DETAILED SYLLABUS AND OTHER CONDITIONS FOR THE PROPOSED COURSE
M.TECH. THERMAL ENGINEERING

Schedule of Teaching				Schedule of Examination				
Lecture	Tutorials (per week)	Total		Time (Hrs.)	Theory Marks	Sessional Marks	Viva	Total
4	0	4	All theory subjects	4	100	50		150
			Project			50	50	100
			Seminar			100		100
			Dissertation			Satisfactory/not Satisfactory		

SEMESTER-I

TH-501	Advanced Mathematics
TH-502	Instrumentation & Measuring Systems
TH-503	Modelling, Simulation & Computer Applications.
TH-504	Advance Thermodynamics
TH-505	Advance Fluid Mechanics
TH-506	Lab-I

SEMESTER-II

TH-507	Advanced Heat Transfer
TH-508	Gas Turbines & Compressor
TH-509	Refrigeration & Air Conditioning Design
TH-	Elective-I
TH-	Elective-II
TH-517	Lab -II

SEMESTER-III

TH-	Elective-III
TH-	Elective-IV
TH-580	Project
TH-590	Seminar

SEMESTER-IV

TH-500	Dissertation

LIST OF ELECTIVES

ELECTIVES

TH-510	Computational Fluid Dynamics & Heat Transfer
TH-511	Thermal Power Point
TH-512	Hydro-dynamic Machine
TH-513	Renewable Energy System
TH-514	Air Conditioning & Ventilation
TH-515	I.C. Engines
TH-516	Combustion

Course No. & Title	**:**	TH- 501 ADVANCED MATHEMATICS FOR ENGINEERS		
Semester	**:**	Autumn		
Contact Hours	**:**	L	T	P
		4	0	0

Objective of Course :

1. **Fourier Transforms**
   Introduction, Fourier Intergral Theorem, Fourier Sine and Cosine Integral, Complex form of Fourier Integrals, Fourier Transforms, Inverse Fourier Transform, Properties, Modulation Theorem, Convolution Theorem for Fourier Transforms, Parseval's Identity, Fourier Transforms of derivative of functions, Relation between Fourier and Laplace transform.

2. **Z – Transforms**
   Introduction, Properties of Z – Transforms, Evaluation of inverse Z – Transforms.

3. **Matrices And Linear System Of Equations**
   Solution of linear simultaneous equations by Gaussian elimination and its modification, Crout's traingularization method, Iterative methods-Jacobins method, Gauss-Seidal method, Determination of Eigen values by iteration.

4. **Conformal Mapping**
   Conformal mapping, linear transformations, Bi-linear transformations, Schwarz's-Christoffel transformations.

5. **Calculus of Variation**
   Euler-Lagrange's differential equation, The Brachistochrone problems and other applications. Isoperi-metric problem, Hamilton's Principle and Lagrange's Equation. Rayleigh-Ritz method, Galerkin method.

Books Recommended :

1. Higher Engineering Mathematics – by Dr. B.S. Grewal; Khanna Publishers
2. Fourier Series and Boundary Values Problems – by Churchill; McGraw Hill.
3. Complex Variables & Applications – by Churchill; McGraw Hill.
4. Calculus of Variations – by elsgole; Addison Wesley.
5. Calculus of Variations – by Galfand & Fomin; Prentice Hall.
6. The Use of Integral Transforms – by I.N. Sneddon, Tata McGraw Hill.

Course No. & Title	**:**	TH- 502 INSTRUMENTATION AND MEASURING SYSTEMS
Semester	**:**	Autumn
Contact Hours	**:**	L T P 4 0 0

Objective of Course :

The Course is intended for the post graduate students of mechanical engineering disciplines to give them a thorough understanding of a measuring system, different transudation principles, error analysis, response etc. and various other issues related to instrumentation system.

Syllabus :

Significance of Measurement and Instrumentation

Introduction; Generalized configuration and functional stages of measuring systems. The traducers and its environment; an overview; sensing process and physical laws.

Types of measurement problems. Transducer classification, Characteristics of instruments, design and selection of components of a measuring system.

