SEMESTER- I

20PMA105	ADVANCED NUMERICAL METHODS	L	T	P	C
		3	2	0	4
Nature of Course	Foundation Course				
Pre requisites	Numerical Analysis in Thermal Science				

Course Objectives

The course is intended to

1. Numerical methods aided by technology to solve algebraic, transcendental and differential equations
2. Apply finite element methods for solving the boundary value problems in differential equations.
3. Develop problem solving skills in numerical integration and differential equations.
4. Understanding of the application of various methods in solving engineering problems.
5. Serve as a precursor for future research.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	List the common numerical methods and how they are used to obtain approximate solutions	Remember
CO2.	Demonstrate the Eigen Value Problems And Curve Fitting	Understand
CO3.	Analyze and evaluate the accuracy of common numerical methods	Analyze
CO4.	Solve the numerical methods to obtain approximate solutions to Mathematical problems.	Apply
CO5.	Evaluate the numerical methods for various mathematical operations and tasks	Evaluate

Course Contents:

UNIT I NUMERICAL SOLUTIONS FOR LINEAR AND NON-LINEAR EQUATIONS 12

System of linear equation: Gauss Elimination Method, Gauss Jordan Method, Choleski Method, Gauss-Seidel Method – System of Non-Linear equations : Method of Iteration, Newton-Raphson Method.

UNIT II EIGEN VALUE PROBLEMS AND CURVE FITTING 12

Eigen value problem: Power Method – Curve fitting: Least Square approximations – Fitting a straight line – Regression Lines – Non-Linear curve fitting – Method of least square for continuous functions.

UNIT III NUMERICAL INTEGRATION 12

Trapezoidal Rule - Simpson's Rules-Adaptive Quadrature Method – Gaussian Quadrature-Double integrals using Trapezoidal and Simpson's rule, Electrical Installations Devices

UNIT IV NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods: Euler's Methods – Modified Euler's Method - Runge-Kutta Method of fourth order – Multi Step methods: Milne's and Adam's Predictor and Corrector Methods. Numerical solution of Ordinary Differential Equation by Finite Difference Method

UNIT V NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace Equation: Gauss Jacobi Method, Gauss Seidel Method – Poisson Equation: Finite difference method. Parabolic Equation: Crank Nicholson Method – Hyperbolic Equation: Explicit method

TOTAL: 60 PERIODS

TEXT BOOKS:

1. P.Kandasamy, K.Thilagavathy, K.Gunavathy, "Numerical Methods", S.Chand and Company Ltd.,Ramnagar, New Delhi, 2010.
2. Veerarajan.T and Ramachandran.T., "Numerical Methods with Programming C", Tata McGraw Hill Publishers, New Delhi, 2007.

REFERENCE BOOKS:

1. Grewal. B. S.,andGrewal. J.S., "Numerical Methods in Engineering and Science", Seventh Edition, Khanna Publishers, New Delhi, 2007.
2. C.F. Gerald and Wheatley. P.O., "Applied Numerical Analysis", (Sixth Edition), Pearson Education,Asia, New Delhi,2006.
3. M.K.Jain, S.R.K. Iyengar and R.K.Jain, "Numerical Methods for Scientific and Engineering Computation", Wiley Eastern Limited, New Delhi, 2004.
4. S.S.Sastry, "Introductory Methods of Numerical Analysis", Prentice Hall of India, New Delhi,2005.
5. Balagurusamy .E., "Numerical Methods", Tata McGraw Hill Publishers, New Delhi,1999, reprint 2007.
6. S.R.K.Iyengar, R.K.Jain, "Numerical Methods", New Age International Publishers, New Delhi, 2009.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
3 High						2 Medium						1 Low			

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE101	ADVANCED HEAT TRANSFER	L	T	P	C
		3	0	0	3
Nature of Course	Professional core				
Pre requisites	Heat and mass transfer				

Course Objectives

The course is intended to

1. Develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows
2. Learn numerical formulation of heat equations and to analyze various heat transfer correlations
3. Understanding of the basic concepts of phase change processes and heat transfer coefficient for compact heat exchangers
4. Identify the application of numerical methods in heat transfer problems.
5. Understand the basic concepts of mass transfer.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain the fundamental concept of heat transfer mechanisms.	Understand
CO2	Solve the free and forced convection problems for different geometries with boundary conditions	Apply
CO3	Analyze the thermal analysis and sizing of heat exchangers and to learn the heat transfer coefficient for compact heat exchanges.	Analyze
CO4	Identify numerical methods for solving the heat transfer problems	Apply
CO5	Evaluate the concepts of phase change in heat and mass transfer processes for various application	Evaluate

Course Contents:

UNIT I CONDUCTION AND RADIATION HEAT TRANSFER 9

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - conduction with moving boundaries - radiation in gases and vapour Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER 9

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k Є model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 9

Condensation with shears edge on bank of tubes - boiling – pool and flow boiling - heat exchanger - Є – NTU approach and design procedure - compact heat exchangers.

UNIT IV NUMERICAL METHODS IN HEAT TRANSFER 9

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation - steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER algorithm.

UNIT V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION 9

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines, compressors and turbines.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Yunus A.Cengal., Heat and Mass Transfer – A practical Approach, 3rd edition, TataMcGraw Hill 2007
2. Holman.J.P., Heat Transfer, Tata Mc Graw Hill,2002

REFERENCES BOOKS

1. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press,2004.
2. Nag.P.K., Heat Transfer, Tata McGraw-Hill,2002.
3. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co.,1985.
4. Yadav, R., Heat and Mass Transfer, Central Publishing House,1995.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			3	3		2	2		2				3	3	
CO2			3	3		2	2		2				3	3	
CO3			3	3		2	2		2				3	3	
CO4			3	3		2	2		2				3	3	
CO5			3	3		2	2		2				3	3	
3	High					2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE102	ADVANCED THERMODYNAMICS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Engineering Thermodynamics				

Course Objectives

The course is intended

1. To impart knowledge of mechanical engineering fundamentals of application.
2. To gain knowledge of thermodynamics process and their applications.
3. To learn the laws thermodynamics of with suitable properties.
4. To develop a clear understanding about thermo chemistry.
5. To explore the knowledge on thermodynamics for refrigeration cycles

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Classify the basic laws of Thermodynamics and study the thermodynamic relations.	Understand
CO2.	Calculate the thermodynamics properties for ideal and real gases	Evaluate
CO3.	Assess the combustion phenomenon using thermo chemistry principles	Evaluate
CO4.	Analysis the thermodynamic system by applying fundamentals of statistical thermodynamics	Apply
CO5.	Choose the power plants and study the thermodynamic phenomenological laws	Analysis

Course contents:

UNIT - I: REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES 9

First and second law thermodynamics, Entropy - Entropy generation. Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation.

UNIT-II: IDEAL AND REAL GASES AND PSYCHOMETRIC 9

Equation of state, Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius, Clapeyro equation. Throttling, Joule. Thompson coefficient. Non reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers.

UNIT- III: COMBUSTION 9

Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat of reaction, adiabatic flame temperature, Enthalpies, Equilibrium. Chemical equilibrium of ideal gas, The Vant Hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

UNIT- IV KINETIC THEORY OF GASES AND STATISTICAL THERMODYNAMICS 9

Basic assumption, molecular flux, collisions with a moving wall, principle of equipartition of energy, classical theory of specific heat capacity, intermolecular forces, collision cross section, mean free path, energy states and energy levels, macro and micro-scales, thermodynamic probability, thermo statistics, statistical interpretation of entropy, distribution function, application of statistics to gases-mono-atomic ideal gas, distribution of molecular velocities.

