
Semester I
Professional core : 3 subjects 12 credits (4 credits each)
Elective: 2 subjects 6 credits (3 credits each)
Sessionals/ Laboratory: 1 or 2 nos. 4 credits
Pre-thesis work and seminar 2 credits
Total 24 credits

Semester II
Professional core : 2 subjects 8 credits (4 credits each)
Elective: 3 subjects 9 credits (3 credits each)
Sessionals/ Laboratory : 1 or 2 nos. 4 credits
Pre-thesis work and seminar 2 credits
Comprehensive viva voce I 2 credits
Total 25 credits

Semester III
Thesis part I 14 credits
Open elective 3 credits
Total 17 credits

Semester IV
Thesis part II 20 credits
Seminar 2 credits
Comprehensive viva voce II 2 credits
Total 24 credits

Total 90 credits
# M.Tech in Thermal Engineering / Heat Power Engineering

## Semester 1

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Subject</th>
<th>L – T – P</th>
<th>Credits</th>
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<tbody>
<tr>
<td>HTPC101</td>
<td>Advanced Fluid Mechanics</td>
<td>3 – 1 – 0</td>
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<tr>
<td>HTPC102</td>
<td>Advanced Heat Transfer – I (Conduction &amp; Radiation)</td>
<td>3 – 1 – 0</td>
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<td>HTPC103</td>
<td>Advanced Refrigeration Engineering</td>
<td>3 – 1 – 0</td>
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<td>Elective – I (Any One):</td>
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<td>HTEP101</td>
<td>Internal Combustion Engines</td>
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<td>HTEP102</td>
<td>Energy Conservation and Management</td>
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<td>HTEP103</td>
<td>Gas Dynamics</td>
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<td>HTEP104</td>
<td>Hydel Power and Wind Energy</td>
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<td>Elective – III (Any One):</td>
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<tr>
<td>HTEP105</td>
<td>Solar Energy Technology</td>
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<td>HTEP106</td>
<td>Thermal and Nuclear Power Plants</td>
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<td>HTEP107</td>
<td>Renewable Energy Systems</td>
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<td>HTEP108</td>
<td>Design of Thermal Systems</td>
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<td>Sessionals / Practicals</td>
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## Semester 2

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<th>Subject</th>
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<tr>
<td>HTPC201</td>
<td>Advanced Engineering Thermodynamics</td>
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<td>HTPC202</td>
<td>Advanced Heat Transfer – II (Convective Heat and Mass Transfer)</td>
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<td>Elective – III (Any One):</td>
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<td>HTEP201</td>
<td>Computational Fluid Dynamics</td>
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<td>HTEP202</td>
<td>Computational Methods in Thermal Engineering</td>
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<td>HTEP203</td>
<td>Experimental Methods in Thermal Engineering</td>
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<td>HTEP204</td>
<td>Heat Exchanger Analysis and Design</td>
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<td>Elective – IV (Any One):</td>
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<td>HTEP205</td>
<td>Theory of Combustion and Emission</td>
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<td>HTEP206</td>
<td>Air Conditioning and Ventilation Systems</td>
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<td>HTEP207</td>
<td>Gas Turbine and Jet Propulsion</td>
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<td>HTEP208</td>
<td>Boiling, Condensation and Two-phase Flow</td>
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<td>Elective – V (Any One):</td>
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<td>HTEP209</td>
<td>Cryogenic Technology</td>
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<td>HTEP210</td>
<td>Aircraft and Rocket Propulsion</td>
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<td>HTEP211</td>
<td>Power Plant Practice and Control</td>
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<td>HTEP212</td>
<td>Finite Element Methods in Thermal Engineering</td>
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### Semester 3

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<th>Contact Hours</th>
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<td>1.</td>
<td><strong>Open Elective (Any one)</strong></td>
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<td>Research Methodology</td>
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<td>Design of Experiments</td>
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<td>Project Management and Costing</td>
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<td>Soft Computing</td>
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<td>Thesis Part I</td>
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### Semester 4

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<td>HTPT401</td>
<td>Thesis Part II (Presentation and Evaluation)</td>
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<td>HTCV401</td>
<td>Seminar</td>
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<td>HTCV402</td>
<td>Comprehensive Viva-Voce II</td>
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**Total Credits: 90**
Advanced Fluid Mechanics

Module I
Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential.