Dynamic Response of Instruments

Mathematical model of a measuring system, response of general form of instruments to various test inputs; time-domain and frequency domain analysis. Elementary transfer functions and Bode plots of general transfer functions.

Errors in Measurement and its Analysis

Causes and types of experimental errors; systematic and random errors. Uncertainty analysis; computation of overall uncertainty; estimation for design and selection for alternative test methods.

Transducers and Transudation Principles

Developments in sensors, detectors and transducer technology; displacement transducers; force, torque and motion sensors; piezoelectric transducers; capacitive type transducers; Strain gage transducers; accelerometers, pressure transducers based on elastic effect.

Data Acquisition and Signal Processing

Systems for data acquisition and processing; modules and computerized data system; digitization rate; time and frequency domain representation of signals.

Flow Measurement

Flow visualization, shadowgraph; schlieren and interferometer techniques; Pitot static tubes; hot wire anemometers; Laser Doppler velometer; flow measurements using coriolis effect.

Temperature and Heat Flux Measurement

Thermoelectric sensors; electric resistance sensors; thermistors; radiations pyrometers; Temperature measuring problems in flowing fluids, dynamic compensation.

List of Recommended Books

1.	Measurement & Instrumentation	A. K. Shawney	
2.	Measurements System Application And Design	Doeblin	McGraw Hill
3.	Transducers in Mechanical and Electronic Design	Harry L. Trietly	Marcel Dekker
4.	Mechanical Measurements (Fifth Edition)	Beckwith, Marangoni	Addision Wesely
5.	Measurements in Heat Transfer	Eckert and Goldstein	McGraw Hill
6.	Fluid Mechanics Measurement	Goldstein	Hemisphere

Laboratory Outline :

Exposure and demonstration of measuring equipments such as

(1) Oscilloscopes, recorders, Indicators and signal conditioners.
(2) Laboratory experiments are on the measurement of strain.
(3) Temperature
(4) Flow
(5) displacement
(6) velocity and acceleration; dynamic response and analysis.

Course No. & Title	**:**	TH-503 MODELLING, SIMULATION AND COMPUTER APPLICATIONS
Semester	**:**	Autumn
Contact Hours	**:**	L T P 4 0 0

Objective

To cover concepts, techniques and tools for modeling and simulation of systems and environments through the use of computers.

Syllabus

Physical Modelling

Concept of system and environment, Continuous and discrete system, linear and nonlinear systems, stochastic activities, static and dynamic models, principles used in modeling

System Simulation

Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems

System Dynamics

Growth and decay models, logistic curves, system dynamics diagrams.

Probability Concepts in Simulation

Stochastic variables, discrete and continuous probability functions, random numbers, rejection method.

Simulation of Flow and Thermal Systems

Laminar and turbulent flow modeling, simulation of conduction, convection and radiation problems

Simulation of Manufacturing Systems

Simulation of job shop model with material handling, flexible manufacturing system

Suggested books

1.	System Simulation	Geoffrey Gordon	Prentice-Hall
2.	System Simulation The Art and Science	Robert E. Shannon	Prentice – Hall
3.	System Modelling and Control	J. Schwarzenbach and K. F. Gill	Edward Arnold
4.	Modelling and Analysis Of Dynamic Systems	Charles M. Close & Dean K. Frederick	Houghton Miffin
5.	Simulation of Manufacturing	Allan Carrie	John Wiley & Sons
6.	Computational Heat Transfer	Y. Jaluria and K. E. Torrance	Hemisphere Publishing
7.	System Simulation	Dr. D. S. Hira	

Course No. & Title	**:**	TH-504 ADVANCED THERMODYNAMICS
Semester	**:**	Autumn
Contact Hours	**:**	L T P 4 0 0

Objective of Course :

Provides advanced treatment of classical thermodynamics including chemical equilibrium of thermodynamic systems thus enhancing analytical capability in this field.

Syllabus :

Review

Review of basic laws of thermodynamics and their consequences.

Availability

Available and unavailable energy, availability of the closed system and steady flow stream; irreversibility; effectiveness, second law analysis of power plant and refrigeration cycles.

Real Gases and Mixtures

Deviation of real gas behavior from ideal gas, equations of state; generalized compressibility chart; property deviations for real gases.

