M.TECH. - THERMAL SCIENCES AND ENERGY SYSTEMS

Department of Mechanical Engineering

India is an energy starved country and per capita consumption of energy in India is one of the lowest in the world. India faces a formidable challenge in providing adequate and efficient energy supplies to users at a reasonable cost. It will be a great challenge to meet the energy demand, and producing it efficiently without polluting the environment. This programme is designed to enable the students to develop expertise in both theory and design of Thermal Systems, Energy Systems and Energy Management. They also acquire knowledge to design and develop micro/nano scale thermal systems. The students learn to simulate various fluid, thermal and energy systems using different computational tools and also do experiments to test various thermal and energy systems.

This programme offers many career options for the youngsters in both public and private sector involved in production of energy, design and production of thermal systems and energy systems. They will also get opportunities to join various Research and Development organizations.

CURRICULUM

First Semester

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Credits 14

Total Credits 65
# LIST OF COURSES

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## Subject Core

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**Project Work**

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16TE601

APPLIED HEAT TRANSFER 3-1-0-4


Radiation: Recapitulation of fundamentals of radiative heat transfer. Radiant energy transfer through absorbing, emitting and scattering media. Combined conduction and radiation systems.

TEXTBOOKS / REFERENCES:

TEXTBOOKS / REFERENCES:

16TE603 THERMAL POWER PLANT CYCLES AND SYSTEMS 3-0-0-3


TEXTBOOKS / REFERENCES:

16TE621 RENEWABLE ENERGY SYSTEMS 3-0-0-3

TEXTBOOKS / REFERENCES:

16TE625 ENERGY CONVERSION LAB 0-0-1-1

CI and SI engines test rigs, fluid machine test rigs, solar water heaters, biomass gasifier, waste heat recovery system, photovoltaic system, wind energy system, etc., wind tunnels, drag and lift measurements and verification using software.

16TE622 DESIGN AND OPTIMIZATION OF THERMAL SYSTEMS 3-0-0-3


TEXTBOOKS / REFERENCES:

16TE623   GAS TURBINES AND JET PROPULSION   3-0-0-3


TEXTBOOKS / REFERENCES:

16TE624   COMPUTATIONAL FLUID DYNAMICS   3-0-0-3


TEXTBOOKS / REFERENCES:
16TE626  THERMAL SCIENCE LAB  0-0-1-1

Heat transfer test rigs, nano and micro heat transfer test rigs, heat pipe systems, heat exchangers, refrigeration and air conditioning systems, fluidized bed system etc.

16TE627  COMPUTATIONAL LAB  0-0-1-1

Programming exercising for fluid flow and heat transfer using finite volume methods. Training on Commercial CFD Software.

16TE701  DESIGN OF HEAT EXCHANGERS  3-0-0-3

Introduction: Types, Classification of heat exchangers; Basic design methods for Recuperators and Regenerators: LMTD, effectiveness-NTU method; Forced convection correlations, pressure drop, fouling in heat exchangers; Double pipe heat exchangers: Thermal and Hydraulic design; Fundamentals of two phase heat transfer; Shell and Tube Heat exchangers: Basic design procedure, Kern method, Bell-Delaware method, stream analysis method; Heat exchanger Network (HEN) and process integration; Pinch design method; Design of Boilers, cooling towers, super heaters, Condensers; Compact Heat Exchangers; Process Fired heaters and furnaces; Thermodynamics of heat exchangers: Principles of Exergy analysis.

TEXTBOOKS / REFERENCES:

16TE702  MULTIPHASE FLOW  3-0-0-3

Introduction- multi phase and multi-component flow, practical examples; method of analysis of multi phase and multi-component flow problems; basic definitions; two phase, one-dimensional conservation equations; pressure gradient components; flow patterns, Two phase flow patterns in mini and micro-channels. Basic flow models – homogeneous flow model, pressure gradient, two phase friction factor for laminar flow and turbulent flow, two phase viscosity, friction multiplier; separated flow model – pressure gradient, Lokhart Martinelli correlation; Multidimensional two fluid model. Drift flux model – gravity dominated flow regime, corrections for void fraction and velocity distribution in different flow regimes, pressure loss due to multi phase flow in pipe fittings, velocity and concentration profiles in multi phase flow; one-dimensional waves in two component flow, void-quality correlations. Boiling and condensation – evaporation, nucleate boiling, convective boiling; bubble formation and limiting volume; boiling map; DNB; critical boiling conditions; static and dynamic instabilities, condensation process – types of condensation, Nusselt theory, deviations from Nusselt theory, practical equations, condensation of flowing vapors; introduction to boiling and condensation in small passages.

