M. Tech. DEGREE

THERMAL POWER ENGINEERING

SYLLABUS FOR CREDIT BASED CURRICULUM (2009 -2010)

DEPARTMENT OF MECHANICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015, INDIA.
The total credits required for completing the M.Tech. Programme in Mechanical Engineering is 61

**SEMESTER I**

<table>
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**Total Credit** 61
M.Tech. (Thermal Power Engineering)

LIST OF ELECTIVES

SEMESTER I

ELECTIVE – I

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SEMESTER II

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MA 609 MATHEMATICAL METHODS (3 – 0 – 0) 3
Calculus of variations - Euler's equation - Variational problems in parametric form - Natural boundary condition – Conditional Extremum - Isoperimetric problems.


Integral equations - Conversion of BVP to integral equations using Green’s Function - Fredholm equation with separable kernels – Solution of Fredholm and Volterra equations by the method of Successive approximations.

Finite difference scheme for elliptic, parabolic, and hyperbolic partial differential equations.

Introduction to Finite Element Method - Rules for forming interpolation functions - Shape functions Application to fluid flow and heat transfer problems.

References

ME 601 FUELS, COMBUSTION, AND EMISSION CONTROL (3 – 0 – 0) 3

Chemical kinetics - Important chemical mechanisms - Simplified conservation equations for reacting flows - Laminar premixed flames - Simplified analysis.

Factors influencing flame velocity and thickness flame stabilization - Diffusion flames - Introduction to turbulent flames.

FBC - Different types of FBCs - Models for droplet and Carbon particle combustion.

Emissions - Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed combustion.

References
ME 603 ADVANCED FLUID MECHANICS (3 – 0 – 0) 3

Review of Basic concepts- Reynold’s transport theorem, Fluid kinematics - Physical conservation laws - Integral and differential formulations.

Navier-Stokes and energy equations - Dimensionless forms and dimensionless numbers - Solution of Navier-Stokes equations.


Turbulent flows - Reynold’s equation - Prandtl and von Karman hypothesis- Universal velocity profile near a wall- flow through pipes

Boundary layer concept- Boundary layer thickness- prandtl’s equations-blassius solution-skin friction coefficient.

References

ME 605 ADVANCED HEAT TRANSFER (3 – 0 – 0) 3

Transient heat conduction - Exact solution - Use of Heisler and Grober chart-Integrated method.

Extended surfaces - Steady state analysis and optimization-Radial fins of rectangular and hyperbolic profiles- longitudinal fin of rectangular profile radiating to free space.

Thermal boundary layers - Momentum and energy equations -Internal and external flows- Forced convection over cylinders, spheres and bank of tubes.


Radiative exchange in furnaces-Radiation characteristics of particle systems, Thermal radiation of a luminous fuel oil and gas- Soot flame- overall heat transfer in furnaces.

References

ME 607 ANALYSIS OF THERMAL POWER CYCLES (3 – 0 – 0) 3

Steam power plant cycle - Rankine cycle - Reheat cycle - Regenerative cycle with one and more feed heaters - Types of feed heaters - Open and closed types - Steam traps types.
Cogeneration - Condensing turbines - Combined heat and power - Combined cycles - Brayton cycle Rankine cycle combinations - Binary vapour cycle.

Air standard cycles - Cycles with variable specific heat - fuel air cycle - Deviation from actual cycle.

Brayton cycle - Open cycle gas turbine - Closed cycle gas turbine - Regeneration - Inter cooling and reheating between stages.

Refrigeration Cycles - Vapour compression cycles - Cascade system - Vapour absorption cycles - GAX Cycle.

References

ME 602 FLUID MECHANICS OF TURBOMACHINES (3 – 0 – 0) 3


Power generating machine I - Axial flow turbines- Stage losses and efficiency – Soderberg’s correlation – Turbine flow characteristics


Power absorbing machine II - Centrifugal pumps, fans, and compressors – slip factor – optimum design of centrifugal compressor inlet choking in a compressor stage.

