ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

for

M.Tech Two Year Degree Course
(A-19)

in

THERMAL ENGINEERING
(TE)

(Applicable for the batches admitted from 2019-2020)

SREENIDHI INSTITUTE OF SCIENCE AND TECHNOLOGY
(An Autonomous Institution approved by UGC and affiliated to JNTUH)
(Accredited by NAAC with 'A' Grade and Accredited by NBA of AICTE)
Yamnampet, Ghatkesar, Malkajigiri Medchal District -501 301.

January, 2019

M.Tech. (THERMAL ENGINEERING)
Course Structure and Syllabus
For the Academic Year: 2019-2020

M.Tech Thermal Engineering

Program Objective

The objective of this course is to facilitate the students to pursue their specialization in the area of Thermal engineering. This course curriculum enhances the student knowledge and their exposure in the area of thermal and fluid sciences. The content and syllabus of the course are shaped based on the need for industry and research. The course structure provides in-depth knowledge building in thermal and fluid sciences by keeping viscous flow, turbulence and advanced heat transfer. To develop the capability to analyze and design the thermo-fluidic systems, the courses: computational fluid dynamics, design of thermal equipments and mechanical measurement in thermo-fluidic systems also included in the curriculum. The program caters to its students with experienced academician, state-of-the-art laboratories and projects.

Vision of the Department

To emerge as a renowned center in mechanical engineering by following the best practices in teaching, learning and research

Mission of the Department

1. Provide good academic environment for pursuing high quality undergraduate, Post graduate and Doctoral programmes in mechanical engineering that will prepare our graduates for outstanding professional careers
2. Provide service to practicing engineers, industry, government, educational and technical societies through effective engagement with these groups and by providing professional knowledge.
3. Ensure that our students are well trained in interpersonal skills, team work, professional ethics, practical industrial training and participate in professional society activities.
4. Conduct and proliferate high quality research work to students for lifetime of learning.

M.Tech. Thermal Engineering

Program Outcomes for M.Tech. Thermal Engineering Programme

At the end of the M. Tech. Thermal Engineering programme, the post graduate will be able to acquire:

PO1: an ability to independently carry out research /investigation and developmental work to solve practical problems by applying the advanced concepts of thermal engineering and perform tests on thermal energy conversion devices to improve performance and interpret results.

PO2: an ability to write and present a substantial technical report/document for research proposal preparation, technical papers for publishing in scientific journals, present research findings in conferences, following the design and analysis of the performance of thermal systems such as gas turbines, propulsion devices, IC engines, etc.

PO3: an ability to demonstrate a degree of mastery over the various courses of thermal engineering such as IC engines, R & AC, CFD and Heat transfer.

PO4: an ability to identify sources of harmful engine emissions to develop pollution abatement techniques and adapt viable renewable energy sources in order to develop appropriate ways to harness them.

PO5: an ability to engage in lifelong learning for career and professional growth with ethical concern for society and environment.

PO6: demonstrate knowledge and understanding of the engineering and management principles and apply these to their profession to finalize technical and financial aspects of a project and to manage in multidisciplinary areas.

I Year – I Semester:

Category	Code	Subject	L	T	P	Credits	CIE	SEE
PC-1	7M101	Thermodynamics and Combustion	3	--	--	3	30	70
PC-2	7M102	Advanced Fluid Dynamics	3	--	--	3	30	70
PC-3	7M103	Energy Conservation and Management	3	--	--	3	30	70
PC-4	7M104	Refrigeration & Air Conditioning Systems Design	3	--	--	3	30	70
PE-1	7M105	Gas Turbines	3	--	--	3	30	70
	7M106	Non-Conventional Energy Sources						
AC-1	7HC18	English for Research Paper Writing***(Grade Evaluation)**	2	--	--	0	30	70
							Grade Evaluation	
Research Methodology	7W105	Research Methodology &IPR	3	--	--	3	30	70
LAB-1	7M171	Advanced Thermal Engineering Lab	--	--	4	2	30	70
Seminar	7M172	Technical Seminar-I	--	--	2	1	100	--
Total			**20**	**--**	**6**	**21**	**340**	**560**

L - Lectures; T - Tutorial; P - Practical; C - Credits
CIE: Continuous Internal Evaluation ; SEE: Semester End Evaluation;
PC : Professional Core; PE : Professional Elective ; AC –Audit course