UNIT- V: POWER CYCLES AND PHENOMENOLOGICAL LAWS 9

Review binary vapour cycle, co-generation and combined cycles, Second law analysts of cycles. Refrigeration cycles. Thermodynamics of irreversible processes. Introduction Phenomenological laws, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Holman J.P., Thermodynamics, Fourth Edition, McGraw – Hill Inc.,1988.
2. Kenneth WarkJt.m., Advanced Thermodynamics for Engineers, McGrew – Hill Inc.,1995.

REFERENCE BOOKS:

1. Wark, Advanced Thermodynamics, McGraw Hill 2000
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons,1988.
3. Rao Y.V.C., Postulational and Statistical Thermodynamics, Allied Publisher Limited, New Delhi,1999.
4. Sears F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Third Edition, Narosa Publishing House, New Delhi,1993.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2					3		2				3	3	
CO2	3	2					3		2				3	3	
CO3	3	2					3		3				3	3	
CO4	3	2					3		3				3	3	
CO5	3	2					3		3				3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE103	ADVANCED FLUID MECHANICS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fluid mechanics				

Course Objectives

The course is intended

1. To understand the laws of fluid flow for ideal and viscous fluids
2. To apply the potential functions for standard flows and combined flows
3. To know and examine the viscous flow theory of flow through pipes
4. To recognize the boundary layer concepts with respect to fluid flow
5. To estimate the one dimensional compressible fluid flow

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Recollect the basic equation of fluid flow	Remember
CO2.	Demonstrate the potential functions for standard flows and combined flows	Understanding
CO3.	Examine the Viscous flow theory for various flow fields	Analyze
CO4.	Determine the Boundary Layer - displacement and momentum thickness	Evaluate
CO5.	Estimate the one dimensional compressible fluid flow	Evaluate

Course contents

UNIT I BASIC EQUATIONS OF FLOW 9

Three dimensional continuity equation - differential and integral forms – equations of motion momentum and energy and their engineering applications

UNIT II POTENTIAL FLOW THEORY 9

Rotational and Irrotational flows - Circulation – Vorticity - stream and potential functions for standard flows and combined flows – representation of solid bodies by flow patterns. Pressure distribution over stationery and rotating cylinders in a uniform flow - Magnus effect - Kutta – Zhukovsky theorem. Complex potential functions

UNIT III VISCOUS FLOW THEORY 9

Laminar and turbulent flow - laminar flow between parallel plates - Poiseuille's equation for flow through circular pipes. Turbulent flow - Darcy Weisbach equation for flow through circular pipe - friction factor - smooth and rough pipes - Moody diagram losses during flow through pipes. Pipes in series and parallel – transmission of power through pipes

UNIT IV BOUNDARY LAYER CONCEPT 9

Boundary Layer - displacement and momentum thickness - laminar and turbulent boundary layers in flat plates - velocity distribution in turbulent flows in smooth and rough boundaries - laminar sub layer.

UNIT V COMPRESSIBLE FLUID FLOW 9

One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers – fundamentals of supersonics – normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Streeter V.L., Wylie E.B. and Bedford K.W., Fluid Mechanics, WCB McGraw Hill, Boston,1998.
2. Munson B.R., Young D.F. and Okiisi, T.H., Fundamentals of Fluid Mechanics, John Wiley and Sons Inc., NewYork, 1990.

REFERENCE BOOKS:

1. Bansal R.K., Fluid Mechanics, Saurabh and Co., New Delhi, 1985.
2. Kumar K.L., Engineering Fluid Mechanics, Eurasia Publishing House, New Delhi, 2002.
3. Schlichting H., Boundary layer theory, Mc Graw Hill Book Company, 1979
4. Shames, Mechanics of Fluids, Mc Graw Hill Book Company, 1962.8.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3				2		3				3	3	
CO2	3		3				2		3				3	3	
CO3	3		3				2		3				3	3	
CO4	3		3				2		3				3	3	
CO5	3		3				2		3				3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE104	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2
Nature of Course	Professional Core				
Pre requisites	Thermal Engineering and Heat transfer				

Course Objectives

The course is intended

1. To make the students to learn the importance of various types of I.C engines and analyze them using commercial and open source software.
2. To study the characteristics of fuels/Lubricates used in IC Engines
3. To study the Performance of Air Compressor
4. To study the heat transfer phenomena predict the relevant coefficient using implementation
5. To find out the performance of cooling tower

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Perform experiments on engines and draw characteristics.	Understanding
CO2.	Determine the volumetric efficiency of a two-stage reciprocating air compressor as a function of receiver pressure and air blower.	Analyze
CO3.	Determine the coefficient of performance using parallel and counter flow Heat Exchangers.	Evaluate
CO4.	Interpret and evaluate the heat transfer coefficient using forced convection and free convection experimental set-up.	Understanding
CO5.	Contrast Fourier law of conduction for composite slab and Newton's law of cooling for pin-fin apparatus.	Apply

Course contents

S.No	Exercises	CO Mapping	Blooms Level
IC engines lab			
1	Constant Speed Performance Test on Single Cylinder CI Diesel Engine.	1	Apply
2	Performance Test on Single-Cylinder CI Diesel Engine.	1	Apply
3	Retardation Test on Single-Cylinder CI Diesel Engine.	1	Apply
4	Determination of volumetric efficiency of the air compressor as a function of receiver pressure	2	Apply
5	Performance and characteristics studies on air Blower.	2	Apply
6	Determination of calorific value of solid and liquid fuels-calorimeter	2	Apply

7	Determination of cloud and pure points of oil products - cloud and pour point apparatus	2	Apply
8	Performance study in a cooling tower.	2	Apply
Heat transfer lab			
9	Performance study on parallel and counter flow Heat Exchangers.	3	Apply
10	Determination of cloud and pure points of oil products - cloud and pour point apparatus	3	Apply
11	Performance study in a refrigeration systems	3	Apply
12	Natural Convection Apparatus: Determination of experimental and empirical values of convection heat transfer coefficient from a Vertical Heated Cylinder losing heat to quiescent air	4	Apply
13	Forced Convection Apparatus: Determination of theoretical, experimental and empirical values of convection heat transfer coefficient for internal forced convection through a circular GI pipe	4	Apply
14	Pin-Fin Apparatus: Determination of temperature distribution, efficiency and effectiveness of the fin working in forced	5	Apply

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3		3		3	3		3	3	3	2		3	3	
CO2	3		3		3	3		3	3	3	2		3	3	
CO3	3		3		3	3		3	3	3	2		3	3	
CO4	3		3		3	3		3	3	3	2		3	3	
CO5	3		3		3	3		3	3	3	2		3	3	
3 High						2 Medium						1 Low			

TOTAL: 60 PERIODS

SEMESTER-II

20PTE201	INSTRUMENTATION FOR THERMAL ENGINEERING	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Thermal Engineering				

Course Objectives

The course is intended to

1. Provide knowledge on various measuring instruments for thermal engineering.
2. Understand the various steps involved in error analysis and uncertainty analysis.
3. Provide knowledge on advance measurement techniques.
4. Gain knowledge of measurement process and their applications.
5. Explore the knowledge on analysis of measurement

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the suitability, accuracy and uncertainty associated with the instrument used for measuring thermal system parameters.	Understand
CO2.	Identify The microprocessors and computers in measurement.	Apply
CO3	Select measuring instruments for advanced applications like process industry.	Apply
CO4	Compare and analysis the performance of advance measurement techniques	Analyze
CO5	Calculate heat release from an IC engine, understand use of flow visualization techniques	Evaluate

Course Contents:

UNIT I MEASUREMENT CHARACTERISTICS 10

Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments

UNIT II MICROPROCESSORS AND COMPUTERS IN MEASUREMENT 8

Data logging and acquisition – use of sensors for error reduction, elements of microcomputer interfacing, intelligent instruments in use.

