UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

M TECH (Thermal Engineering)

Programme

2018

						Examination Duration (Hrs.)		Evaluation Scheme					
Course Code	**Course Title**	**Period (Hrs.)**	**L**	**T**	**P**			**Sessional**				**University Exam**	
						Theory	**Practical**	**CT**	**Atten-dance**	**TA**	**Total**	**ESE**	**Total**
1st Year						**1st Semester**							
MTET-100	Advanced Mathematics	4	3	1	0	3	……	30	10	10	50	100	150
MTET-101	Advanced Thermodynamics	4	3	1	0	3	……	30	10	10	50	100	150
MTET-102	Advanced Fluid Mechanics	4	3	1	0	3	……	30	10	10	50	100	150
MTET-103	Advanced Heat Transfer	4	3	1	0	3	……	30	10	10	50	100	150
MTET-11X	Elective-I	4	3	1	0	3	……	30	10	10	50	100	150
Total		**20**	**15**	**0**	**0**								**750**
						2nd Semester							
MTET-201	Convective Heat & Mass Transfer	4	3	1	0	3	……	30	10	10	50	100	150
MTET-22X	Elective-II	4	3	1	0	3	……	30	10	10	50	100	150
MTET-22X	Elective-III	4	3	1	0	3	……	30	10	10	50	100	150
MTET-22X	Elective-IV	4	3	1	0	3	……	30	10	10	50	100	150
MTET-22X	Elective-V	4	3	1	0	3	……	30	10	10	50	100	150
		20	**15**	**5**	**0**								**750**
2nd Year						**3rd semester**							
MTES-301	Seminar	4									100	….	100
MTEP-301	Project	4									100	100	200
MTED-301	M.Tech. Dissertation	12									200	….	200
Total		**20**									**400**	**100**	**500**
						4th Semester							
MTED-401	M. Tech. Dissertation	24									250	250	500
Total		**24**											**500**

Semester wise distribution of Marks & Credit Points

Semester	Credits
I	20
II	20

III	12
IV	12
Total	**64**

List of Elective Subjects for

M. Tech. (Thermal Engineering)

	Subject code	**Subject Name**
Elective-I		
	MTET-111	Solar Energy
	MTET-112	Computational Fluid Dynamics & Heat Transfer
Elective-II to Elective-V		
	MTET-221	Power Plant Engineering
	MTET-222	Refrigeration and air conditioning system design
	MTET-223	I.C. Engines
	MTET-224	I.C. Engines Combustion Process Modeling
	MTET-225	Renewable Energy Systems
	MTET-226	Gas turbine & Compressor
	MTET-227	Cryogenic Systems

MTET-100	**Advanced Mathematics**	**L**	**3**	**T**	**1**	**P**	**0**	**Credit 04**	

Pre-requisite: Nil

Objective of Course: The course discusses exclusively the application of various topics useful for thermal engineering course.

Details of Course

S.No	Particulars	Contact Hours
1	Four standard forms of non-linear partial differential equations, linear equations with constant coefficients.	04
2	Wave equation, Diffusion equation, Laplace equation in Cartesian, cylindrical and spherical coordinates solution by separation of variables.	07
3	Matrix Theory, Solution of linear system of Algebraic and Differential Equation, Eigen values and Eigen Vectors, Unitary , Hermitian and Normal Matrices.	04
4	Definition, linearity property of Z-Transform, Z-Transform of elementary Functions, shifting theorems, initial and final value theorem, Convolution Theorems, Inverse of Z-transform.	06
5	Fourier integral theorem, Fourier Transform, Application of Fourier Transform, Laplace Transform and its applications.	06
6	Special Functions- Bessel's, Legendres, Chebyshev Polynomials.	06
7	Calculus of variation : Euler's Equation , solution of Euler's Equations,Geodesics, Isoperimetric Problems ,Several Dependent Variables, Functionals involving Higher order Derivatives, Applications to Dynamical Problems ,Weistress sufficiency Conditions for week and strong minimum and maximum Extreme	09
	Total	**42**

Suggested Books :

S.No	Name of books/Authors/Publisher
1	"Partial Differential Equations",I.N Snedon
2	"Engineering Mathematics" B.S Grewal, Khanna Publications
3	"Method of Applied Mathematics", F.B Hilderbrand, PHI Publications
4	"Differential Equation & Calculus of variation", L. Elsgeets, Mir Publications