I Year – II Semester:

	Code	Subject	L	T	P	Credits	CIE	SEE
PC-5	7M207	Advanced Heat Transfer	3	--	--	3	30	70
PC-6	7M208	Steam Engineering	3	--	--	3	30	70
PC-7	7M209	Computational Fluid Dynamics	3	1	--	4	30	70
AC-2	7HC19	Ethics. Moral, Gender Sensitization and Yoga ***(Grade Evaluation)**	2	--	--	0	30	70
							Grade Evaluation	
PE-2	7M210	Refrigeration and Cryogenics	3	--	--	3	30	70
	7M211	Design of Heat Exchangers						
	7M212	Thermal and Nuclear Power Plants						
PE-3	7M213	Advanced Mathematical Methods in Engineering	3	--	--	3	30	70
	7M214	Advanced Finite Element Analysis						
Seminar	7M273	Technical Seminar-II	--	--	2	1	100	
LAB-2	7M274	CFD Laboratory	--	--	4	2	30	70
Comprehensive-viva	7M275	Comprehensive Viva-Voce	--	--	2	1	30	70
Mini Project		Mini Project with Seminar	Evaluation is in II Year I Sem					
Total			**17**	**1**	**8**	**20**	**340**	**560**

II Year - I Semester:

Category	Code	Course Title	L	T	P	Credits	Marks	
							CIE	SEE
PC-8	7M315	Design of Solar and Wind Systems	3	--	--	3	30	70
OE	7ZC32	Cost management of Engineering Projects	3	--	--	3	30	70
	7ZC31	Business Analytics						
	7WC17	Industrial Safety						
	7WC18	Operation Research						
	7WC19	Composites						
	7MC17	Waste to Energy						
Mini Project	7M376	Mini Project with Seminar	--	--	6	3	30	70
Project	7M377	Project Phase I with Seminar	--	--	10	5	30	70
Total			**6**	**--**	**16**	**14**	**120**	**280**

Grading: A: Excellent, B: Good, C: Satisfactory, D: Unsatisfactory
CIE: Continuous Internal Evaluation ; SEE: Semester End Evaluation;
AC : Audit course; OE : Open Elective

II Year - II Semester:

Category	Code	Subject	L	T	P	Credits	Marks	
							CIE	SEE
Poject	7M478	Project Phase II with Seminar	--	--	12	6	30	70
Dissertation	7M479	Dissertation and Defence Viva	--	--	--	7	30	70
Total			--	--	**12**	**13**	**60**	**140**

Grading: A: Excellent, B: Good, C: Satisfactory, D: Unsatisfactory

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
THERMODYNAMICS AND COMBUSTION
(PROFESSIONAL CORE)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M101

Course Objectives:
The course is intended to

1. Provide analytical methods for the determination of the direction of processes from the first and second laws of thermodynamics and understand the concept of exergy
2. Gain the knowledge on non-reactive mixture properties , Psychometric Mixture properties and psychometric chart and Air conditioning processes
3. Understand the concept of heat of reaction , adiabatic flame temperature, Stoichiometric ratio
4. Make students analyze equilibrium, spontaneity of combustion reaction -entropy generation& free energy change
5. Gain knowledge of power cycles – compounding , cogeneration , binary cycle concepts
6. Provide in depth knowledge of various Direct Energy Conversion systems & power generation through them

Course Outcomes:
At the end of the course, the student will be able to:

1. Explain basic thermodynamic concepts and laws and calculate exergy change
2. Describe the concepts enthalpy, entropy and Gibbs free energy change and their use in analyses of combustion reactions
3. Analyze power plants, refrigeration plants and thermal/chemical installations
4. Evaluate means of delaying equilibrium and obtaining desired combustion products
5. Construct/design basic direct energy conversion systems and generate power
6. Use advanced thermodynamics on a research case

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X		X			
CO2			X		X	X
CO3		X	X			X
CO4			X	X		
CO5	X		X			X
CO6	X	X				

UNIT -I:
Review of Thermodynamic Laws and Corollaries: First law, Second law of thermodynamics, Entropy, Availability and unavailability, Irreversibility, Third law of thermodynamics, Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance..