UNIT III MEASUREMENT OF PHYSICAL QUANTITIES 9

Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

UNIT IV ADVANCE MEASUREMENT TECHNIQUES 8

Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement.

UNIT V MEASUREMENT ANALYSIS 10

Chemical thermal, magnetic and optical gas analyzers, measurement of smoke, Dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Barnery, Intelligent Instrumentation, Prentice Hall of India, 1988

2. Bolton.W, Industrial Control & Instrumentation, Universities Press, Second Edition, 2001.

REFERENCE BOOKS:

1. Holman J.P., Experimental methods for engineers, McGraw-Hill, 2012.
2. John G Webster, The measurement, Instrumentation and sensors Handbook, CRC and IEE
3. Press, 1999.
4. Morris A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.
5. Nakra, B.C., Choudhry K.K., Instrumentation, Measurements and Analysis Tata McGraw Hill,
6. New Delhi, 2nd Edition 2003.
7. T.G.Beekwith R.D., Marangoni and J.H. Lienhard, Mechanical Measurements, Pearson
8. Education, 2001.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	3		2								3	3	
CO2	2	2	3		2								3	3	
CO3	2	2	3		2								3	3	
CO4	2	2	3		2								3	3	
CO5	2	2	3		2								3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE202	FUELS AND COMBUSTION	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamental Concepts of Combustion Science and Engineering				

Course Objectives

The course is intended to

1. Describes the environmental problems arising due to the advanced technology.
2. Explains and provides knowledge on the energy resources and their management without wastage and prevention of over-exploitation.
3. Analysis of various types of pollution and its control methods for solving the problems arising due to them.
4. Learn combustion mechanisms of gaseous, liquid and solid fuels.
5. Explain the equipment's involved in combustion

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Summarize the characterization of fuels.	Understand
CO2.	Select the various solid and liquid fuels	Apply
CO3.	Discuss about the various gaseous fuels	Understand
CO4.	Analyze the process of combustion processes	Analyze
CO5.	clarify the equipment's involved in combustion	Analyze

Course Contents:

UNIT I FUEL CHARACTERIZATION 8

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation - Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

UNIT II SOLID OF LIQUID FUELS 9

Solid Fuels Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals – Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels - Manufactured Solid Fuels. Liquid Fuels Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number.

UNIT III GASEOUS FUELS 8

Gaseous Fuel Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non - Thermal Route - Biogas – Digesters - Reactions - Viability - Economics.

UNIT IV COMBUSTION: STOICHIOMETRY & KINETICS 12

Stoichiometry – Mass Basis & Volume Basis – Excess Air Calculation – Fuel & Flue Gas Compositions - Calculations – Rapid Methods – Combustion Processes – Stationary Flame – Surface or Flameless Combustion – Submerged Combustion – Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion – Ignition & Ignition Energy – Spontaneous Combustion – Flame Propagation – Solid, Liquid & Gaseous Fuels Combustion – Flame Temperature – Theoretical, Adiabatic & Actual – Ignition Limits – Limits of In-flammability.

UNIT V COMBUSTION EQUIPMENTS 8

Coal Burning Equipment's – Types – Pulverized Coal Firing – Fluidized Bed Firing – Fixed Bed & Recycled Bed – Cyclone Firing – Spreader Stokers – Vibrating Grate Stokers – Sprinkler Stokers, Traveling Grate Stokers. Oil Burners – Vaporizing Burners, Atomizing Burners – Design of Burners. Gas Burners – Atmospheric Gas Burners – Air Aspiration Gas Burners – Burners Classification according to Flame Structures – Factors Affecting Burners & Combustion.

TOTAL: 45 PERIODS

Text Books:

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman,1990.
2. B.I. Bhatt and S.M. Vora, Stoichiometry, 2nd Edition, Tata Mcgraw Hill,1984.
3. Blokh A.G., Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn,1988.

Reference Books:

1. Sharma SP., Mohan Chander, Fuels & Combustion, Tata McGraw Hill,1984.
2. Holman J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc.,1988.
3. Yunus A. Cengel and Michael A. Boles, Thermodynamics, McGraw-Hill Inc.,2006.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3					2	2							1	2
CO2	3					2	2							1	2
CO3	3					2	2							1	2
CO4	3					2	2							1	2
CO5	3					2	2							1	2
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
Video presentation	10	5				
Attendance	10	5				

20PTE203	ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Chemistry				

Course Objectives

The course is intended to

1. Impart knowledge on the atmosphere and its present condition, global warming and eco-legislations.
2. Detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
3. Elaborate on the technologies available for generating energy from waste.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Explain emission standards	Understand
CO2.	Identify the pollution with suitable waste management system	Analysis
CO3.	Classify the types of power generation	Understand
CO4.	State the pollution from various industries.	Remember
CO5.	Select different types of waste water treatment	Apply

Course Contents:

UNIT –I INTRODUCTION 9

Global atmospheric change – greenhouse effect – Ozone depletion - natural cycles - mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental. Legislations

UNIT – II AIR POLLUTION 9

Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.

UNIT – III WATER POLLUTION 9

Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

Unit - IV WASTE MANAGEMENT 9

Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization

Unit – V OTHER TYPES OF POLLUTION FROM INDUSTRIES 9

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies. Radiation pollution: types, sources, effects, control of radiation pollution.

TOTAL: 45 PERIODS

Text Books:

1. Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International Edition, McGraw-Hill book Co, Singapore, 2000.
2. G.Masters, Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, New Delhi, 2003

Reference Books:

1. Arcadio P Sincero and G.A.Sincero, Environmental Engineering–A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 1998.
3. H.Ludwig, W.Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands N.J.(1991).
4. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Publishers, 2006.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3					3	3			2			3	
CO2		3					3	3			2			3	
CO3		3					3	3			2			3	
CO4		3					3	3			2			3	
CO5		3					3	3			2			3	
	3	High		2	Medium							1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE204	DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS	L	T	P	C
		3	2	0	4
Nature of Course	Professional core				
Pre requisites	Fundamentals of Mechanical Engineering				

Course Objectives

The course is intended to

1. Impart knowledge of mechanical engineering fundamentals of application.
2. Gain knowledge of thermodynamics process and their applications.
3. Learn the laws thermodynamics of with suitable properties.
4. Develop a clear understanding about thermo chemistry.
5. Explore the knowledge on thermodynamics for refrigeration cycles

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Summarize the basic design concepts.	Remember
CO2.	To get knowledge the modeling and systems simulation	Analyze
CO3.	To learn the New generation optimization techniques	Understand
CO4.	Infer and compare the dynamic and analysis	Analyze
CO5.	To learn the ground reality and application case study	Understand

Course Contents:

UNITI DESIGN CONCEPTS 12

Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor, modeling overview – levels and steps in model development - Examples of models – curve fitting and regression analysis

UNITII MODELLING AND SYSTEMS SIMULATION 12

Modelling of thermal energy systems – heat exchanger - solar collectors – distillation - rectification turbo machinery components - refrigeration systems - information flow diagram - solution of set of nonlinear lgebraic equations - successive substitution - Newton Raphson method- examples of thermal systems simulation

UNITIII OPTIMIZATION 12

Objectives - constraints, problem formulation - unconstrained problems - necessary and sufficiency conditions. Constrained optimization - Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis - New generation optimization techniques – examples

UNITIV DYNAMIC BEHAVIOUR 12

Steady state Simulation, Laplace Transformation, Feedback Control Loops, Stability Analysis, Non-Linearities

UNIT V APPLICATIONS AND CASE STUDIES 12

Case studies of optimization in thermal systems problems- Dealing with uncertainty- probabilistic techniques – Trade-offs between capital and energy using Pinch analysis

TOTAL: 60 PERIODS

TEXT BOOKS:

1. B.K.Hodge, Analysis and Design of Thermal Systems, Prentice Hall Inc.,1990.
2. Rao S. S., Engineering Optimization Theory and Practice, New Age Publishers,2000.