Power generating machine II - Radial flow turbines, Loss coefficients – off design operating condition – clearance and windage losses 90 deg IFR turbines.

References

ME 604 INSTRUMENTATION (3 – 0 – 0) 3


Static and dynamic characteristics of instruments zero order, first order, second order instruments.
Error analysis - Uncertainty propagation – Oscilloscope for analysis of dynamic and transient events.

Principles and analysis of measurement systems used for measurement of flow, power, pressure, and temperature.

Basics of control system - Types of control – proportional control, Derivative control, Integral control, PID control-Programmable logic controllers.

References

PRACTICAL
Use of oscilloscope for measurement of dynamic parameters - PV diagram of compressors and IC engines - Comparison of flow measuring instruments - Measurement of static and dynamic characteristics of instruments.

ME 606 COMPUTATIONAL FLUID DYNAMICS (3 – 0 – 0) 3

Classification of partial differential equations - Discretization methods - finite difference and finite volume formulations – classification of PDES.

Numerical solution of elliptical equations - Linear system of algebraic equations – Iterative solution of system of linear equation.


Solutions of convection - Diffusion equation – Conservative and non-conservative schemes – concept of artificial viscosity and Numerical Diffusion.

Navier-Stokes equations and algorithms; Basics of grid generation- Numerical solution of hyperbolic equations - Burgers equation generation.

References

ELECTIVE - I

ME 631 ANALYSIS AND DESIGN OF PRESSURE VESSELS (3 – 0 – 0) 3

Establishment of design conditions – Fracture Mechanics – Heads, Basic shell thickness - Reinforcement of openings – Special components like flange, tube plate, supports.

Application of general analysis – Flat closure plates –conical heads and reducers – hemispherical and torispherical, ellipsoidal heads.

Development of cracks - Fracture mechanics - Corrosion - Selection of working stress for ductile and brittle materials.

Finite element analysis for high pressure and high temperature components.

**References**


**ME 633 ADVANCED IC ENGINES (3 – 0 – 0) 3**

Engine design and operating parameters – Thermo chemistry of fuel air mixtures- properties of working fluids.

Ideal model of engine cycles – cycle analysis with constant specific heats – Volumetric efficiency – Super charging and Turbo charging

Fuel intake systems and combustion in SI and CI engines – Carburetor an fuel injection systems – Squish prechamber engine flows.

Pollutant formation and control in IC engines - Types of diesel combustion system – Fuel spray behavior – Ignition delay.

Engine friction and lubrication – measurement of friction – fluid mechanics based multi dimensional models – Engine operating characteristics.

**References**


**ELECTIVES II, III & IV**

**ME 632 ENERGY CONSERVATION, MANAGEMENT, AND AUDIT (3 – 0 – 0) 3**


Energy Performance Assessment for Equipment and Utility systems -Boilers-Furnaces-Cogeneration, Turbines (Gas, Steam)- Heat Exchangers-Electric Motors and Variable Speed Drives-Fans and Blowers-Water Pumps-Compressors


Reference

ME 634 ADVANCED REFRIGERATION AND AIR CONDITIONING (3 – 0 – 0) 3

Actual vapor compression system - Multipressure vapour compression system - Environment friendly refrigerants – cascade system.

Absorption refrigeration system – Three fluid absorption system – comparison of absorption with compression system - Analysis of multistage systems

Advanced psychrometric calculations - Cooling load calculations – Determination of U factor – short method calculation


Room air distribution – Friction losses in ducts - Duct design, Air filters clean rooms – Air curtain

References

ME 636 BOILER AUXILIARIES AND PERFORMANCE EVALUATION (3 – 0 – 0) 3

Boiler types - Efficiency calculation - Balance diagram – Boiler start up calculations –Boiler turbine matching – Power Plant balance diagram


Feed pumps – Different types, Specifications, Operation and maintenance aspects - Fans, blowers – Applications – Performance requirements, Selection, Operation and maintenance.
Dust cleaning equipment – Selection criteria – Design, operation and maintenance of electrostatic precipitators, Bag filters.