UNIT-II:
P.V.T Surface: P-V diagram, P-T diagram, T-S diagram, Clausius-Clapeyro equation. Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Joule Thompson Throttling coefficient. Vapor pressure. 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-I: Combustion definition, Combustion reactions, balance equation, theoretical air, percentage excess air, stoichiometric ratio, A/F ratio, Enthalpy of formation. Entropy of formation, Reference levels of tables- tables of standard enthalpy & entropy of formation. Heat of reaction, Adiabatic flame temperature. Calculation of Heat of reaction and adiabatic flame temperature.

UNIT-IV
Combustion-II : Equilibrium definition, Chemical equilibrium of ideal gases, Gibbs free energy, Standard Gibbs free energy change, conditions for spontaneous and non-spontaneous reaction, criteria for equilibrium, The vent hoff's equation, equilibrium or rate constant. The chemical potential and criteria for phase equilibrium. The Gibbs phase rule.

UNIT-V:
Power Cycles: Review binary vapour cycle, co generation and combined cycles, Second law efficiency analysis of cycles, Thermodynamic Irreversibility – causes of Irreversibility. Refrigeration cycles. Introduction, Phenomenological laws- Fourier law, Fick's law, Onsaga Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production.

UNIT-VI:
Direct Energy Conversion Introduction: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells.

REFERENCES:

1. Engineering Thermodynamics – Roges & Mayhew – Pearson.
2. Thermal Engineering / Rathore / TMH
3. Basic and Applied Thermodynamics/ P.K.Nag/ TMH
4. Applied Thermodynamics – R.K. Rajput – Laxmi Publications
5. Thermodynamics/Holman/ Me Graw Hill.
6. Thermal Engineering / Soman / PHI
7. Engg. Thermodynamics/PL.Dhar / Elsevier
8. Thermodynamics/Sonnatag & Van Wylen / John Wiley & Sons
9. Thermodynamics for Engineers/Doolittle-Messe / John Wiley & Sons
10. Irreversible Thermodynamics/HR De Groff.
11. Thermodynamics & Heat Power – Granet & Bluestein- CRC Press
12. Engineering Thermodynamics/Chatopadyaya

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
ADVANCED FLUID DYNAMICS
(PROFESSIONAL CORE)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M102

Course Objectives:
The course is intended to:
1. Familiarize the students on the effects of pressure and viscosity on fluid flow
2. Make the students understand the effect of boundary layers on system drag
3. Give the students an insight on the effect of turbulence on flow
4. Familiarize the students with the effect of Mach number on varying fluid density and the concepts of supersonic flow

Course Outcomes:
At the end of the course, the student will be able to:
1. Understand the basic driving forces and conservation equations driving fluid flow
2. Gain in-depth knowledge of the effects of viscosity on flow
3. Understand the effect of solid boundary resulting in drag in the flow domain
4. Understand the effect of turbulence in external and internal flows
5. Develop insights on the effect of varying density on flow fields
6. Understand supersonic flows and shock waves

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X		X			X
CO2			X		X	X
CO3			X			X
CO4			X	X		
CO5			X			X
CO6	X		X			X

UNIT I:
Inviscid Flow of Incompressible Fluids: Lagrangian and Eulerain Descriptions of fluid motion - Path lines, Stream lines, Streak lines, stream tubes - velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation - Stream and Velocity potential functions.
Basic Laws of fluid Flow: Condition for irrotationality, circulation & vorticity - Accelerations in Cartesian systems normal and tangential accelerations - Euler's, Bernoulli equations in 3D - Continuity and Momentum Equations

UNIT II:
Viscous Flow: Derivation of Navier-Stokes Equations for viscous compressible flow - Exact solutions to certain simple cases : Planar Poisoulle flow - Couette flow with and without pressure gradient - Hagen Poisoulle flow

UNIT III:
Boundary Layer Concepts : Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory - Boundary layer thickness for flow over a flat plate – Blasius solution – Creeping motion (Stokes) - Oseen's approximation - Von-Karman momentum integral equation for laminar boundary layer - Expressions for local and mean drag coefficients for different velocity profiles.