MTET-226	Gas Turbine and Compressor	L	3	T	1	P	2	Credit 04

Pre–requisite: Nil

Objective of Course: It is intended to give a thorough understanding of gas turbines, compressors, gas turbine cycle, Energy and fluid flow Dynamics and power plant based on gas turbine

Details of course:

S.No	Particulars	Contact Hour
1	**Introduction, development, classification and field of application of gas turbines**	3
2	Gas Turbines Cycles, Ideal and actual cycles, multi-stage compression: reheating, regeneration, combined and cogeneration	6
3	**Energy Transfer and Fluid Flow Characteristics** Energy transfer between fluid and rotor: axi-symmetric flow in compressor and gas turbine	6
4	**Centrifugal Compressor** Principles of operation; compressors losses; adiabatic efficiency; slip factor; pressure coefficient; power unit; design consideration for impeller and diffuser systems; performance characteristics.	6
5	**Axial Flow Compressor** Elementary theory; vortex theory; degree of reaction; simple design; elementary air foil theory; isolated air foil and cascade theory; three dimensional flow; stages; stage efficiency and overall efficiency; performance characteristics.	6
6	**Turbines** Axial flow and radial flow turbines; impulse and reaction turbines; fundamental relation and velocity triangles; elementary vortex theory; limiting factors in turbine design application of airfoil theory to study of flow through turbine blades; aerodynamic and thermodynamic design considerations; blade material; blade attachments and blade cooling.	10
7	**Gas Turbine Power Plant** Fuel and fuel feed system; combustion system-design and consideration and flame stabilization; regenerator types and design; gas turbine power; plant performance and matching; applications.	5
	Total	**42**

Suggested book:

S.no	Name of books/authors/publisher	Years publishing
1.	Gas turbine theory. Cohen and rogers, longmen	
2.	Theory and design of gas turbine and jet engines. Vincent, Mcgraw hills	
3.	Gas turbine principles and practice , cox newnes	
4.	Turbines, compressors and fans, yahya H.M, TMH	2002
5	Centrifugal compressors, boyce, M.P , Pennwell	2003
6	Gas turbine , ganeshan, V, THM	2002

MTET-111	Solar Energy	L	3	T	1	P	0	Credit 04

Pre – requisite: Nil

Objective of Course: The course is intended to impart knowledge of solar energy with respect to its Availability, utilization and economic viability

Details of Course:

S.No	Particulars	Contact Hour
1	Introduction to solar energy	1
2	Fundamentals of solar radiations and heat transfer	8
3	Flat plate solar collectors	6
4	Focusing solar collectors	6
5	Solar thermal energy storage	4
6	Solar heating of buildings; active and passive methods	3
7	Solar refrigeration and air conditioning	2
8	Solar thermal power, solar desalination, solar drying of foods	3
9	Solar photovoltaic: analysis of other applications	4
10	Modeling of solar systems	3
11	Economic analysis	2
	Total	**42**

Suggested Book:

S.no	Name of books/authors/publisher	Year publication
1	Solar engineering of thermal process, duffie and backman, john willey and inc.	1991
2	Principles of solar energy goswami kreith and kreider, taylor and francis	1997
3	Solar energy sukhatme, tata mcgraw hill, new delhi	1999
4	Solar energy garg and prakash, tata mcgraw hill, new delhi	2000
5	Solar energy tiwari, narosa publishing house	2002
6	Applied solar energy meinel, Addison wesiey	1997

MTET-227	CRYOGENIC SYSTEM	L	3	T	1	P	0	Credit 04

Pre – requisite: Basic knowledge of refrigeration principles.

Objective of Course: To introduce the students to the field of low engineering (Cryogenics) which has applications in Rocket propulsion, electronics, biological and medical science, food preservation, mechanical designing etc.

Details of Course:

S.No.	Particulars	Contact Hours
1	Introduction, Historical background, presents area involving cryogenics.	01
2	Low temperature properties of engineering materials: Mechanical properties, Thermal properties, Electrical and Magnetic properties, Properties of cryogenics fluids.	08
3	Gas liquification system: Joule Thomson effect, Adiabatic expension, simple Linde-Hampson system, Precooled Linde-Hampson, Linde Dual pressure system, Cascade system, claud system, Kapitza system, Collins Helium liquification system,.	08
4	Critical component of liquification system: Effect of heat exchanger, effectiveness on system performance, effect of compressor and expander efficiency on system performance, effect of heat transfer to the system.	04
5	Cryogenic refrigeration system: Phillips refrigerators, importance of regenerator effectiveness for Phillips refrigerator, Gifford-McMohan refrigerator.	04
6	Measurement system for low temperatures: Temperature measurement, flow rate measurement, liquid level measurement.	04
7	Cryogenic storage and transfer system: cryogenic fluid storage vessels, insulations, cryogenic transfer system.	06
8	Vacuum Technology importance of vacuum technology in cryogenics flow regime in vacuum systems, conductance in vacuum systems. Calculation of pump down time for a vacuum system.	08
	Total	**42**

Suggested Books:

s.no	Name of books/authors/publisher
1	Cryogenic system, barron, Mcgraw hill
2	Cryogenic system engineering timmerhaus and flyn, plenum press.