TEXTBOOKS / REFERENCES:

16TE703 FLUIDIZED BED SYSTEMS 3-0-0-3

Introduction to fluidized bed technology - Regimes of fluidized behavior - Heat transfer in fluidized bed - Residence time distribution and size distribution in fluidized bed – Heat transfer to immersed surfaces in fluidized and packed beds. Theory of fluidized bed combustion (FBC) - System design for combustion and gasification - Fluidized bed combustion systems for power plants - Air distribution design - Combustion efficiency - Start up and shut down - Combustion of coal in fluidized beds – Desulfurization of coal in fluidized bed - Use of wood and agricultural waste for fluidized bed combustion. Mathematical modeling of fluidization process - Multiphase models - Fluidized bed gasification systems - Production of gaseous fuels form coal in fast fluidized beds - Chemically active fluidized bed gasifier - Conversion of gas in bubbling beds - Entrainment and elutriation. Fluidized bed heat exchangers - Fluidized bed furnaces and boilers - Fluidized bed steam generator for liquid metal fast breeder reactor - Pressurized fluidized bed combustion boilers - Pressurized adiabatic and pressurized air tube fluidized bed combustion.

TEXTBOOKS / REFERENCES:

16TE704 NANO /MICRO HEAT TRANSFER 3-0-0-3

Introduction, Overview of Macroscopic Thermal Sciences, Elements of Statistical Thermodynamics and Quantum Theory, Statistical Mechanics of Independent Particles, Thermodynamic relations, Basic Quantum Mechanics, Emission and Absorption of photons by Molecules or Atoms, Energy-Mass- Momentum in terms of Relativity,

Kinetic Theory and Micro/Nan fluidics, Kinetic Description of Dilute Gases, Transport Equations and properties of Ideal Gases, the Boltzmann Transport Equation, Micro-Nano fluidics Heat Transfer,

Thermal Properties of Solids and the size effect, Specific heat of Solids, Quantum size effect on the specific heat, Electrical and Thermal Conductivities of solids, Thermoelectricity, Classical size effect on conductivities and Quantum conductance

Electron and Phonon Transport, The Hall effect, General classification of solids, Crystal structures, Electronic Band structures, Phonon dispersion and scattering, Electron emission and tunnelling, Electrical transport in semiconductor devices,

Nonequilibrium Energy Transfer in Nanostructures, Phenomenological theories, Heat Conduction across layered structures, Heat conduction regimes.

Fundamentals of Thermal radiation, radiative properties of semi-infinite media, Dielectric function models. Radiative properties of Nanomaterials, Radiative properties of a single layer, Radiative properties of a multilayer structures, Photonic crystals, Periodic gratings, BRDF,

TEXTBOOKS / REFERENCES:

16TE705 MICROSCALE THERMAL SCIENCES 3-0-0-3


TEXTBOOKS / REFERENCES:

16TE706 MEASUREMENTS IN THERMAL SYSTEMS 3-0-0-3

Generalized configuration and functional description of measuring instruments, generalized performance characteristics of instruments - static characteristics, dynamic characteristics, and Uncertainty analysis. Data logging and acquisition, use of intelligent instrument for error reduction, elements of micro-computer interfacing, intelligent instruments in use. Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of intelligent instruments for the physical variables. Chemical, Thermal, magnetic and optical gas analyzers, measurement of smoke, dust and moisture, gas chromatography, spectrometry. Shadowgraph, Schlieren, Interferometer, Laser-Doppler anemometer, heat flux measurement.

16TE707 EMERGING REFRIGERATION TECHNOLOGIES 3-0-0-3


TEXTBOOKS / REFERENCES:

16TE708 SOLAR ENERGY 3-0-0-3


TEXTBOOKS / REFERENCES:

TEXTBOOKS / REFERENCES:

TEXTBOOKS / REFERENCES:

16TE711 COMPRESSION FLOW 3-0-0-3

Conservation equations for inviscid flows, one dimensional flow – speed of sound, Mach number, normal shock relations, Hugoniot equation, one dimensional flow with friction and heat transfer, flow through variable area ducts, oblique shock waves and expansion waves, supersonic flow over wedges, cone, detached shock, regular reflection from solid boundary, intersection of shocks of same and opposite families, Prandtl-Meyer expansion waves, shock expansion theory. Unsteady wave motion – moving normal shock waves, reflected shock wave, incident and reflected expansion waves, shock tube relations. Linearised flow, critical Mach number. Transonic and Hypersonic flows, Properties of high temperature gases, high temperature flows – some basic examples.

TEXTBOOKS / REFERENCES:

16TE712 IC ENGINE COMBUSTION AND POLLUTION 3-0-0-3


**TEXTBOOKS / REFERENCES:**

**16TE713 FUEL TECHNOLOGY 3-0-0-3**


**TEXTBOOKS / REFERENCES:**

**16TE714 MICRO CHANNEL FLOW AND MIXING ANALYSIS 3-0-0-3**


**TEXTBOOKS / REFERENCES:**

ENERGY MANAGEMENT


TEXTBOOKS / REFERENCES:

ENERGY POLICIES FOR SUSTAINABLE DEVELOPMENT


Social cost benefit analysis - Computation of IRR and ERR - Advance models in energy planning – Dynamic programming models in integrated energy planning - Energy planning case studies -
Development of energy management systems - Decision support systems for energy planning and energy policy simulation.

TEXTBOOKS / REFERENCES:
4. “Annual Energy Planning Reports of CMIE” Govt. of India.