Module II

Module III

Books:
Advanced Fluid Mechanics, Som and Biswas, Tata McGraw Hill
Fluid Mechanics, A.K.Mohanty
Fundamentals of Fluid Mechanics, Schlitching
Introduction to Fluid Mechanics, Shaughnessy, Oxford University Press
Advanced Heat Transfer–I (Conduction & Radiation)

Module I

Conduction; Derivation of generalized conduction equation for anisotropic inhomogeneous solids, conductive tensor, concepts of isotropic and homogeneous conductivity. ; Steady state conduction: Recapitulation of fundamentals analysis and design variable and cross section and circumferential fins. Analysis of heat conduction in 2-D fins, 2-D and 3-D conduction in solids with complex boundary conditions and heat generation. ;

Module II


Module III


Books
V.S Arpaci – *Conduction Heat Transfer*
E.M Sparrow, R.D Cess – *Radiation Heat Transf*
R.Siegal and J.R Howell-*Thermal radiation heat transfer.*
Y.A.Sengel, Heat Transfer, Tata McGrawHill
Krith, Fundamentals of Heat Transfer
Ozisik, Heat Transfer, John Wiley
Advanced Refrigeration Engineering

Module I
Analysis of refrigeration cycle, principles of psychrometry properties and processes, Air washer, Cooling towers, dehumidifiers, wet bulb and dew point temperatures. Multistage cycle and their optimization.

Module II

Module III
Analysis and thermal design of Refrigeration compressor, condenser, evaporator and flow control devices; Design, Lubrication, charging and testing of refrigeration plants, defrosting capacity control, system component balancing, Design and construction details of unitary refrigeration equipment.

Books
*Refrigeration and Air Conditioning, C.P.Arora, Tata McGraw Hill*
*Refrigeration and Air Conditioning, Stoecker and Zones, McGraw Hill*
*Refrigeration and Air Conditioning, Domkundwar and Arora, Dhanpat Rai and Sons*
*Refrigeration and Air Conditioning, Manohar Prasad, East West Press*
*Refrigeration and Air Conditioning, P.L.Balaney*
Module I

Module II

Module III

Books
I.C. Engine, Mathur and Sharma, Dhanpat Rai and Sons
Energy Conservation and Management

Module I

Significance and Scope of Energy conservation and Management, Basic principles and total energy concept, First law optimization, availability. Exergy analysis. Second law optimization of thermal systems.

Module II


Module III

Energy sources, Classification and characterization of fuels (fossil and bio-fuel), conversion and utilization, environmental and economic issues, optimum use of energy resources, Thermodynamic cycles, Principles of thermal energy conversion in boilers, internal combustion engines and gas turbines, cogeneration and combined cycle power generation, fuel cells and MHD technology, solar, wind and nuclear power, utilization of industrial heat, Energy management in industry, Environmental and economic evaluation advanced pollution control technology.

Book


V. Kadambi, and M. Prasad, Introduction to energy conversion turbo machinery: Energy conversion cycle- Wiley Eastern, New Delhi, 1974,
Gas Dynamics

Module I:
Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations ; Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number;

Module II:
Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves ; Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers ; Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line ;

Module III:
Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction ; Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point ; Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

Text Books

References
Hydel Power and Wind Energy

Module I:
Elements of hydropower scheme, hydropower development in India. Power house structures and Layout. Hydropower plants classification: Surface and underground power stations, Low- medium-high head plants-layout and components, pumped storage plants. Load and power studies: load curve, load factor, load duration curve, firm capacity, reservoir capacity, capacity factor