Dalton's law; pseudo-critical temperature and pressure; Kay's rule.

Chemical Equilibrium and the Third Law

Chemical potential; phase equilibrium; phase rule without chemical reaction; chemical potential of ideal gases; fugacity, evaluation of fugacity of mixtures; fugacity of solids and liquids; ideal solutions, Rault's and Henry's laws; equilibrium constants; third law; Δ W, ΔG and ΔS of reaction, reaction; reversible cell; Gibbs-Helmholtz equation.

Kinetic Theory of Gases

Equation of state of an ideal gas; distribution of modecular velocities; energy distribution function; principle of equipartition of energy; classical theory of specific heat capacity; mean free path, distribution of free paths; coefficient of viscosity; thermal conductivity; mass diffusivity.

List of Recommended Books :

1	Advanced Thermodynamics For Engineers	Wark	McGraw Hill
2	Advanced Engineering Thermodynamics	Bejan A.	John Wiley & sons
3	Thermodynamics : Kinetic Theory of Gass and Statistical Mechanics	Sears	Addison Wesley
4	Advanced Engineering Thermodynamics	Benson	Pergamon Press
5	Introduction to Thermo dynamics : Chassical & Statistical	Sonntag & Van Wylen	John Wiley
6	Basic Thermodynamics	Moran & Shapiro	

Course No. & Title	**:**	TH – 505 ADVANCED FLUID MECHANICS		
Semester	**:**	Autumn		
Contact Hours	**:**	L	T	P
		4	0	0

Objective of Course

This course is designed to provide advanced analytical tools for analysis of fluid flow and design of flow systems.

Syllabus :

Basic Equations

Deformation and the rate of strain; the deformation tensor; skew-symmetry of the deformation tensor; symmetry of the stress tensor; polar and non-polar fluids; stokesian and Newtonian fluids.

Derivation of the general differential equations of continuity, momentum and energy in vector form; Euler and Navier-Stokes equations, integration of the momentum equation; the generalized Bernoulli's equation.

Two-Dimensional Irrotational Flow

Two dimensional flow in rectangular and polar coordinates; continuity equation and the stream function; irrotationality and the velocity potential function; vorticity and circulation; plane potential flow and the complex potential function.

Sources, sinks, doublets and vortices; superposition of uniform stream with above; flow around corners; Rankine ovals; flow around circular cylinders with the without circulation; pressure distribution on the surface of these bodies.

Elements of two-dimensional aerofoils theory; Joukowski transformation; circular arc, symmetrical aerofoil theory; Joukowski aerofoils; Joukowski hypothesis; lift and moment.

Three-Dimensional Irrotational Flow

Irrotionality and the velocity potential function; symmetric flows and the Stokes stream function; sources, sinks.

Vortex Motion

Definitions; vortex lines, surfaces and tubes; vorticity, circulation; Kelvin's circulation theorem; Helmholtz's vorticity theorems; the convection and diffusion of vorticity.

Viscous Flow

Exact solution; plane Poiselle and Couette flows; Hagen-Poiselle flow through pipes.

Flows with very small Reynolds number;

Flows with very large Reynolds number; elements of two dimensional boundary layer theory; displacement thickness and momentum thickness, skin friction; Blassius solution for boundary layer on a flat plate without pressure gradient; the Karman-Polhausen integral method for obtaining approximate solutions.

Drag on bodies; form drag and skin friction drag profile drag and its measurement.

List of Recommended Books :

1	The Phenomena of Fluid Motion	Brodkey	Addition Wesley
2	Foundation of Fluid Mechanics	Yuan	Prentice Hall
3	Advanced Fluid Mechanics	Raudkiri & Callander	Edward Ronald
4	Fundamentals of Mechanics of Fluids	Currie	McGraw Hill
5	Fluid Mechanics	Landau & Lifshitz	Addition Wesley
6	Fluid Mechanics & Hyde antic Machinery	Som & Biswas	Tata McGraw

TH--506 Lab-I

Max. Marks: 100
Time Allowed: 2hrs

One lab /field/industrial oriented project /problem will be allocated to each student related to the subjects related to the subjects taught in 1st semester.