REFERENCES BOOKS:

1. D.J. Wide, Globally Optimal Design, Wiley- Interscience,1978.
2. Kapur J. N., Mathematical Modelling, Wiley Eastern Ltd, New York,1989.
3. Stoecker W. F., Design of Thermal Systems, McGraw Hill Edition,1989.
4. YogeshJaluria , Design and Optimization of Thermal Systems , CRC Press ,2007.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2		2								3	3	
CO2	3	3	2		2								3	3	
CO3	3	3	2		2								3	3	
CO4	3	3	2		2								3	3	
CO5	3	3	2		2								3	3	
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE205	THERMAL SYSTEMS SIMULATION LABORATORY	L	T	P	C
		0	0	4	2
Nature of Course	Professional Core				
Pre requisites	Thermodynamics, Thermal Engineering I & II				

Course Objectives

The course is intended

1. To learn the modeling and simulation analysis of various thermal engineering application using analysis software's
2. To perform a thermal system simulation and solve for a workable solution using the method of successive substitution
3. To generate an objective function and the appropriate constraints for a complete thermal system design problem

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Make use of heat exchanger analysis using NTU and LMTD method	Apply
CO2.	Experiment with convection heat transfer analysis – Velocity boundary layer and internal flow.	Apply
CO3.	Experiment with radiation heat transfer analysis – emissivity and critical radius of insulation analysis method	Apply
CO4.	Examine the lumped heat transfer analysis method	Apply
CO5.	Simply the condensation heat transfer analysis	Apply

Course Contents:

S.No	Exercises	CO Mapping	Blooms Level
IC engines lab			
1	Heat exchanger analysis – NTU method	1	Apply
2	Heat exchanger analysis – LMTD method	1	Apply
3	Convection heat transfer analysis – Velocity boundary layer.	2	Apply
4	Convection heat transfer analysis – Internal flow	2	Apply
5	Radiation heat transfer analysis – Emissivity	3	Apply
6	Critical radius of insulation	3	Apply
7	Lumped heat transfer analysis	4	Apply
8	Condensation heat transfer analysis	5	Apply

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3		3		3	3		3	3	3	2		3	3	
CO2	3		3		3	3		3	3	3	2		3	3	
CO3	3		3		3	3		3	3	3	2		3	3	
CO4	3		3		3	3		3	3	3	2		3	3	
CO5	3		3		3	3		3	3	3	2		3	3	
	3	High				2	Medium					1	Low		

TOTAL: 60 PERIODS

20PTE206	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1
Nature of Course	Employability Enhancement Course				
Pre requisites	Undergraduate Project Presentation				

COURSE OBJECTIVES:

1. To Enhance the ability of self-study
2. To encourage the students to study advanced engineering developments
3. To Improve presentation and communication skills
4. To prepare and present technical reports.
5. To encourage the students to use various teaching aids such as overhead projectors, PowerPoint presentation and demonstration models.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	To review, prepare and present technological developments	Understand
CO2	To face the placement interviews	Understand
CO3	To improve the speaking skills	Understand
CO4	To develop your confidence in handling information, making useful notes, and presenting an argument	Understand
CO5	To improve the research and development Knowledge	Understand

GUIDELINES

- The student is expected to present a seminar in one of the current topics in the field of Thermal Engineering related issues / technology.
- The seminar shall be of 30 minutes duration and give presentation to the Seminar Assessment Committee (SAC).
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- In a session of two periods per week, 4 students are expected to present the seminar.
- Students are encouraged to use various teaching aids such as power point presentation and demonstrative models.
- Students are required to prepare a seminar report in the prescribed format given by the department.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-			3	2	3	2	3	2	2	-	-	-
CO2	-	-	-	-	-	1	1	3	3	3	2	2	-	-	-
CO3	-	-	-	-	-	3	1	2	2	2	3	3	-	-	-
CO4	-	-	-	-	-	2	2	3	3	2	3	2	-	-	-
CO5	-	-	-	-	-	3	1	3	2	2	3	3	-	-	-
	3	High					2		Medium			1	Low		

TOTAL: 30 PERIODS

PROFESSIONAL ELECTIVE

20PTEE01	AIRCRAFT AND JET PROPULSION	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft and Jet Propulsion				

Course Objectives

The course is intended to

1. To gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rockets
2. To gain knowledge in Aircraft system
3. To analysis and performance of aircraft engines
4. To learn about the rocket propulsion
5. To understand the classification of rocket thrust chamber

Course Outcomes

On successful completion of this course the student will be able to understand the working of different types of Aircraft and Jet propulsion systems and their performance characteristics.

CO. No.	Course Outcome	Bloom's Level
CO1.	Define the basis of Gas dynamics	Remember
CO2.	Summarize the thermodynamics aspects in aircraft engines	Understand
CO3.	Analyze the performance of aircraft engines	Analyze
CO4.	Illustrate the performance characteristics of Rocket propulsion	Understand
CO5.	Classify the Rocket thrust chamber	Analyze

Course Contents

UNIT I GAS DYNAMICS 8

Wave motion - Compressible fluid flow through variable area devices – Stagnation state Mach Number and its influence and properties, Isentropic Flow, Rayleigh and Fanon Flow. Deflagration and Detonation – Normal shock and oblique shockwaves.

UNIT II THERMODYNAMICS OF AIRCRAFT ENGINES 9

Theory of Aircraft propulsion – Thrust – Various efficiencies – Different propulsion systems – Turboprop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft. Variable thrust- nozzles – vector control.

UNIT III PERFORMANCE CHARACTERISTICS OF AIRCRAFT ENGINES 9

Engine - Aircraft matching – Design of inlets and nozzles – Performance characteristics of Ramjet, Turbojet, Scramjet and Turbofan engines.

UNIT IV ROCKET PROPULSION 9

Theory of rocket propulsion – Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics – Losses and efficiencies.

UNIT V ROCKET THRUST CHAMBER 10

Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Non-equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer.

TOTAL = 45 PERIODS

Reference Books:

1. Bonney E.A., Zucrow N.J, Principles of Guided Missile Design, Van Nostranc Co., 1956.
2. Khajuria P.R. and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
3. Mattingly J.D., Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition, 1997.
4. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.
5. S.M.Yahya, Fundamentals of Compressible Flow, Third edition, New Age International Pvt Ltd, 2003.
6. Zucrow N.J., Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons, New York, 1970.
7. Zucrow N.J., Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc, New York, 1975.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2										3	1	2
CO2	3	3	2										3	1	2
CO3	3	3	2										3	1	2
CO4	3	3	2										3	1	2
CO5	3	3	2										3	1	2
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE02	HYDROGEN AND FUEL CELL TECHNOLOGIES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamental knowledge in Hydrogen and Fuel Cell Technologies				

Course Objectives

The course is intended to

1. To study in detail on the hydrogen production methodologies
2. To learn the possible applications and various storage options.
3. To understand the working principle of a typical fuel cell
4. To gain the knowledge of various types fuel cell and to elaborate on its thermodynamics and kinetics.
5. To study the cost effectiveness and eco-friendliness of Fuel Cells.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Define the properties of hydrogen and its production methodologies	Remember
CO2.	Illustrate the hydrogen storage techniques and its applications	Understand
CO3.	Explain on working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics	Understand
CO4.	Outline the concepts of different fuel cells	Understand
CO5.	Analysis the cost effectiveness and eco-friendliness of Fuel Cells	Apply

Course Contents:

UNIT –I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES: 9

Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water

UNIT – II HYDROGEN STORAGE AND APPLICATIONS: 9

Hypothesis: sources, types and characteristics; Sample survey: sample and census survey, probability, non- probability and mixed sampling

UNIT – III FUEL CELLS: 9

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery vs fuel cell.