Module II:
Hydraulic turbines and types and classification, constructional features, selection, characteristic curves, governing of turbine, drafts tubes-types, hydraulic principles. Gates and valves types. Penstock and surge tanks. Wind machine types, classification, parameters. Wind measurements, data presentation, power in the wind. Wind turbine aerodynamics, momentum theories, basic aerodynamics, airfoils and their characteristics

Module III:
Horizontal Axis Wind Turbine (HAWT) - Blade Element Theory, wake analysis, Vertical Axis Wind Turbine (VAWT) aerodynamics. HAWT rotor design considerations, number of blades, blade profile, 2/3 blades and teetering, coning, power regulation, yaw system, tower. Wind turbine loads, aerodynamic loads in steady operation, wind turbulence, static - dynamic - fatigue analysis, yawed operation and tower shadow, WECS control system, requirements and strategies. Wind Energy Conversion System (WECS) siting, rotor selection, Annual Energy Output (AEO). Synchronous and asynchronous generators and loads, integration of wind energy converters to electrical networks, inverters. Testing of WECS.

Text Books
Water Power Engineering: M.M.Desmukh, Dhanpat rai and Sons

Reference Books
Water power Development : Mosonyi
Davis’ Handbook of applied hydraulics : Zipparro, V. J. and Hasen H., Mc-GrawHill, Inc.,
Hydropower structures : R.S.Varshiray, Nem Chand and Bros. Roorkee
Water Power Engineering: M.M.Dandekar and K.N.Sharma, Vikas Pub
Elective II

Solar Energy Technology

Module I

Module II
Simulations, design methods. System design and optimizations. Solar thermal systems applications to power generation, heating and cooling.

Module III
Solar passive devices solar stills, ponds, greenhouse, dryers. Trombe wall, overhangs and winged walls. Wind energy conversion systems. Economics of solar and wind energy systems.

Text Books

References
Thermal and Nuclear Power Plants

**Module I:**

**Module II:**

**Module III:**

**Text Book:**


**Reference**


Renewable Energy Systems

Module I

Module II
Hot water system, practical consideration, solar ponds, Non-convective solar pond, extraction of thermal energy and application of solar ponds. Wind energy: The nature of wind. Wind energy resources and modeling. Geothermal energy: Origin and types of geothermal energy and utilization.

Module III

Books

Reference
Design of Thermal Systems

Module I
Modeling of Thermal Systems: types of models, mathematical modeling, curve fitting, linear algebraic systems, numerical model for a system, system simulation, methods for numerical simulation;

Module II
Acceptable Design of a Thermal System: initial design, design strategies, design of systems from different application areas, additional considerations for large practical systems; Economic Considerations: calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design, application to thermal systems;

Module III
Problem Formulation for Optimization: optimization methods, optimization of thermal systems, practical aspects in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems; search methods: single-variable problem, multivariable constrained optimization, examples of thermal systems; geometric, linear, and dynamic programming and other methods for optimization, knowledge-based design and additional considerations, professional ethics.

Text Books

References


Advanced Thermodynamics


Essential Readings:

Supplementary Reading:
Advanced Heat Transfer-II (Convective Heat & Mass Transfer)


Essential Readings:

Supplementary Reading:
Computational Fluid Dynamics

Introduction: Basic tools of CFD, Numerical Vs experimental tools. ; Mathematical Behavior of PDEs: Parabolic, Hyperbolic and Elliptic PDEs. ; Methodology of CFDHT: Discrete representation of flow and heat transfer domain: Grid generation, Governing equations and boundary conditions based on FVM/FDM, Solution of resulting set of linear algebraic equations, Graphical representation and analysis of qualitative results, Error analysis in discretization using FVM/FDM. ; Solution of 1-D/2-D steady/unsteady: Diffusion problems, Convection problems, Convection-diffusion problems, source term linearization. ; Explicit and Implicit Approach: Explicit and implicit formulation of unsteady problems, Stability analysis. ; Solution of Navier-Stokes Equations for Incompressible Flows: Staggered and collocated grid system, SIMPLE and SIMPLER algorithms. ; Special Topics in CFDHT: Numerical Methodology for Complex Geometry, Multi-block structured grid system, Solution of phase change Problems.