UNIT IV:
Introduction to Turbulent Flow: Fundamental concept of turbulence - Time Averaged Equations - Boundary Layer Equations - Prandtl Mixing Length Model - Universal Velocity Distribution Law: Van Driest Model - Approximate solutions for drag coefficients - More Refined Turbulence Models - k-epsilon model - boundary layer separation and form drag - Karman Vortex Trail, Boundary layer control, lift on circular cylinders
Internal Flow: Smooth and rough boundaries - Equations for Velocity Distribution and frictional resistance in smooth rough Pipes – Roughness of Commercial Pipes – Moody's diagram

UNIT V:
Compressible Fluid Flow - I: Thermodynamic basics - Equations of continuity, Momentum and Energy - Acoustic Velocity - Derivation of Equation for Mach Number - Flow Regimes - Mach Angle - Mach Cone - Stagnation State

UNIT VI:
Compressible Fluid Flow - II: Area Variation - Property Relationships in terms of Mach number - Nozzles, Diffusers - Fanno and Raleigh Lines - Property Relations – Isothermal Flow in Long Ducts - Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks - Supersonic Wave Drag

REFERENCES:

1. Fluid Mechanics and Machines - Modi and Seth - Standard Book House
2. Fluid Mechanics - Jog - Cambridge
3. Fluid Mechanics with Engineering Applications - Finnemore & Franzini - McGrawHill
4. Fluid Mechanics and Machinery - Khan - Oxford
5. Fluid Mechanics - Cohen and Kundu - Elsevier - 5th edition
6. Fluid Mechanics - Potter - Cengage Learning
7. Fluid Mechanics - William S Janna - CRC Press

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
ENERGY CONSERVATION AND MANAGEMENT
(PROFESSIONAL CORE)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M103

Course Objectives:

1. To know the different energy resources and demonstrate the importance and role of energy management
2. Understand the economics of energy conversion
3. Enable the students to understand the basic energy conversion and management principles and to identify sources of energy loss and target savings
4. Enable students in carrying out budgeting and risk analysis
5. To know about alternative energy sources such as solar and wind energy

Course Outcomes:

At the end of the course, the student will be able to:

1. Acquire insight about the source and importance of energy, principles of energy management and its influence on environment
2. Analyze all scenarios from energy consumption
3. Generate scenarios of energy consumption and predict the future trend
4. Suggest and plan energy conservation solutions

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X		X	X		
CO2			X	X		
CO3			X		X	X
CO4					X	X

UNIT-I:

INTRODUCTION: Energy sources, Importance and types of renewable energy sources, Ecological effect due to energy utilization, Importance and different ways of energy saving in domestic, industrial and other sectors, Indian energy scenario, National sector-wise energy consumption data.

ENERGY MANAGEMENT: Define energy management and its importance, Basic principles of effective energy management, Energy policies for future India, Bureau of Energy Efficiency (BEE) and Star rating system.

UNIT–II:

ENERGY AUDIT: Definition and concepts. Basic components of energy audits, Industrial audits, commercial audits, residential audits, Energy Auditing Services, Detail data gathering, types of energy audit instruments and metering

UNIT-III:

ECONOMIC ANALYSIS: Scope, Characterization of an investment project. Types of depreciation, Time value of money. Budget considerations, Risk analysis, Sources of funds, Tax considerations.

UNIT-IV:

METHODS OF EVALUATION OF PROJECTS: Payback, Annualized costs, Investor's rate of return, Present worth, Internal rate of return, Pros and cons of the common method of analysis, Replacement analysis.

UNIT-V:
ENERGY CONSERVATION: Practical methods and technologies for energy conservation programs, Design for conservation of energy materials, Energy flow networks. Critical assessment of energy usage. Formulation of objectives and constrains, Synthesis of alternative options and technical analysis of options. Cogeneration System Design & Analysis.

UNIT-VI:
ALTERNATIVE ENERGY SOURCES: Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems.

TEXT BOOKS

1. Energy Management Hand Book by W.C. Turner & Steve Doty
2. Energy Management Principles by CB Smith, Pergamon Press

REFERENCE BOOKS

1. Energy Management by W.R.Murphy and G.Mc.Kay, BS Publication
2. Management by H.Koontz and Cyrill Donnel, McGraw Hill
3. Financial Management by S.C.Kuchhal, Chaitanya Publishing House

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
REFRIGERATION AND AIR CONDITIONING SYSTEM DESIGN
(PROFESSIONAL CORE)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M104

Course Objectives:
The course aims at giving an overview of the design aspects involved in the systems concerned with Refrigeration and Air Conditioning. It will focus on the various components, processes and applications related to the R&AC systems.