UNIT - IV FUEL CELL – TYPES: 9

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits

UNIT – V APPLICATION OF FUEL CELL AND ECONOMICS: 9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell, Future trends in fuel cells.

TOTAL: 45 PERIODS

Reference Books:

1. Viswanathan B. and Aulice Scibioh.M, Fuel Cells – Principles and Applications, Universities Press, 2006.

2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK2005.
4. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany1996.
5. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
6. Jeremy Rifkin, the Hydrogen Economy, Penguin Group, USA2002. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2		2						2		3	3	
CO2	3	2	2		2						2		3	3	
CO3	3	2	2		2						2		3	3	
CO4	3	2	2		2						2		3	3	
CO5	3	2	2		2						2		3	3	
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE03	ENERGY RESOURCES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals of Mechanical Engineering				

Course Objectives

1. To explain concepts of various forms of Non-renewable and renewable energy.
2. To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications.
3. To study the environmental and cost economics of using renewable energy sources compared to fossil fuels.
4. Learn the present energy scenario and the need for energy conservation.
5. Analyze the environmental aspects of renewable energy resources.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Classify the commercial energy and renewable energy sources.	Understand
CO2.	Contrast the working principle of various energy systems.	Understand
CO3.	Identify Winds energy as alternate form of energy and to know how it can be tapped.	Apply
CO4.	Explain bio gas generation and its impact on environment.	Analyze
CO5.	Compare the Geothermal &Tidal energy, its mechanism of production and its applications.	Analyze

Course Contents:

UNIT I COMMERCIAL ENERGY 9

Coal, Oil, Natural gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India.

UNIT II SOLAR ENERGY 9

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

UNIT III WIND ENERGY 9

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India – Repowering concept.

UNIT IV BIO-ENERGY 9

Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - types of biogas Plant - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT V OTHER TYPES OF ENERGY 9

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plant - ocean wave energy conversion - tidal energy conversion – small hydro - geothermalenergy-geothermalpowerplant–hydrogenproductionandstorage-Fuelcell– principle of working - various types - construction and applications.

TOTAL = 45 PERIODS

Reference Books:

1. Sukhatme S.P., “Solar Energy”, Tata McGraw Hill, 1984.
2. Twidell J.W. and Weir A., “Renewable Energy Sources”, EFN Spon Ltd., 1986.
3. Kishore V.V.N., “Renewable Energy Engineering and Technology”, Teri Press, New Delhi, 2012
4. Peter Gevorkian, “Sustainable Energy Systems Engineering,” McGraw-Hill, 2007.
5. Kreith F. and Kreider J.F., “Principles of Solar Engineering”, McGraw-Hill, 1978.
6. Godfrey Boyle, “Renewable Energy Power for a Sustainable Future”, Oxford University Press, U.K, 1996.
7. Veziroglu T.N., Alternative Energy Sources”, Vol 5 and 6, McGraw-Hill, 1990.
8. Anthony San Pietro, “Biochemical and Photosynthetic aspects of Energy Production”, Academic Press, 1980.
9. Bridgurater A.V., “Thermochemical processing of Biomass”, Academic Press, 1981.
10. Bent Sorensen, “Renewable Energy”, Elsevier, Academic Press, 2011.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3			2				3			3		3	3	1
CO2	3			2				3			3		3	3	1
CO3	3			2				3			3		3	3	1
CO4	3			2				3			3		3	3	1
CO5	3			2				3			3		3	3	1
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE04	ADVANCED INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Thermal Engineering				

Course Objectives

The course is intended to

1. To update the knowledge in engine exhaust emission control.
2. To make aware of alternate fuels and its significance.
3. To enable the students to understand the recent developments in IC Engines.
4. To educate them with the technological advancements of I.C Engine.
5. To educate students with the technological advancements of S.I Engine.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	List the various types of I.C. Engines and its Cycles of operation.	Remember
CO2.	Explain the performance parameters in IC Engines.	Understand
CO3.	Summarize the causes of emission.	Understand
CO4.	Estimate the engines performance with alternative fuels.	Evaluate
CO5.	Justify the environmental and social impact of IC Engines.	Evaluate

Course Contents:

UNIT I SPARK IGNITION ENGINES 9

Spark ignition Engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – factors affecting knock – Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES 9

States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behavior – spray structure, spray penetration and evaporation – air motion – Introduction to Turbo charging.

UNIT III POLLUTANT FORMATION AND CONTROL 9

Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS 9

Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

UNIT V RECENT TRENDS 9

Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – laser Doppler, Anemometry. Use of nano technology in IC Engines.

TOTAL = 45 PERIODS

Text Books:

1. Heinz Heisler, Advanced Engine Technology," SAE International Publications, USA, 1998
2. Ganesan V., Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2007

Reference Books:

1. Duffy Smith, Auto fuel Systems, The Good Heart Willox Company, Inc., 1989.
2. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.
3. K.K. Ramalingam, Internal Combustion Engine fundamentals, SciTech Publications, 2002.
4. Kirpal Singh, Automobile Engineering Vol - I, Standard Publishers, Delhi 2013.
5. R.B. Mathur and R.P.Sharma, Internal Combustion Engines, Dhanapat Rai Publications, 1993.
6. V. Ganesan, Internal Combustion Engines, II Edition, Tata McGraw-Hill Education, 2002.
7. Willard W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 1997.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2						2				3	3	1
CO2	3	3	2						2				3	3	1
CO3	3	3	2						2				3	3	1
CO4	3	3	2						2				3	3	1
CO5	3	3	2						2				3	3	1
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE05	ADVANCES IN METROLOGY AND INSPECTION	L	T	P	C
		3	0	0	3
Nature of Course	Professional elective				
Pre requisites	Inspection, Analysis of Thermal Components				

Course Objectives

1. To basic concepts in various methods of engineering measurement techniques and applications.
2. To understand the importance of measurement and inspection in manufacturing industries.
3. To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.
4. To design and develop a new measuring methods.
5. Understand the advanced measurement techniques used in industries.

Course Outcomes

On successful completion of the course, students will be able to

CO No	Course Outcomes	Blooms Level
CO 1	Understand the advanced measurement principles	Understand
CO 2	Select the sophisticated measurement and inspection facilities	Remember
CO 3	Choose the new measuring methods for Inspection	Evaluate
CO 4	List the Measuring instruments and its applications	Analyze
CO 5	Applying the Image Processing technique in Metrology	Apply

Course Contents:

UNIT I CONCEPTS OF METROLOGY **8**

Terminologies – Standards of measurement – Errors in measurement – Interchangeability and Selective assembly – Accuracy and Precision – Calibration of instruments – Basics of Dimensional metrology and Form metrology

UNIT II MEASUREMENT OF SURFACE ROUGHNESS **9**

Definitions – Types of Surface Texture: Surface Roughness Measurement Methods-Comparison, Contact and Non-Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.