Course No. & Title	**:**	TH – 507 ADVANCED HEAT TRANSFER
Semester	**:**	Spring
Contact Hours	**:**	L T P 4 0 0

Objective of Course :

It provides the knowledge of advanced techniques for analysis of heat transfer processes in thermal systems.

Syllabus :

Review

Review of the basic laws of conduction, radiation and convection.

Conduction

One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source; local heat source in non-adiabatic plate;

Extended surfaces-review; optimum fin of rectangular profile; straight fins of triangular and parabolic profiles; optimum profile; cirucumferential fin of rectangular profile; spines; design considerations.

Two dimensional steady state conduction; semi-infinite and finite flat plates; temperature field in finite cylinders and in infinite semi-cylinders;

Unsteady state conduction; sudden changes in the surface temperatures of infinite plate, cylinders and spheres; solutions using Groeber's and Heisler's charts for plates, cylinders and spheres suddenly immersed in fluids.

Radiation

Review of radiation principles; diffuse surfaces and the Lambert's Cosine law.

Radiation through non-absorbing media; Hottel's method of successive reflections;

Radiation through absorbing media; logarithmic decrement of radiation; apparent absorptivity of simple shaped gas bodies; net heat exchange between surfaces separated by absorbing medium; radiation of luminous gas flames.

Convection

Heat transfer in laminar flow; free convection between parallel plates; forced internal flow through circular tubes; fully developed flow; velocity and thermal entry lengths; solutions with constant wall temperature and with constant heat flux; forced external flow over a flat plate; the two dimensional velocity and temperature boundary layer equations; Karman Pohlhousen approximate integral method.

Heat transfer in turbulent flow; eddy heat diffusivity; Reynold's analogy between skin friction and heat transfer; von Karman; turbulent flow through circular tubes.

List of Recommended Books :

1	Analysis of Heat and Mass Transfer	Eckert and Drake	McGraw Hill
2	Fundamentals of Heat Transfer	Grober, Erk and Grigull	Mc Graw Hill
3	Conduction Heat Transfer	Schneider	Addison Wesley
4	Thermal Radiation	Siegel and Howell	McGraw Hill
5	Heat, Mass and Momentum transfer	Rohsenow and Choi	Prentice Hall
6	Fundamentals of Heat Transfer	Encropera	

Course No. & Title	**:**	TH-508 GAS TURBINES AND COMPRESSORS		
Semester	**:**	Spring		
Contact Hours	**:**	L	T	P
		4	0	0

Objective of the Course :

It is intended to give a thorough understanding of gas turbines, compressors, gas turbine cycles, energy and fluid flow dynamics and power plants based on gas turbines.

Syllabus

Introduction :

Development, classification and field of application of gas turbines.

Gas Turbine Cycle :

Ideal and actual cycles; multi-stage compression; reheating, regeneration, combined and cogeneration.

Energy Transfer and Fluid Flow Characteristics :

Energy transfer between fluid and rotor; axi-symmetric flow in compressors and gas turbines.

Centrifugal Compressors :

Principles of operation; compressor losses; adiabatic efficiency; slip factor; pressure coefficient; power unit; design consideration for impeller and diffuser systems; performance characteristics.

Axial Flow Compressors :

Elementary theory; vortex theory; degree of reaction; simple design; elementary air-foil theory; isolated airfoil and cascade theory; three dimensional flow; stages; stage efficiency and overall efficiency; performance characteristics.

Turbines :

Axial flow and radial flow turbines; impulse and reaction turbines; fundamental relations and velocity triangles; elementary vortex theory; limiting factors in turbine design; application of airfoil theory to the study of flow through turbine blades; aerodynamic and thermodynamic design considerations; blade materials; blade attachments and blade cooling.

Gas Turbine Power Plants :

Fuel and fuel feed systems; combustion systems-design considerations and flame stabilization; regenerator types and design; gas turbine power; plant performance and matching; applications.