Essential Reading:

Supplementary Reading:
Computational Methods in Thermal Engineering


Finite Difference Method: Classification, Initial and Boundary conditions, Forward, Backward difference, Uniform and non-uniform Grids, Grid Independence Test. Basic finite difference schemes. Boundary treatments. Fourth order RK methods and Predictor-corrector methods and Nachshem-Swigert iteration with applications to flow and heat transfer.


Convection dominated problems: The failure of standard discretization, Upwinding and Higher order methods.

Supplementary Reading(s):
Heat Exchange Analysis & Design


Essential Reading:

Supplementary Reading:
Theory of Combustion & Emission

UNIT 1. CYCLE ANALYSIS: Gas, steam and combined power cycles, refrigeration and air conditioning cycles, second law analysis.

UNIT 2. COMBUSTION THEORY: Fuels and types, combustion process, combustion mechanism, adiabatic flame temperature, flame propagation, stability, kinetics, combustion aerodynamics, gaseous detonations, flame ignition and extinction and condensed phase combustion, combustion in SI and CI engines, ignition and burning rate analysis.

UNIT 3. COMBUSTION SYSTEMS: Solid burning equipments, stokers, pulverized coal burning systems, cyclone combustors, emissions, types of fluidized beds, fluidized bed combustion, fundamentals bubbling bed, gas and liquid burners types, gas turbine combustion systems, combustion modeling.

UNIT 4. DESIGN OF COMBUSTION SYSTEMS: Design of combustion systems for boilers, furnaces, gas turbines and internal combustion engines, combustion chamber performance.

UNIT 5. PROPELLANT SYSTEMS: Types, theory of combustion, energy balance calculations.

Supplementary Reading(s):
Air Conditioning & Ventilation Systems


Supplementary Reading(s):

Gas Turbine & Jet Propulsion

Introduction, application, shaft power gas dynamics – Compressibility effect, steady one dimensional compressible flow of a perfect gas in a duct, isentropic flow in a constant area duct with friction, normal shock waves, oblique shock wave, isentropic two dimensional, supersonic expansion and compression.; Centrifugal fans Blowers and Compressors: Principle of operations, work done and pressure rise, slip factor, diffusers, compressibility effects, non dimensional qualities for plotting compressor characteristics. Brayton cycle, regeneration and reheating cycle analysis; Axial flow fans and compressors: Elementary theory, degree of reaction, three dimensional flow, simple design methods, blade design, calculation of stage performance, overall performance, and compressibility effects. Performance characteristics.; Combustion system: Form of combustion, important factors affecting combustion chamber design, combustion processes, combustion chamber performance, practical problem.; Axial flow turbines: elementary theory, vortex theory, choice of blade profile, pitch and chord; estimation of stage performance, he cooled turbine.; Prediction of performance of simple gas turbines: component characteristic, off design shaft gas turbine, equilibrium running gas generators, off design free turbine and jet engine, methods of displacing the equilibrium, running line, incorporation of variable pressure losses, methods of improving part load performance, matching procedure for twin spool engines, behavior of gas turbine .Gas turbine rotors and stresses.

Supplementary Reading:
1. J.E Lee, Theory and design of stream and gas turbine.
2. Cohen & Rogers, Gas Turbines
Cryogenic Technology


Essential Reading:

Supplementary Reading:
Aircraft & Rocket Propulsion


Supplementary Reading:
HTPE211 POWER PLANT PRACTICE AND CONTROL


Environmental impacts of energy use-Air pollution –SOX, NOX, CO, particulates solid and water pollution formation of pollutants measurement and controls; sources of emission effect of operating and design parameters on emission ,control method, exhaust emission test, procedure standards and legislation; environmental audits; emission factors ad inventories Global warming, CO₂ emission, impacts, mitigation sustainability, externalities, future energy Systems.

BOOKS: