quality, estimating heat loss & heat gain, design conditions, thermal transmission, infiltration & ventilation loads, components of cooling load, internal loads, solar load through transparent surfaces, opaque surfaces, problems. Selection of components and system performance. | **08** |
| 4 | **Air Distribution**<br>Flow through Ducts, Static & Dynamic Losses, Air outlets, Duct Design–Equal Friction Method, Duct Balancing, Indoor Air Quality, Thermal Insulation, Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units.Guide wheel, Vane geometry and torque on controlling mechanism, Discharge and circulation, spiral, speed ring, draft tube. | **08** |
| 5 | **Air Handling Equipment's**<br>Fans, air conditioning apparatus, unitary equipment, accessory equipment, Classification – all air- system, air water system, heat recovery system, radiation panel system, heat pump, air washers. noise control. | **08** |

**Textbooks**

| Sr.No. | Title | Author | Publisher |
|---|---|---|---|
| 1 | Refrigeration & Air Conditioning | Manohar Prasad | New Age Publishers |
| 2 | Refrigeration & Air Conditioning | Stocker | McGraw Hill, 1992 |
| 3 | Refrigeration and Air-conditioning | Arora C.P. | Tata McGraw Hill, 1985 |
| 4 | Design of Thermal Systems | ARI | Prentice Hall, New Delhi, 1993 |
| 5 | Refrigeration & Air Conditioning | Stocker | McGraw Hill, 1992 |

| Reference Books | | | |
|---|---|---|---|
| Sr.No. | Title | Author | Publisher |
| 1 | Handbook of Air-Conditioning System Design | Carrier Incorporation | McGraw Hill Book Co., U.S.A, 1965 |
| 2 | ASHRAE Handbook: HVAC Systems and Equipment | — | ASHRAE, 1996 |
| 3 | Control Systems for Heating, Ventilation and Air-Conditioning | Hainer R.W. | Van Nostrand |
| 4 | Modern Air Conditioning | Norman C. Harris | McGraw-Hill, New York, 1974 |
| 5 | Air Conditioning Engineering | Jones W.P. | Edward Arnold Publishers Ltd., London, 1984 |

| Useful Links: | |
|---|---|
| 1 | https://youtu.be/e2IryaMQQ6A |
| 2 | https://youtu.be/YUgN5D-bmpg |
| 3 | https://youtu.be/Dj8ATzgrxyA |
| 4 | https://youtu.be/nvUhiXD63Eg |

| Title of the Course: Design of Solar and Wind System<br>Course Code: 25MHP1105C | L | T | P | Credit |
|---|---|---|---|---|
| | 3 | -- | - | 3 |

**Course Prerequisite:** Preliminary knowledge of **Thermodynamics**, **Fluid Mechanics**, and **Heat Transfer.**

**Course Description:**
This course provides a comprehensive overview of renewable energy sources with a primary focus on solar thermal and wind energy systems. It explores the global and Indian energy scenario, various solar thermal applications, solar collectors, and performance analysis techniques. The course also delves into the fundamentals of wind energy, wind turbine theory, and the design and classification of wind machines. Emphasis is placed on practical applications, performance evaluation, and the potential of these technologies in the Indian context.

**Course Objectives:**
1. To develop a comprehensive technological understanding in solar PV system components.
2. To provide in-depth understanding of design parameters to help design and simulate the performance of a solar PV power plant.
3. Learn principles and operational features of wind machines, wind data performance.

**Course Outcomes:**

| CO | After the completion of the course the student should be able to |
|---|---|
| CO1 | **Explain** the basics of solar energy conversion systems. |
| CO2 | **Apply** knowledge of solar irradiance and site assessment techniques to determine the feasibility of solar PV installations. |
| CO3 | **Analyze** a standalone photovoltaic (PV) system for performance and component selection. |
| CO4 | **Evaluate** different wind energy conversion systems, their characteristics, and feasibility in Indian energy context. |
| CO5 | **Design** and compare thermal and electrical solar collector systems for various energy applications. |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | - | - | - | - | - | - | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 2 | - | - | - | - | 2 |

**Assessment Scheme:**
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%,30% and 50% weightage respectively.

| Assessment Component | Marks |
|---|---|
| CA1 | 10 |
| CA2 | 10 |
| MSE | 30 |
| ESE | 50 |

**CA1** and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.
**MSE** is based on 50% of course content.
**ESE** is based on 100% course content with 60-70% weightage for course content covered after MSE.

| Course Contents | | |
|---|---|---|
| **Unit No.** | **Unit Title and Contents** | **Hours** |
| 1 | **Introduction to Global and Indian Energy Scenario**<br>Energy scenario, Man and energy, World's production of commercial energy sources, India's production and reserves, Energy alternatives, The solar energy option. | **08** |

| | | |
|---|---|---|
| 2 | **Solar Thermal Energy Applications**<br>Thermal applications, Water heating, Space heating, Space cooling and refrigeration, Power generation, Distillation, Drying and Cooking, Concentrating collector, Central receiver system. | **08** |
| 3 | **Solar Collectors and Performance Analysis**<br>Liquid flat plate collector, Performance analysis, Collection efficiency factor, Selective surfaces, Evacuated tube collector, BNL, Polymer and concrete collector, Solar air collector, types, performance analysis, Air heater with fins. | **08** |
| 4 | **Wind Energy Fundamentals**<br>Wind energy fundamentals and applications, Merits, Limitations, Nature and origin of wind, Wind turbine theory, Power of wind turbine for given incoming wind velocity Vi, Wind to electric energy conversion system. | **08** |
| 5 | **Wind Machines and Energy Utilization**<br>Classification and development of wind machines, Multi bladed type, Propeller type, wind machines, Wind data performance calculation, Concluding remarks, prospects of wind energy for India. | **08** |

**Text Book**

| Sr.No. | Title | Author | Publisher |
|---|---|---|---|
| 1 | Energy Technology – Nonconventional, Renewable & Conventional | S. Rao, Dr. B. B. Parulekar | Khanna Publishers |
| 2 | Solar Energy | S. P. Sukhatme and J. K. Nayak | McGraw Hill Education |
| 3 | Solar Power Engineering | B. S. Mangal | Tata McGraw Hill, New Delhi, 1990 |
| 4 | Wind Turbine Technology, Fundamentals of Concept in Wind Turbine Engg. | Spera D. A. (1994) | ASME eBook |

**Reference Books**

| Sr.No. | Title | Author | Publisher |
|---|---|---|---|
| 1 | Principles of Energy Conversion | Culp, Archie W. | McGraw Hill Book Company |

| | | | |
|---|---|---|---|
| 2 | Active Solar Collectors and Their Applications | Rabl, A. (1985) | Oxford University Press |
| 3 | Solar Engineering of Thermal Processes | John A. Duffie, W. A. Beckman | John Wiley and Sons Inc |
| 4 | Wind Energy Systems | Gary L. Johnson | Prentice Hall, New Jersey |
| 5 | Wind Energy Fundamentals, Resource Analysis and Economics | Sathyajith Mathew | Springer Verlag, Berlin |
| 6 | Electric Energy from Winds | Kloeffler R.G., Sitz E.L. (1946) | Kansas State College of Engg., Manhattan, Kans |

| **Useful Links:** | |
|---|---|
| 1 | https://nptel.ac.in/courses/103/103/103103206/ |