Course Outcomes:
At the end of the course, the student will be able to:
1. Gain insights into the components and performance of vapor compression systems.
2. Learn the liquefaction of gases.
3. Solve problems in the design and optimization of air craft refrigeration systems.
4. Understand the processes and properties of air conditioning systems.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			
CO2	X		X			
CO3	X		X		X	
CO4			X			

UNIT-I
VAPOUR COMPRESSION REFRIGERATION: Performance of Complete vapor compression system. Actual Vs Ideal cycle - Effect of operating parameters on COP, Components of Vapor Compression System: The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit. Compound Compression: Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

UNIT -II
PRODUCTION OF LOW TEMPERATURE: Liquefaction system, Liquefaction of gases, Hydrogen and Helium, Cascade System – Applications– Dry ice system. Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram. Lithium – Bromide system Three fluid system – HCOP.

UNIT-III
AIR REFRIGERATION: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems. Steam Jet refrigeration system: Representation on T-s and h-s diagrams – limitations and applications.
Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles.

UNIT-IV
AIR CONDITIONING: Psychometric properties and processes – Construction of Psychometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body –Effective temperature and Comfort chart – Parameters influencing the Effective Temperature. Summer, winter and year round air – conditioning systems. Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load.

UNIT-V

AIR CONDITIONING SYSTEMS: All Fresh air, Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP, RSHF, ESHF and GSHF for different systems

UNIT-VI

COMPONENTS: Humidification and dehumidification equipment – Systems of Air cleaning – Grills and diffusers – Fans and blowers – Measurement and control of Temperature and Humidity.

REFERENCES:

1. ASHRAE Handbook.
2. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.
3. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.
4. Norman C. Harris, "Modern Air Conditioning", New York, McGraw-Hill,1974.
5. Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.
6. Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand Reinhold Co., New York, 1984
7. Arora C.P., "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
8. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
9. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.
10. Stoecker, "Design of Thermal Systems", Mc Graw Hill, 1992.

M.Tech. (THERMAL ENGINEERING) I Year - I Sem

GAS TURBINES

(PROFESSIONAL ELECTIVE-I)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M105

Course Objectives:

The course aims at giving an overview of different types of turbomachinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic, steam and gas-turbines. It will focus on applications in power generation, transport, refrigeration and the built environment.

Course Outcomes:

At the end of the course, the student will be able to:

5. Give examples of the main applications of turbomachines
6. Recognize typical designs of turbomachines
7. Explain the working principles of turbomachines and apply it to various types of machines
8. Determine the velocity triangles in turbomachinery stages operating at design and off-design conditions
9. Apply the affinity laws to pumps such as to determine their off-design behavior Match a pump to a system and discuss various solutions of pump matching from a sustainability point-of-view
10. Explain the working principle of various types of hydro turbines and know their application range Perform the preliminary design of turbomachines (pumps, compressors, turbines) on a 1- D basis Use design parameters for characterizing turbomachinery stages
11. Determine the off-design behavior of turbines and compressors and relate it to changes in the velocity triangles

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			X
CO2			X			X
CO3			X		X	X
CO4	X		X			
CO5			X		X	X
CO6	X		X			X
CO7	X		X			

UNIT-I:

Fundamentals of Turbo Machines: Classifications, Applications, Thermodynamic analysis, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross sectional areas, Unsteady flow in turbo machines.

UNIT -II:

Impulse turbines, Compounding, Work done and Velocity triangle, Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

UNIT-III:

Gas Dynamics: Fundamental thermodynamic concepts, isentropic conditions, mach numbers and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Super sonic flow, oblique shock waves. Normal shock recoveries, Detached shocks, Aerofoil theory.

UNIT-IV:
Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

UNIT-V:
Axial Flow Compressors: Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance
Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

UNIT-VI:
Axial Flow Gas Turbines: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, Off design performance.