UNIT III INTERFEROMETRY **8**

Introduction, Principles of light interference – Interferometers – Measurement and Calibration – Laser Interferometry.

UNIT IV MEASURING MACHINES AND LASER METROLOGY **10**

Tool Makers Microscope – Microhite – Coordinate Measuring Machines – Applications – Laser Micrometer, Laser Scanning gauge, Computer Aided Inspection techniques - In-process inspection, Machine Vision system-Applications.

UNIT V IMAGE PROCESSING FOR METROLOGY **10**

Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, gray scale models, histogram models, Image Transforms - Examples.

TOTAL: 45 PERIODS

REFERENCES

1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., 1992.
2. Bewoor, A.K. and Kulkarni, V.A., "Metrology and Measurement", Tata Mc Graw-Hill, 2009.
3. Galyer, F.W. and Shotbolt, C.R., "Metrology for engineers", ELBS, 1990.
4. Gupta, I.C., "A Text Book of engineering metrology", Dhanpat Rai and Sons, 1996.
5. Jain, R.K., "Engineering Metrology", Khqanna Publishers, 2008.
6. Rajput,R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers,2001.
7. Smith,G.T., "Industrial Metrology", Springer,2002
8. Sonka,M., Hlavac,V. and Boyle.R., "Image Processing, Analysis, and Machine Vision", Cengage- Engineering,2007.
9. Whitehouse, D.J., "Surface and their measurement", Hermes Penton Ltd, 2004.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
	3	**High**				**2**	**Medium**					**1**	**Low**		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE06	NON DESTRUCTIVE TESTING AND FAILURE ANALYSIS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals of Mechanical Engineering				

Course Objectives

The course is intended to

1. To understand the principles behind various NDT techniques
2. To study about NDT equipments and accessories
3. To learn working procedures of various NDT techniques
4. To compare and selection of different NDT methods
5. To design and material improvements derived from case studies

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Demonstrate good grounding in the area of NDT	Understand
CO2.	Classify the proper NDT Method and its application.	Analyze
CO3.	Determine the utilization of test and measurement appropriate to the area of his study/problem	Evaluate
CO4.	Compare and selection of different NDT methods	Evaluate
CO5.	Explain the design and material Improvements derived from case studies	Evaluate

Course Contents:

UNIT I NDT VS DESTRUCTIVE TESTING 9

NDT Vs destructive testing – advantages and limitations – different types of NDT

UNIT II NDT TECHNIQUES 9

Eddy current and ultrasonic techniques

UNIT III DIFFERENT NDT METHODS 9

Comparison and selection of different NDT methods – statistical significance – reliability aspects Need for multiple NDT procedures in critical components – concept of NDE

UNIT IV NDT METHOD 9

Detailed discussion of LPT, MPT and radiography

UNIT V FAILURE ANALYSIS 9

Concept of failure analysis – methodology, approaches and tools – design and material Improvements derived from case studies – fracture mechanics approach

TOTAL = 45 PERIODS

Text Books:

1. Baldev Raj, Jayakumar, Thavasimuthu. M., Practical Non-destructive testing, Narosa Publishing, 1997.
2. Das. A.K., Metallurgy of failure analysis, Tata McGraw Hill, 1992. Heinz Heisler, „Advanced Engine Technology," SAE International Publications,USA,1998
3. Ganesan V." Internal Combustion Engines" , Third Edition, Tata McGraw-Hill ,2007

Reference Books:

1. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1st edition (2001).
2. J. Thomas Schmidt, K. Skeie and P. MacIntire, ASNT Non Destructive Testing Handbook: Magnetic Particle Testing, American Society for Nondestructive Testing, American Society for Metals, 2nd edition (1989).
3. V. S. Cecco, G. V.Drunen and F.L. Sharp, Eddy current Manual: Test method, Vol.1,Chalk River Nuclear Laboratories (1983).
4. B.P.C. Rao, Practical Eddy Current Testing, Alpha Science International Limited (2006).
5. N. A. Tracy, P. O. Moore, Non-Destructive Testing Handbook: Liquid PenetrantTesting,Vol.2, American Society for Nondestructive Testing, 3rd edition (1999).
6. Don E. Bray and Roderic K. Stanley, Nondestructive Evaluation: A Tool in Design, Manufacturing and Service, CRC Press (1996).

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3			2				1				3	3	
CO2	3	3			2				1				3	3	
CO3	3	3			2				1				3	3	
CO4	3	3			2				1				3	3	
CO5	3	3			2				1				3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE07	POLYMERS AND COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3
Nature of Course	Professional elective				
Pre requisites	Composites, polymers and its Characterization				

Course Objectives

1. To teach the students basic concepts in various methods of engineering Materials and applications.
2. Understand the importance of Composite Materials in manufacturing industries.
3. To impart knowledge on types, physical properties and processing of polymer matrix composites
4. To design and develop a new Processing methods involved in Ceramics composites.
5. Understand the advanced Process involved in metal matrix composites used in industries.

Course Outcomes

CO No	Course Outcomes	Blooms Level
CO 1	Define the composite material, reinforcements of polymer composites.	Remember
CO 2	Develop knowledge on processing, interfacial properties and application of composites.	Apply
CO 3	Select reinforcements of polymer matrix composites	Evaluate
CO 4	List the Process of Metal matrix Composites	Analyze
CO 5	Importance of Processing technique in Ceramic Matrix Composites and its applications.	Apply

Course Contents:

UNIT I PROCESSINGOF POLYMERS **9**

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

UNIT II FIBERS AND MATRIX MATERIALS **9**

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibers - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface
– Tests for measuring interfacial strength - Physical and chemical properties.

UNIT III PROCESSING OF POLYMERMATRIX COMPOSITES **9**

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs –recycling of PMCs.

UNIT IV PROCESSING OF METAL MATRIX COMPOSITES **9**

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

UNIT V PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES **9**

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites –applications.

TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. ASM Handbook – Composites, Vol-21, 2001, ISBN: 978-0-87170-703-1.
2. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers,2002.
3. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009. ISBN: 978-0-387-35539-9.
4. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012,ISBN:978-0-387-74364-6.
5. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
6. Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers,2003.
7. Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999, ISBN:0-8247-0178-x.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
	3	**High**				**2**	**Medium**					**1**	**Low**		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

ELECTIVE III & IV

20PTEE11	COMPUTATIONAL FLUID DYNAMICS FOR THERMAL SYSTEMS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Computational Fluid Dynamics for Thermal Systems				

Course Objectives

The course is intended to

1. This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion.
2. It will enable the students to understand the various discretization methods and solving methodologies
3. To create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
4. To develop finite volume discretized forms of the CFD equations.
5. To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Summarize the governing differential equation in heat transfer	Understand
CO2.	Solve the steady diffusion problems for different dimensions	Apply
CO3.	Examine the finite volume method	Analyze
CO4.	List the various type of flow process	Analyze
CO5.	Discuss the description of turbulent flow and its modelling	Create

Course Contents:

UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETIZATION TECHNIQUES 9

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretization techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretization of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes

UNIT III CONVECTION – DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme

UNIT IV FLOW PROCESSES: FINITE VOLUME METHOD 9

Discretization of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT V TURBULENCE AND ITS MODELING **9**

Description of turbulent flow, free turbulent flows, flat plate boundary layer and pipe flow, Algebraic Models, One equation model, k – ε & k – ω models Standard and High and Low Reynolds number models