List of Recommended Books :

1.	Gas Turbine Theory	Cohen & Rogers	Longman
2.	Theory & Design of Gas Turbine and Jet Engines	Vincent	McGraw Hill
3.	Gas Turbine Principles and Practice	Cox	Newnes
4.	Introduction to the Gas Turbine	Shepherd	Constable
5.	Jet Propulsion and Gas Turbine	Zucrow	John Wiley

Course No. & Title	**:**	TH-509 REFRIGERATION AND AIR CONDITIONING SYSTEM DESIGN
Semester	**:**	Spring
Contact Hours	**:**	L T P 4 0 0

Objective of the Course :

To introduce the students the basic design principles of refrigeration and Air conditioning equipment and component such as evaporators, condensers, capillary tubes, expansion valves, etc.

Syllabus

Load Calculations :

Solar heat gains through structures; review of refrigeration and air conditioning load calculations.

Refrigeration System :

Vapour compression; multiple evaporator and compound compression system with and without inter cooling; dual compressors; cascade systems; Vapour absorption system-analysis.

Solid carbon dioxide; principle of production; three stage system with water and flash inter-cooler; pressure snow chambers; regenerative liquid; binary system.

Performance characteristics and capacity control of reciprocating, rotary and centrifugal compressors; screw compressors; hermetically sealed units; analysis of centrifugal compressors.

Water – cooled and air-cooled condensers; overall heat transfer coefficients; fouling factor; performance characteristics and design; performance and heat transfer processes in evaporative condenser.

Flooded and dry expansion type evaporators, liquid chiller, overall performance of evaporators.

Capillary tubes; system design factors; pressure and temperature distribution; ASHRAE simplified calculation procedure.

Expansion valves; operation and performance calculation of thermostatic expansion valve; application of constant pressure expansion valve.

Pressure Drop and Heat Transfer :

Two phase flow; flow regimes; maps; pressure drop in evaporator and condensers; Martinelli relation

Applications and System Design :

Ice manufacture; Design of refrigerated cars and ware houses.

List of Recommended Books :

1.	Refrigeration and Air-conditioning	Stoecker	McGraw Hill
2.	Air conditioning Design Handbook	Carrier Corpn.	McGraw Hill
3.	ASHRAE Handbooks	-	ASHRAE
4.	Environmental Engg. Analysis & Practice	Jennings	International
5.	Climatological and Solar Data for India	CBRI	Sarita Prakashn

Course No. & Title : TH-510 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER (MAJOR ELECTIVE)

Contact Hours	**:**	L	T	P
		4	0	0

Objective of the Course :

It is intended to provide the basic tools needed for numerically solving fluid flow and heat transfer processes using computer.

Syllabus

Introduction; Conservation equations, mass, momentum and energy equations; convective forms of the equations and general description.

Clarification into various types of equation, parabolic, elliptic, boundary and initial conditions; over view of numerical methods.

Finite difference methods; different means for formulating finite difference equations, Taylor series expansion, integration over element, local function method; finite volume methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment, accuracy of f.d. method.

Solution of finite difference equations; fast. Fourier transform, applications.

Numberical grid generation; basic ideas; transformation and mapping.

Finite element methods; Rayleigh- Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications.

List of Recommended Books :

6.	Computational Fluid Mechanics and Heat Transfer	D.A. Anderson J. C. Tannehvi and R. H. Pletcher	Hemisphere, N.Y
7.	Computational Fluid Dynamics	P.J. Roache	Hermosan New Mexico
8.	Fundamentals of Heat and Mass Transfer	F. P. Incropera & D. P. Dewitt	Wiley, N.Y.
9.	Numerical Heat Transfer and Fluid Flow	S.V. Patankar	Hemisphere, Washington D.C.
10.	The Finite Element Method In Engineering Science	O.C. Zienkiewicz	Mc Graw Hill
11.	Numerical Heat Transfer	J. M. Shih	Hemisphere, Washington D.C.

Course No. & Title	**:**	TH- 511 THERMAL POWER PLANT (MAJOR ELECTIVE)
Contact hours	**:**	L T P 4 0 0

Objective of Course

Aims to give knowledge of Advance Power Plant Engg.

Syllabus

A Review

Rankine cycle with reheat & regeneration; binary vapor cycle, gas power cycle and flow through nozzles.

Introduction

Resources & development of power in India, hydro, thermal and nuclear energy; present power position & future planning of policies in India.

Thermal power plant

Introduction, Fossils fuels & its resources, Fuel properties & storage, classification of coal, use of high ash coal, lignite coal, drying, storage and handling of liquid fuels, types of petroleum fuels, producer gas, fuel firing, furnace construction, grates, pulverizers, oil & gas burners & fluidized bed combustion system. Ash handling and glue gas analysis. High pressure boiler, super critical boilers. Steam plant accessories – economizers, air pre heaters, super heaters, soot blowers, condensers, cooling towers, effect of component characteristics on the plant performance and variable load problem.

Gas turbine plants

Introduction, classifications & different types of gas turbine plants. Analysis of closed cycle and open cycle constant pressure gas turbine plants. Methods to improve the thermal efficiency of a simple open cycle constant pressure gas turbine plant; Auxiliaries & controls. Environmental impact of gas turbine power plants.

Hydro electric power plant

Classification of hydro units, Design construction & operation of different components of hydro electric power stations.

Nuclear power plants

Basic principles of nuclear energy, classification & main parts of nuclear reactors, different types of reactors i.e. PWR, BWR, heavy water reactors, gas cooled reactor, liquid metal cooled reactors; organic moderated cooled reactors, breeder reactors plant operation, safety features & radioactive waste disposal.

Non conventional power generation

Introduction, geo thermal power, tidal, solar & wind power plants and direct energy conversion systems.

Economic analysis of power plants and tariffs

Instrumentation & controls in thermal power plants; energy conservation & Management.

Environment aspect of power generation

Pollutants from fossils fuels and health hazards, control of emissions and particulate matter, desulfeorization, coal gassfication & introduction to green house effect.

List of recommended books

1.	Power plant theory & design	Pottor	Ronald press
2.	Power plant	Zerban & Nye	International
3.	Nuclear power plants	Loffness	Divan Hostrand
4.	Nuclear power plant system & fequipment	Lish	Industrial press
5.	A course in power plant Engineering	Arora & Dom kund war	Dhanpatrai, New Delhi

Course No. & Title : TH- 512 HYDRODYNAMIC MACHINES (MAJOR ELECTIVE)

Contact Hours :

L	T	P
4	0	0

Objective of Course

To expose students to various strategic issues related to hydrodyanamic machines such as turbines, pumps etc. Being a Post graduate Course the design of these has been included.

Syllabus

Introduction

Basic fluid mechanics of turbomachiery; Eulers equation for energy conversion through rotor ; one-dimensional theory and its limitations; two – dimensional theory of flow through axial and radial – flow machines.

Hydrodynamic Machines

Classification of turbines and various forms of turbine runners.

Impulse turbines; general theory of impulse machines; performance characteristics; design of runner; bucket shape and size; design of nozzles; regulation mechanisms; penstock design.

Reaction turbines; general theory of reaction machines; performance characteristics; types; Francis and Kaplan turbines; runner design; blade design; design of the spiral casing; guide vanes and draft tube design; 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; design of casings and diffusers; cavitation effects in impellers.

Hydrodynamic Transmissions

General features; primary and secondary units of the systems; fluid couplings and torque converters; general theory; performance characteristics; basic design considerations;

List of Recommended Books

1.	Fluid Mechanics of Turbomachinery, Vol. I	Wislicenus	Dover
2.	Principles of Turbomachinery	Shepherd	Macmillan
3.	Hydraulic Turbines	Nechleba	Artia (Prague)
4.	Centrifugal & Axial Flow pumps	Stepanoff	John Wiley
5.	Theory & Design of Automatic Transmission Components	Weston	Butterworths

Course No. & Title : TH-513 RENEWABLE ENERGY SYSTEMS (MAJOR ELECTIVE)

Contact Hours :

L	T	P
4	0	0

Objective of Course

Technological development depends primarily on Energy. The depletion of the conventional energy sources and the environmental problems associated with them, necessitate mankind to look for renewable energy systems. This course will expose the students and society to the renewable energy systems and thus will help in sustaining the development of the society.

Syllabus

General

Energy and development; energy demand and availability; energy crisis; conventional and non-conventional, renewable and non-renewable energy resources; environmental impact of conventional energy usage; basic concepts of heat and fluid flow useful for energy systems.

Solar Energy Systems

Solar radiations data; solar energy collection, storage and utilization; solar water heating; air heating; power generation; refrigeration and air conditioning; solar energy system economics.

Micro and Small Hydro Energy Systems

Resource assessment of micro and small hydro power; micro, mini and small hydro power systems; economics; pump as turbine; special engines for low heads; velocity head turbines.

Biomass Energy Systems

Availability of biomass- agro, forest, animal, municipal and other residues; bioconversion technologies; cooking fuels, biogas, producer gas, power alcohol from biomass; power generation. ; internal engine modifications and performance; system economics.

Wind Energy Systems

Wind data; horizontal and vertical axis wind mills; wind farms; performance and economics of wind energy.

Integrated Energy Systems

Concept of integration of conventional and non-conventional energy resources and systems; integrated energy system design and economics.

List of Recommended Books

1.	Solar Engineering of Thermal Processes	Duffie & Beckman	John Wiley
2.	Energy, the Biomass Option	Bungay	John Wiley
3.	Introduction to Wind Energy Technology	Lysen	Georgia Inst.
4.	Energy	Doolittle	Matrix Pub.
5.	Energy & Environment	Fowler	McGraw Hill
6.	Solar Energy	S.P. Sukhatme	Tata McGraw Hill

Course No and Title : TH-514 AIR- CONDITIONING AND VENTILATION (MAJOR ELECTIVE)

Contact Hours :	L	T	P
	4	0	0

Objective of Course

To introduce the students the basic physiological principles, comfort charts, air conditioning systems and the design of piping and ducts.

Syllabus

Psychrol

Goff and gratach method of calculation of moist air properties; mass transfer and evaporation of water into moist air; theory of psychrometer; correlation of w.b.t. with temperature of adiabatic saturation; Lewis number; construction of h.w. psychrometric chart.

Psysiological Principles

Comfort; thermal interchanges with environment; physiological body regulatory processes against heat or cold; high and low temperature harards; extreme environmental conditions; heat stress index; ASHRAE comfort standards.

Simultaneous Heat and Mass Transfer

Direct contact transfer equipment; simple air washer and indirect evaporative cooling contact mixture principle; enthalpy potential; basic equation for direct contact transfer equipment; graphical and analytical methods for heat and mass transfer analysis of airwahsers with heated and chilled water sprays; cooling towers.

Extended Surface Heat Transfer Apparatus

Cooling and Dehumidifying coils, Design of finned surfaces, Adsorption cooling systems.

Ventilation

Necessity; ventilation standards; natural and mechanical ventilation; forces for natural ventilation; general ventilation rules; advantages of mechanical ventilation; various methods; ejector systems; determining ventilation requirement; use of decay equation.

Air Cleaning

Physical and chemical vitiation of air; permissible concentration of air contaminants; mechanical and electronic air cleaners; dry and wet filters; air sterlization; odour control.

Steam Heating Systems

Elements of steam, water and warm-air heating systems; radiators and convectors. Design of an year-round air conditioning system.

Piping and Ducts

Pressure drops in piping and fittings; design of water and refrigerant piping; Air conditioning duct design methods.

List of Recommended Books

1.	Thermal Environmental Engineering	Threlkeld	Prentice Hall
2.	ASHRAE Handbook (Fundamentals)	-	ASHRAE
3.	Refrigeration and Air-conditioning	Stoecker & Jones	Mc Graw Hill
4.	Air-conditioning Engg	Jones	Arnold
5.	Fundamentals of Industrial Ventilation	Baturin	Pergamon
6.	Refrigeration & Air conditioning	Arora	Tata-McGraw Hill

Course No. & Title : TH-515 I.C. ENGINES (MAJOR ELECTIVE)

Contact Hours :	L	T	P
	4	0	0

Objective of the Course

The course is advanced level course of IC Engines and deals with the analysis of engine processes.

Syllabus

Introduction

Introduction and historical perspective.

Thermodynamic analysis of IC Engines Cycle

Properties of working fluid, thermodynamic charts, unburned mixture charts, burned mixture, fuel air cycle analysis, real cycles, availability analysis of engine processes.