MTET-224	I.C. Engine Combustion Process Modeling	L	3	T	1	P	0	Credit 04

Pre-requisite: Course on I.C. Engine at U.G. level

Objective of Course: The course is intended to expose the students to the most widely used mathematical models for in-cylinder spray and combustion process. These processes are most important for fuel economy and pollutant emissions.

Details of Course:

S.No	Particulars	Contact Hours
1	Essential features of combustion process in S.I. and C.I. Engines, Flame Structure and speed, spray structure, auto ignition	4
2	Engine Combustion Modeling- An Overview	2
3	Modeling Fluid Motions in Engines, intake jet flow, swirl generation during induction squish, prechamber flows, crevice flow and flow by	6
4	Modeling Flame Propagation and Heat Release in Engines, laminar burning speed, flame propagation relations, heat release in diesel engines, zero dimension burning rate function free gas jet theory, packet models	8
5	Knock, fundamentals, kinetic modeling of hydrocarbon combustion, auto ignition, knock models	6
6	Modeling Spray, spray equation, droplet kinematics, spray atomization, droplet breakup droplet/droplet and spray wall interactions, fuel vaporization	8
7	Modeling pollutant formation in S.I. and C.I. engines, Models for NOx, CO and soot formation	8
	Total	**42**

Suggested Books:

S.No	Name of books/Authors/Publisher	Year of Publication
1	"Internal Combustion Engine Fundamentals", H.Wood, McGraw Hill Inc.	1988
2	"Modeling Engine Spray and Combustion Processes", G. Stiesch, Springer-Verlag.	2003
3	"Combustion Modeling in Reciprocating Engines", Eds: J.N. Mattavi, and A. Charles, Plenum Press	1980
4	"Fluid Dynamics and Transfer of Droplets & Sprays", W.A. Sirignano, Cambridge University Press	2000
5	"Combustion: Physical and Chemical Fundamentals, Modeling and simulation, Experiments, Pollutant Formation", J. Warnatz, U. Mass, R.W.Dirbble, Springer-Verlag.	2001
6	"I.C. Engines", Ferguson, J Wiley	2004

MTET-201	Convective Heat & Mass Transfer	L	3	T	1	P	0	Credit 04

Pre–requisite: Advanced Heat Transfer

Objective of course: The course discusses exclusively the various aspects of the convective heat and mass transfer.

Details of Course:

S.No	Particulars	Contact Hours
1	Introduction: Concepts and Conservation Principles and Laws	2
2	Equation of continuity, momentum, energy, mass and entropy, Dimensional Analysis and Similarity Principles	5
3	Laminar Heat Transfer in Ducts	4
4	Laminar Boundary Layers	3
5	Turbulence fundamentals and models	3
6	Turbulence Boundary Layers	4
7	Natural Convection	4
8	Boiling	3
9	Condensation	3
10	Steady and Unsteady state molecular diffusion	2
11	Convective Mass Transfer	4
12	Simultaneous Heat and Mass Transfer	5
	Total	**42**

Suggested Books:

S.No	Name of Books/Authors/Publishers	Year of Publication
1	"Convective Heat Transfer", V.S.Arpaci and P.S.Larsen, Prentice Hall Inc.	1984
2	"Convective Heat Transfer", L.C. Burmeister, John Wiley & Son Inc.	1993
3	"Heat Transfer", L.C.Thomas (Professional version 2nd edition), Capstone Publishing.	
4	"Convective Heat and Mass Transfer", W.M. Kays, M.E. Crawfoed and B. Weigand, Tata McGraw Hill, New Delhi.	2005
5	"Fundamentals of Momentum, Heat and Mass Transfer", Editors: James R. Welty, Charles E. Wicks, Robert E. Wilson, (4th edition), John Wiley & Sons.	2001

MTET-223	I.C. ENGINE	L	3	T	1	P	0	Credit 04

Pre- requisite: Nil

Objective of course: the course discusses exclusively the various aspect of the internal combustion engine.