**References**


**ME 638 HEAT TRANSFER EQUIPMENT DESIGN (3 – 0 – 0) 3**

Classification of heat transfer equipment - Design of shell and tube heat exchanger - Finned surface heat exchanger –Heat exchangers for special services – Fired heaters

Plate and spiral plate heat exchanger – plate heat exchanger for Dairy industry – Heat Pipes

Thermal design of heat exchange equipments such as Air pre-heaters , Economizer – Super heater and condensers.

Selection of compact heat exchangers.

Analysis and design of cooling towers.

**References**


**ME 640 TRIBOLOGY (3 – 0 – 0) 3**

Introduction - Tribology in design, Tribology in industry. Lubricants- Properties- physical and chemical, Types of additives, extreme pressure lubricants. Lubrication-introduction, basic modes of lubrication

Friction - friction measurement, theory of friction. Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theory of wear.

Gas Lubrication. Lubrication in metal working: Rolling, Forging, Drawing and extrusion.

Solid tribological coatings and materials, – surface treatments –surface modification processes. Tribological properties of metallic and ceramic coatings.

Surface topography measurements - Electron microscope and friction and wear measurements - Use of transducers and instruments in Tribology- film thickness measurement using modern techniques – Development of test rigs for Tribology research.
References

**ME 642 FINITE ELEMENT METHOD IN HEAT TRANSFER ANALYSIS (3 – 0 – 0) 3**

Introduction, Weighted Residual Methods, Shape functions, Coordinate systems, Numerical Integration.

Modeling of Heat Conduction, Variational Formulation, Galerkin’s Approach for one dimensional and two dimensional problems

Introduction – A one dimensional Problem solved using a single element – Linear element, Quadratic element, the use of numerical integration. A one dimensional problem solved using an assembly of elements.


Introduction, Basic Equations, Galerkin’s Methods for steady Convection – Diffusion problems, Upwind Finite Elements in One Dimension, Heat Transfer in fluid flow between parallel planes, Convection on melting and solidification.

**Laboratory Experiments**

1. Basic problems in Heat Transfer Analysis using ANSYS
2. 1D, 2D and 3D conduction field problems
3. Convection problems
4. Heat Transfer in Fluid Flow
5. Convection on Melting and Solidification

**References**


**ME 644 ALTERNATIVE FUELS FOR I.C ENGINES (3 – 0 – 0) 3**

Availability and Suitability to Piston Engines, Concept of conventional fuels, potential alternative fuels-Alcohol, Methanol, DEE/DME-Hydrogen, LPG, Natural gas, Producer gas, Bio-gas and vegetable oils-Use in IC engines-Merits and demerits of various fuels.


Atmospheric pollution from piston engines, Global warming, Pollutant Formation in IC Engines- Emission measurement-control of Engine pollution–driving cycles and Emission standards. Emission measuring instrumentation including HC, CO, NOx, smoke and particulates.

References

ME 671 ENVIRONMENTAL POLLUTION AND CONTROL (3 – 0 – 0) 3

Air pollution - Classification and properties of Air pollutants - Sampling and analysis of air pollutants –Control of air pollution.

Dispersion of air pollutants - Gaussian plume model- Control of gaseous pollutants - Volatile organic compounds - Control of gaseous emission - Air pollution laws and standards.

Water pollution - Sampling and analysis of waste treatment – Advanced waste water treatments by physical, chemical, biological and thermal methods - Effluent quality standards.

Solid waste management - Classification and their sources - Health hazards - Handling of toxic and radioactive wastes - Incineration and verification.

Pollution control in process industries namely Cement, Paper, Petroleum and petrochemical, Fertilizers and distilleries, thermal power plants and automobiles.

References