Gas Exchange Processes

Inlet and exhaust processes in the four stroke cycle, volumetric efficiency, quasistatic and dynamic effects, flow through valves. Scavenging in the two-stroke cycle engines, scavenging parameters and models, actual scavenging processes, flow through ports. Supercharging and turbocharging, basic relationships, compressors, turbines characteristics, matching of compressor, turbines and engine characteristics.

Combustion in SI Engines

Essential features of the process, thermodynamic analysis of SI engine combustion, combustion process characterization, cyclic variations in combustion.

Combustion in Compression – Ignition Engines

Essential features of process, types of diesel combustion systems, phenomenological model of compression – ignition engine combustion. Fuel spray behaviour, spray structure, atomization, spray penetration droplet size distribution, spray evaporation, ignition delay.

Pollutant formation and Control

Nature and extant of problem, Nitrogen oxides. Kinetics of NO formation, NO_x formation in spark-ignition engines, NO_x formation in CI engines. Carbon monoxide, unburned hydrocarbon emissions. Particulate emissions exhaust gas treatment, catalytic converters, three way catalysts, particulate traps.

List of Recommended Books

1.	Internal Combustion Engine Fundamentals	Heywood	McGrawHill
2.	Internal Combustion Engines Vol. 1 & 2	Taylor	John Wiley
3.	Internal Combustion Engines	Ferguson	John Wiley
4.	Internal Combustion Engines Vol. 1 & 2	Benson & White house	Pergamon
5.	Thermodynamic Analysis of Combustion Engines	Campbell	John Wiley

Course No. & Title : TH-516 COMBUSTION (MAJOR ELECTIVE)

Contact Hours :	L	T	P
	4	0	0

Objective of the Course

To expose students to the basic principles involved in the combustion phenomenon and to enhance their understanding of various practical combustion systems and problems.

Syllabus

Introduction

Importance of combustion, combustion equipment, hostile fire problems, pollution problems arising from combustion.

Thermodynamics of Combustion

Enthaphy of formation, enthalpy of reaction, heating values, first and second law analysis of reacting systems, chemical equilibrium, equilibrium composition, adiabatic and equilibrium flame temperature.

Kinetics of Combustion

Law of mass action, reaction rate, simple and complex reactions, reaction order and modecularity, Arhenius Law, activation energy, Chain reaction steady state and partial equilibrium approximations. Chain explosion, Explosion limits and oxidation characteristics of hydrogen, carbon monoxide and hydrocarbons.

Flames

Premixed Flames structure and propagation of flames in homogeneous gas mixtures; simplified Rankine Hugoniot relations; properties of hugoniot curve; analysis of deflagration and detonation branches, properties of Chapman Jouguet wave. Laminar flame structure; therories of flame propagation and calculation of flame speeds, flame speed measurements.

Stability limits of laminar flames; flammability limits and quenching distance; burner design. Mechanisms of flame stabilization in laminar and turbulent flows; flame quenching. Diffusion flames; comparison of diffusion with premixed flame. Combustion of gaseous fuel jets Burke and shumann development.

Burning of condensed phase

General mass burning considerations, combustion of fuel droplet in a quiescent and convective environment. Introduction to combustion of fuel sprays.

Ignition

Concepts of ignition, chain ignition, thermal spontaneous ignition, forced ignition.

Combustion Generated Pollution & its Control

Introduction, nitrogen oxides thermal fixation of atmospheric nitrogen prompt NO, thermal NOx formation and control in combustors.

Fuel NOx and control, post – combustion destruction of NOx, Nitrogen dioxide carbon monoxide oxidation – quenching, hydro carbons, sulphur oxides.

List of Recommended Books

1.	Combustion	Glassman	Academic Press
2.	Introduction to combustion Phenomenon	Kanury Murty	Mc Graw Hill
3.	Combustion, Fundamentals	Strehlow	Mc Graw Hill
4.	Combustion, Flames and Explosion of Gases	Lewis & von Elbe	Academic Press
5.	Combustion Theory	Williams FA	Cummings
6.	Combustion symposia (International)	-	Combustion Institute

TH--517 Lab-II

Max. Marks: 100
Time Allowed: 2hrs

One lab /field/industrial oriented project /problem will be allocated to each student related to the subjects related to the subjects taught in 2$^{nd\ t}$ semester.