Detail of course:

S.No.	Particulate	Contact hour
1.	Introduction and historical perspective	2
2.	Thermodynamic analysis of I.C. engine cycle Ideal models of engine process, thermodynamic relation for engine process, cycle analysis, comparisons with real cycle	6
3.	Combustion in spark ignition engine Essential features of the process, thermodynamic analysis of SI engine combustion, burned and unburned mixture states, analysis of cylinder data, combustion process characterization, flame structure and speed, cyclic variation in combustion, knock and surface ignition, fuel factors	10
4.	Combustion in compression ignition engine Essential features of the process, types of diesel combustion system, phenomenological model of CI engine combustion, analysis of cylinder pressure data, fuel spray behavior, spray structure, droplet size distribution, spray evaporation, ignition delay	10
5.	Pollutant Formation and Control Pollutant formation in SI engines, nature and extent of the problem, nitrogen oxides, carbon monoxide, unburned hydrocarbon emissions, catalytic converters, pollutant formation in CI engines, oxides of nitrogen, carbon monoxides and unburned hydrocarbon emission from diesel engines, particulates, particulate traps, noise from diesel engines.	14

Suggested Books:

S.No.	Name of books/authors/Publisher	Year of Publication
1.	"Internal Combustion Engine", Heywood, J.B., McGraw Hill	1998
2.	"Engineering Fundamentals of Internal Combustion Engine", Pulkrabek, W.W., Pearson	2005
3.	"Introduction to Internal Combustion Engines", Stone, R.	
4.	"Internal Combustion Engine in Theory and Practice",Taylor, C.F.	
5.	"Internal Combustion Engines", Ferguson, C.R., Kirkpatrick	
6.	SAE Transactions	
7.	"I.C. Engines", Ferguson, J.Wiley	2004

MTET-225	Renewable	L	3	T	1	P	0	Credit 04

Pre-requisite: Nil

Objective of course: Technological development depends upon primarily on energy. The depletion of the conventional energy source and environmental problem associated with them necessitate mankind to look for renewable energy system. This course expose the students and society to the renewable energy system and thus will help in sustaining the development of the society.

S.No.	Particulars	Contact Hour
1	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 concept of heat and fluid flow useful for energy systems.	6
2	Solar Energy Systems Solar radiation data, solar energy collection, storage and utilization, solar water heating, power generation, refrigeration and air conditioning, solar energy system economics.	16
3	Micro and Small Hydro Energy System- Resources 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 hydrams, water mills, tidal power	4
4	Biomass energy Systems-Availability of biomass-agro, forest, animal, municipal and other residues, bio conversion technologies, cooking fuels, bio gas, producer gas, power alcohol from biomass, power generation, internal engine modifications, and performance, system economics	4
5	Wind energy system- Wind data, horizontal and vertical axis wind mills, wind farms, performance and economics of wind energy	4
6	Integrated Energy System- Concept of integration of conventional and non-conventional energy resources and systems, integrated energy system design	5

	and economics	
	Total	**40**

Suggested Books:

S.No	Name of Books/Author/Publisher
1	"Solar Engineering of Thermal Process", Duffie & Beckman,John Wiley
2	"Energy, The Biomass Option', Bungay, John Wiely
3	"Introduction to Wind Energy",Lysen ,Georgia Inst.
4	"Energy", Doolittle, MTrix Pub.
5	"Energy and environmental',Folwer,Mcgraw Hill
6	"Solar Energy", S.P. Sukhatme, Tata Mcgraw Hill
7	Energy hand book,Loftness

MTET-215	Advanced Fluid Mechanics	L	3	T	1	P	0	Credit 04

Pre-requisite: U.G. level course in fluid mechanics

Objective of course: The course is design to provide advanced analytical tool for fluid flow analysis.