TOTAL: 45 PERIODS

References

1. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and HeatTransfer " Hemisphere Publishing Corporation, New York, USA,2012.
2. Bose, T.K., "Numerical Fluid Dynamics" Narosa Publishing House,1997.
3. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag,1991.
4. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag,1988.
5. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
6. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
7. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			3	3		2	2		2				3		2
CO2			3	3		2	2		2				3		2
CO3			3	3		2	2		2				3		2
CO4			3	3		2	2		2				3		2
CO5			3	3		2	2		2				3		2
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE12	FANS, BLOWERS AND COMPRESSORS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamental knowledge in Prime movers				

Course Objectives

The course is intended to

1. To develop knowledge about turbo machinery and its working principles.
2. To formulate analysis of compressors, centrifugal blowers and testing of fans.
3. To understand the design concepts of compressors
4. To analysis various testing and control techniques of fans
5. To understand the blowers control techniques in thermal applications

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Understand about Turbo machinery and its working principles	Remember
CO2.	Analysis function and characteristics of blowers and fans	Apply
CO3.	Understand the design concepts of compressors	Understand
CO4.	Analysis various testing and control techniques of fans	Apply
CO5.	Apply a blowers control techniques in thermal applications	Apply

Course Contents:

UNIT – I PRINCIPLES OF TURBO MACHINERY: 9

Introduction to turbo machines - Transfer of energy to fluids - Performance characteristics - fan laws - Dimensionless parameters - Specific speed - selection of centrifugal, axial, and mixed flow machines

UNIT – II ANALYSIS OF CENTRIFUGAL BLOWERS AND FANS: 9

Centrifugal Blowers: Theoretical characteristic curves, Euler's characteristics and Euler's velocity triangles, losses and hydraulic efficiency, flow through impeller inlet volute, diffusers, leakage disc friction mechanical losses multivane impellers of impulse type, cross flow fans.

UNIT – III ANALYSIS OF COMPRESSOR: 9

Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

UNIT - IV TESTING AND CONTROL OF FANS: 9

Fan testing, noise control, materials and components blower regulation, speed control, throttling, control at discharge and inlet

UNIT – V APPLICATIONS OF BLOWERS: 9

Applications of blowers, induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

TOTAL: 45 PERIODS

Reference

1. S.M. Yahya, Turbines, Compressors and Fans, Tata McGraw-Hill Education, 1987.
2. Stepanoff A.J., Turbo blowers, John Wiley & Sons, 1970.
3. Brunoeck, Fans, Pergamon Press, 1973.
4. Austin H. Church, Centrifugal pumps and blowers, John Wiley and Sons, 1980.
5. Dixon, Fluid Mechanics, Thermodynamics of turbomachinery, Pergamon Press, 1984.
6. Dixon, Worked examples in turbomachinery, Pergamon Press, 1984.
7. Earl Logan Jr., Ramendra Roy, Handbook of Turbomachinery, Second Edition, Marcel Dekker, Inc, New York, 2003.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	3						2				3	3	
CO2	2	2	3						2				3	3	
CO3	2	2	3						2				3	3	
CO4	2	2	3						2				3	3	
CO5	2	2	3						2				3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE13	FOOD PROCESSING, PRESERVATION AND TRANSPORT	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	None				

Course Objectives

The course is intended to

1. To develop knowledge about food products, Mechanism of food spoilage critical microbial growth requirements and design for control of microorganisms
2. To understand methods of food processing and preservation of foods
3. To understand the various methods of food freezing and drying.
4. To understand the concepts of cold storage design & instrumentation systems
5. To understand packing and transporting food products.

Course Outcomes

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Develop knowledge about food products, Mechanism of food spoilage critical microbial growth requirements and design for control of microorganisms	Apply
CO2.	Summaries methods of food processing and preservation of foods	Understand
CO3.	Analysis the various methods of food freezing and drying techniques	Analyze
CO4.	Classify the concepts of cold storage design & instrumentation systems	Understand
CO5.	List the packing and transporting food products.	Analyze

Course contents:

UNIT I INTRODUCTION 9

Microbiology of Food Products, Mechanism of food spoilage critical microbial growth requirements, Design for control of microorganisms, The role of HACCP, Sanitation, Regulation and standards.

UNIT II PROCESSING & PRESERVATION 12

Thermodynamic properties and Transfer properties, Water content, Initial freezing temperature, Ice fraction, Transpiration of fresh fruits & vegetables, Food processing techniques for Dairy products, Poultry, Meat, Fruits & Vegetables.

UNIT III FREEZING & DRYING 12

Precooling, Freeze drying principles, Cold storage & freezers, Freezing drying limitations, Irradiation techniques, Cryofreezing, Numerical and analytical methods in estimating Freezing, Thawing times, Energy conservation in food industry.

UNIT IV COLD STORAGE DESIGN & INSTRUMENTATION 7

Initial building consideration, Building design, Specialized storage facility, Construction methods, Refrigeration systems, Insulation techniques, Control & instrumentation, Fire protection, Inspection &maintenance

UNIT V PACKAGING AND TRANSPORT **5**

Refrigerated transportation, Refrigerated containers & trucks, Design features, Piping & Role of cryogenics in freezing & transport. Basic packaging materials, types of packaging, Packaging design. Packaging for different types of foods.

TOTAL : 45 PERIODS

References

1. Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub.,1989.
2. Ibraham Dincer, Heat Transfer in Food Cooling Applications, Tailor & Francis Pub.,1997.
3. Stanley E. Charm, Fundamentals of Food Engineering, III Edition, AVI Pub. Company Inc. 1989.
4. Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub. New York,1991.
5. Arora C.P., Refrigeration and Air conditioning II Edition, McGraw-Hill, Pub.,2000.
6. ASHRAE Handbook, Refrigeration, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta,1988.
7. Fellows P.J., Food processing Technology: Principle and Practices, Wood Head Publishing, 1997.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3		2					2	2				3	1	2
CO2	3		2					2	2				3	1	2
CO3	3		2					2	2				3	1	2
CO4	3		2					2	2				3	1	2
CO5	3		2					2	2				3	1	2
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE14	CRYOGENIC ENGINEERING	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Thermodynamics, fluid mechanics and heat transfer, along with a basic understanding of engineering materials.				

Course Objectives

The course is intended to

1. To understand the basic concepts of cryogenic systems
2. To gain the knowledge of air-liquefaction processes to practical situations.
3. To Interpret and analyze the separation of cryogenic gases techniques.
4. To understand the classification of Cryogenic refrigeration systems
5. To understand the various measuring flow techniques in cryogenic engineering

Course Outcomes

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Illustrate the concepts of cryogenic systems.	Understand
CO2.	Relate air-liquefaction processes to practical situations.	Remember
CO3.	Interpret and analyze the separation of cryogenic gases techniques.	Evaluate
CO4.	Classify Cryogenic refrigeration systems.	Remember
CO5.	Apply the various measuring flow techniques in cryogenic engineering	Apply

Course contents:

UNIT I INTRODUCTION **9**

Definition and Engineering Applications of Cryogenics, Properties of solids for cryogenic systems

UNIT II REFRIGERATION AND LIQUEFACTION **9**

Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle

UNIT III ULTRA-LOW-TEMPERATURE REFRIGERATORS **9**

Definition and Fundamentals regarding ultra-low temperature refrigerators, Equipment associated with low-temperature systems, Various Advantages and Disadvantages.

UNIT IV STORAGE AND HANDLING OF CRYOGENIC REFRIGERANTS **9**

Storage and Transfer systems, Insulation, Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on

UNIT V APPLICATIONS **9**

Broad Applications of Cryogenic Refrigerants in various engineering systems

TOTAL = 45 PERIODS

TEXT BOOKS

1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics - Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. Arora, C.P., Refrigeration and Air-conditioning, Tata-McGraw Hill, 2008.
3. A. R. Jha, Cryogenic Technology and Applications, Butterworth-Heinemann, 2005.