S.No.	Particulars	Contact hour
1	Review of basic concept, concept of continuum, type of fluids, tensor analysis.	03
2	Basic laws in integral form, Reynold's transport theorem, mass, momentum, and energy equations in integral form and their applications.	05
3	Differential fluid flow analysis, continuity equation, Navier Stroke's equations, and excat solutions, energy equations.	07
4	Ideal fluid flow analysis, two dimensional flow in rectangular and polar co-ordinates; continuity equation and the stream function; irrotationality and the velocity potential function, vorticity and circulation, plane potential flow and complex potential function. Sources, sinks, doublets and vortices, flow over bodies and D-Alembert's paradox; aero foil theory and its application.	08
5	Low Reynold's number flow, approximation, of N-S equation,approximate solution of Navier Stroke's equation, Stoke's and Oseen flows, hydrodynamics theory of lubrication.	04
6	Large Reynold's number flow, approximation, Prandtl's boundary layer equations, Blausius solutions. Falkner-Skan solutions, momentum integral equation. Halstein and Bohlen method, thermal boundary layers.	08
7	Compressible fluid flow, One dimensional isentropic flow, Fanno and Rayleigh flows, chocking phenomenon, normal and oblique shocks.	07
	total	**43**

Suggested Book:

S.No.	Name of Books/ Authors/Publisher	Year of Publication
1	Foundation of fluid mechanics, S.W. Yuan, Prentice Hall inc	1998
2	Advanced engineering fluid mechanics, K. Murlidhar and G. Bishwas, Narosa Publication	1996
3	Compressible flow, P.H. Oosthuizen and W. E. Carscallen, Mcgraw Hills inc.	1997
4	Introduction to fluid dynamics, G. K. Balchlor, Cambridge University Press.	2000
5	Viscous fluid flow F. M. White, Mcgraw inc.	2005
6	Boundary layer theory H. Schlichting, K. Gersten, E. Krause, H. J. Oertel, C. Mayes (8^{th} edition) Sringer verlag	2004

MTET-103	Advanced heat transfer	L	3	T	1	P	0	Credit 04

Pre-requisite: U.G. level course in heat transfer.

Objective of course: The course is design to provide advanced analytical tool for heat transfer analysis.

S. No.	Contents	Contact Hours
1.	**Heat Conduction**: Fourier's law, thermal conductivity of matter, heat diffusion equation for isotropic and anisotropic media, boundary and initial conditions; One-dimensional steady-state conduction through plane wall, cylinder and sphere, conduction with thermal energy generation, heat transfer from extended surfaces, radial fins and fin optimization; Transient conduction – lumped capacitance method and its validity, plane wall and radial systems with convection, semi-infinite solid.	12
2.	**Heat Convection**: Boundary layers concepts, laminar and turbulent flows, conservation equation, non-dimensional analysis, boundary layer equations, Reynolds analogy for turbulent flows; Forced convection inside tubes and ducts – correlations for laminar and turbulent forces convection; Forced convection over exterior surfaces – bluff bodies, packed beds, tube bundles in cross flow; Natural convection; Combined free and forced convection; Combined convection and radiation.	10
3.	**Heat Transfer with Phase Change**: Nucleate, film and pool boiling, boiling in forced convection; Filmwise and dropwise condensation	6
4.	**Thermal Radiation:** Fundamental concepts, radiation intensity and its relation to emission, irradiation and radiosity, blackbody radiation, surface emission, surface absorption, reflection, and transmission, gray surface; Radiation exchange between surfaces, view factor, blackbody radiation exchange, radiation exchange between diffuse gray surfaces in an enclosure with absorbing and emitting media; Flame Radiation, solar Radiation.	8
5.	**Numerical Methods in Heat Transfer:** Finite difference method for	4

	numerical simulation of steady state and transient heat transfer problems.	
Total		**40**

MTET-222	**Refrigeration and air conditioning system and design**	**L**	**3**	**T**	**1**	**P**	**0**	**Credit 04**

S. No.	**Contents**	**Contact Hours**
1.	Review of thermodynamic principles of refrigeration.Carnot refrigeration cycle – Vapour compression refrigeration cycle – use of P.H. charts – multistage and multiple evaporator systems – cascade system – COP comparison. Air Refrigeration cycles.	7
2.	Compressors – reciprocating and rotary (elementary treatment), Types of condensers, evaporators, cooling towers – Functional aspects. Refrigerants – properties-selection of refrigerants, Alternate Refrigerants, Cycling controls.	10
3.	Psychrometric processes use of psychrometric charts – Grand and Room Sensible Heat Factors – bypass factor – air washers, requirements of comfort air conditioning, summer and Winter Air conditioning.	9
4.	Cooling load calculation working principles of Centralized Air conditioning systems, Split, Ductable split, Packaged Air conditioning, VAV & VRV Systems. Duct Design by equal friction method, Indoor Air quality concepts.	9
5.	Vapor Absorption system Ejector jet, Steam jet refrigeration, thermo electric refrigeration. APPLICATIONS: ice plant food storage plants milk chilling plants.	7
Total		**42**

MTET-221 POWER PLANT ENGINEERING

1. **A Review:** Rankine Cycle with reheat & regeneration; binary vapor cycle, gas power cycle and flow through nozzles.
2. **Introduction**: resources & development of power in India, hydro, thermal and nuclear energy, present power position & future planning of policies in India.
3. **Thermal power plant:** Introduction, fossil 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 and gas burners & fluidized bed combustion system. Ash handling and flue 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.
4. **Diesel electric power plants :**

   Field of use, outline of diesel power plant, different systems, super charging. Diesel; power plant, efficiency, heat balance. Present trends in diesel power plant research.
5. **Gas Turbine plants.**

   Introduction, classification & different types of gas turbine plants. Analysis of closed and open cycle constant pressure gas turbine plants. Methods to improve the thermal efficiency of as simple open cycle constant pressure gas turbine plant; auxillaries and controls. Environment impacts of gas turbine power plants.
6. **Hydro-electric power plant:**

   Hydrology-rain fall, run off & its measurement hydrograph & storage of water. Classification of hydro units, design construction & operation of different components of hydro electric power stations.
7. **Nuclear power plants:**

   Basic principles of Nuclear Energy, classification and main part of nuclear research , different types of reactors i.e. PWR,BWR , heavy water reactors gas cooled reactors, liquid metal cooled reactors. Organic moderated cooled reactors, breeder reactors plant operations, safety features & radioactive waste disposal.

8. **Economic analysis of power plants and tariffs:**

   Instrumentation and control in thermal power plants; energy conservation and management.

9. **Environment aspects of power generation:**

   Pollutants from fossils fuel and health hazards control of emissions and particulate matter, desulfurization, coal gasification and introduction to green-house effect.

SUGGESTED BOOKS FOR POWER PLANT ENGINEERING

1. "Power plant theory and design", Potter, Ronald Press
2. "Modern Power Station Practices",CEGN, Pergamon Press
3. "Power Plants", Zerban & Nye, International
4. "Nuclear Power Plant equipment",Lish, Industrial Press
5. "A course In Power Plant Engineering", Arora & Domkundwar, Dhanpatrai , New delhi
6. "Power Plant engineering", P.K. Nag, Tata McGraw Hills

MTET-101 Advance Thermodynamics

S.No.	Particulars	Contact hour
1	Review of I & ll laws of thermodynamics, transient flow analysis, entropy balance, entropy generation.	05
2	Exergy Analysis, concepts, exergy balance, exergy transfer, exergetic efficiency, exergy analysis of power and refrigeration cycles.	09
3	Real gases and mistures, equations of state, thermodynamics property relations, residual property functions, properties of saturation states.	06
4	Thermodynamics properties of homogeneous mixtures, partical molal properties, chemical potential, fugacity and fugacity coefficient, fugacity relations for real gas mixtures, ideal solutions, phase equilibrium, rault's law.	08
5	Reacting systems, l & ll Law analysis of reacting system, absolute entropy and the third law, fuel cells, chemical energy, Exergectic efficiency of reacting systems, Chemical equilibrium, equilibrium flame temperature.	14

Suggested Book:

Advance Thermodynamics for Engineers, K. Wark, John Willey & Sons

Advance Engineering Thermodynamics, A. Bejan, John Willey & Sons

Advance Engineering Thermodynamics, Annamalai & Puri, CRC Press

Fundamental of Engineering Thermodynamics, A. Bejan, G. Tsatsarones, & Moran, John Willey & Sons

MTET-112Computational Fluid Dynamics and Heat Transfer

S.NO.	Particulars	Contact hour
1	Introduction; conservation equation, mass, momentum and energy equation; convective form of the equation and general description.	03
2	Clarification into various type of equation, parabolic, elliptic, boundary and initial conditions; over view of numerical methods.	04
3	Finite difference methods; different means for formulating finite difference equation, Taylor series expansion, integration over element, local function method; finite volume methods; central, upwind and hybride 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.	10
4	Solution of finite difference equations; iterative methods; matrix inversion methods; ADI methods; operator splitting, fast. Fourier transforms, applications.	07
5	Numerical grid generation; basic ideas; transformation and mapping.	05
6	Finite element methods; Rayleigh- Ritz, Galerkine and least square methods; interpolation functions; one and two dimensional element; applications.	10
07	Phase change problems, different approaches for moving boundary; variable time step method; enthalpy methods.	04