REFERENCES

1. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, PlenumPress, New York, 1989.
2. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
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5. Robert W. Vance, Cryogenic Technology, John wiley & Sons, Inc., New York, London.
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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3		2			1			2					3	1
CO2	3		2			1			2					3	1
CO3	3		2			1			2					3	1
CO4	3		2			1			2					3	1
CO5	3		2			1			2					3	1
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE15	AIR CONDITIONING SYSTEMS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	None				

Course Objectives

1. To learn the psychometric concepts underlying Air conditioning process.
2. To learn the design features and load estimation principles of specific Air conditioning system.
3. To learn about the critical auxiliary systems such as air distribution circuits, water distribution circuits etc.
4. To evaluate the cooling load for air conditioning systems used for various Characteristics
5. To understand the conceptually the design of a HVAC system in automobiles.

Course Outcomes

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Illustrate the cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems	Understand
CO2.	List the properties, applications and environmental issues of different refrigerants	Analyze
CO3.	Classify the fundamental principles and different methods of air conditioning	Analyze
CO4.	Evaluate the cooling load for air conditioning systems used for various Characteristics	Evaluate
CO5.	Analyze the air conditioning systems in automobiles	Analyze

Course contents:

UNIT I PSYCHROMETRY AND AIR CONDITIONING PROCESSES 9

Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Enthalpy potential and its insights.

UNIT II LOAD ESTIMATION 10

Thermal comfort – Design conditions – Solar Radiation-Heat Gain through envelopes – Infiltration and ventilation loads – Internal loads – Procedure for heating and cooling load estimation.

UNIT III AIR CONDITIONING SYSTEMS 8

Thermal distribution systems – Single, multi zone systems, terminal reheat systems, Dual duct systems, variable air volume systems, water systems and Unitary type systems.

UNIT IV AIR DISTRIBUTION AND CONTROL 10

Flow through Ducts, Static & Dynamic Losses, Diffusers, Duct Design–Equal Friction Method, System Balancing, Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units – Control of temperature, humidity, air flow and quality.

UNIT V HVAC SYSTEM IN AUTOMOBILES 8

Automotive System layout and Components- Commonly used Refrigerants- Safety devices – Climate control – Fuel efficiency aspects.

TOTAL = 45 PERIODS

References

1. Ali Vedavarz, Sunil Kumar, Mohammed Iqbal, Hussain Handbook of Heating, Ventilation and Air conditioning for Design Implementation, Industrial press Inc, 2007.
2. Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill Pub. Company, 2010.
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4. Carrier Air Conditioning Co., Handbook of Air Conditioning Systems design, McGraw Hill, 1985.
5. Jones, Air Conditioning Engineering, Edward Amold pub.2001.
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7. Langley, Billy C., Refrigeration and Air Conditioning Ed. 3, Engie wood Cliffs (N.J) Prentice Hall1986.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3		3			3	3		3			3	1	2
CO2		3		3			3	3		3			3	1	2
CO3		3		3			3	3		3			3	1	2
CO4		3		3			3	3		3			3	1	2
CO5		3		3			3	3		3			3	1	2
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE16	MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES	L	T	P	C
		3	0	0	4
Nature of Course	Professional elective				
Pre requisites	Material testing				

Course Objectives

1. This course aims to impart knowledge on various techniques of material characterization.
2. Understand the importance of microstructure evaluation, crystal structure analysis.
3. To impart knowledge on Chemical and Thermal Analysis.
4. To Design and develop a new methods involved in Mechanical testing.
5. Understand the advanced Process involved in Dynamic tests in industries.

Course Outcomes

On successful completion of this course the student will be able to

CO No	Course Outcomes	Blooms Level
CO 1	Define the Micro and Crystal structure analysis	Understand
CO 2	Develop the knowledge on Electron Microscopy techniques.	Remember
CO 3	Select reinforcements of polymer matrix composites and its applications.	Evaluate
CO 4	List the Process of Mechanical testing-Staic Tests	Analyze
CO 5	Importance of Mechanical testing-Dynamic Tests	Apply

Course contents:

UNIT I MICRO AND CRYSTALSTRUCTUREANALYSIS **10**

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers–Microstructure of Engineering Materials Elements of Crystallography – X-ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT II ELECTRON MICROSCOPY **9**

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications .

UNIT III CHEMICAL AND THERMAL ANALYSIS **9**

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravity metric Analysis (TGA)

UNITIV MECHANICAL TESTING –STATICTESTS **8**

Hardness– Brinell, Vickers, Rockwell and Micro Hardness Test–Tensile Test–Stress–Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNITV MECHANICAL TESTING –DYNAMIC TESTS **9**

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

TOTAL: 45 PERIODS

REFERENCES:

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
	3	**High**				**2**	**Medium**					**1**	**Low**		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE17	ALTERNATIVE FUELS FOR IC ENGINES	L	T	P	C
		3	0	0	3
Nature of Course	Professional elective				
Pre requisites	Fundamental of IC Engines				

Course Objectives

1. To understanding of the engineering issues and perspectives affecting fuel and engine development
2. To examine future trends and development, including hydrogen as an internal combustion engine fuel.
3. To explore further fuel specification and performance requirements for advanced combustion Systems.
4. To understand the various alternative fuel options available for conventional fuels and their performance and emission characteristics.
5. To classify the combustion in spark compression ignition by gaseous fuels

Course Outcomes

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Solve a problem oriented in depth knowledge of Alternate fuel and energy system	Apply
CO2.	Identify the combustion in spark ignition by liquid fuels	Understand
CO3.	Inspect the combustion in spark compression ignition by liquid fuels	Analyze
CO4.	Measure the combustion in spark ignition by gaseous fuels	Evaluate
CO5.	Classify the combustion in spark compression ignition by gaseous fuels	Understand

Course contents:

UNIT I INTRODUCTION 12

Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels – Ethanol, Methanol, Diethyl ether, Dimethyl ether, Hydrogen, Liquefied Petroleum Gas, Natural Gas, Bio- gas and Bio-diesel.

UNIT II LIQUID FUELS FOR S.I.ENGINES 9

Requirements, Utilisation techniques – Blends, Neat form, Reformed Fuels, Storage and Safety, Performance and Emission Characteristics

UNIT III LIQUID FUELS FOR C.I.ENGINES 8

Requirements, Utilisation techniques - Blends, Neat fuels, Reformed fuels, Emulsions, Dual fuelling, Ignition accelerators and Additives, Performance and emission characteristics.

UNITI V GASEOUS FUELS FOR S.I.ENGINES 8

Hydrogen, Compressed Natural gas, Liquefied Petroleum gas, and Bio gas in SI engines – Safety Precautions – Engine performance and emissions.

UNIT V GASEOUS FUELS FOR C.I.ENGINES 8

Hydrogen, Biogas, Liquefied Petroleum gas, Compressed Natural gas in CI engines. Dual fuelling, Performance and emission characteristics.

TOTAL = 45 PERIODS

REFERENCES

1. Alcohols as motor fuels progress in technology - Series No.19 - SAE Publication USE, 1980.
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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3					2	1						3	1	
CO2	3					2	1						3	1	
CO3	3					2	1						3	1	
CO4	3					2	1						3	1	
CO5	3					2	1						3	1	
	3	High				2	Medium					1	Low		

Assessment	**Marks**	**Weightage**	**Marks**	**IAE Marks**	**FE**	**Total Marks**
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IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				