REFERENCES:

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Fundamentals of Turbomachinery/William W Perg/John Wiley & Sons
3. Element of Gas Dynamics/Yahya/TMH
4. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/Newyork
5. Turbines, Pumps, Compressors/Yahya/TMH
6. Practice on Turbo Machines/ G.Gopal Krishnan & D. Prithviraj/ Sci Tech Publishers, Chennai
7. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/London
8. Gas Turbines Theory and Practice/Zucrow/John Wiley & Sons/Newyork
9. Element of Gas Dynamics/Liepeman and Roshkow/ Dover Publications

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
NON-CONVENTIONAL ENERGY RESOURCES
(PROFESSIONAL ELECTIVE-I)

L	T	P	C
3	1	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M106

Course objectives:
The course is intended to
1. introduce to the technology of renewable sources of energy
2. learn about the solar radiation, its applications and radiation measuring instruments
3. learn about the various types of geothermal resources and its applications
4. study the biomass energy resources , bio-mass systems
5. learn the methods of energy extraction from the wind and oceans
6. learn to the technology of direct energy conversion methods

Course Outcomes:
At the end of the course, the student will be able to:
1. Identify the renewable energy sources and their utilization
2. Understand the basic concepts of the solar radiation and analyze the solar Thermal systems for their utilization
3. Understand the principle of working of solar cells and their modern manufacturing techniques
4. Understand the concepts of the ocean thermal energy conversion systems and their applications
5. Outline the methods of energy storage and identify the appropriate methods of energy storage for specific applications
6. Understand the energy conversion from wind energy, geothermal energy, biomass, biogas, fuel cells and hydrogen

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1				X	X	
CO2			X	X	X	
CO3			X		X	X
CO4			X		X	X
CO5			X			X
CO6			X	X	X	

UNIT-I
Introduction, Energy Scenario, Survey of energy resources. Classification and need for conventional energy resources.
Solar Energy: The Sun-sun-Earth relationship, Basic matter to waste heat energy circuit, Solar Radiation, Attention, Radiation measuring instruments.
Solar Energy Applications: Solar water heating. Space heating, Active and passive heating. Energy storage. Selective surface. Solar stills and ponds, solar refrigeration, Photovoltaic generation.

UNIT -II
Geothermal Energy: Structure of earth, Geothermal Regions, Hot springs. Hot Rocks, Hot Aquifers. Analytical methods to estimate thermal potential. Harnessing techniques, Electricity generating systems.

UNIT-III
Direct Energy Conversion: Nuclear Fusion: Fusion, Fusion reaction, P-P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic. Thermionic & thermoelectric generation, MHD generator.

Hydrogen Gas as Fuel: Production methods, Properties, I.C. Engines applications, Utilization strategy, Performances.

UNIT-IV

Bio-energy: Biomass energy sources. Plant productivity, Biomass wastes, aerovic and Anaerobic bioconversion processed, Raw metrical and properties of bio-gas, Bio-gas plant technology and status, the energetics and economics of biomass systems, Biomass gasification

UNIT-V

Wind Energy: Wind, Beaufort number, Characteristics, Wind energy conversion systems, Types, Betz model. Interference factor. Power coefficient, Torque coefficient and Thrust coefficient, Lift machines and Drag machines. Matching, Electricity generation.

UNIT-VI

Energy from Oceans: Tidal energy. Tides. Diurnal and semi -diurnal nature, Power from tides, Wave Energy, Waves, Theoretical energy available. Calculation of period and phase velocity of waves, Wave power systems, Submerged devices. Ocean thermal Energy, Principles, Heat exchangers, Pumping requirements, Practical considerations.

REFERENCES:

1. Non-conventional Energy Resources – Khan – McGraw Hill
2. Energy Resources Utilization & Technologies – Y.Anjaneyulu & T. Francis – BS Publications
3. Renewable Energy Resources- Basic Principles and Applications/ G.N.Tiwari and M.K.Ghosal/ Narosa Publications
4. Renewable Energy Resources/ John Twidell & Tony Weir/Taylor & Francis/2nd edition
5. Alternative Energy Sources & Systems – Steeby – Cengage Learning
6. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/E&FN Spon
7. Renewable Energy Sourse – Tasneem & S.A. Abbasi - PHI
8. Solar Energy – Sukhatme & Nayak – McGraw Hill

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
ENGLISH FOR RESEARCH PAPER WRITING
(AUDIT COURSE-I)

L	T	P	C
2	-	-	0

CIE Marks:30, SEE Marks:70

CODE: 7HC18

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand how to improve writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission Syllabus

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1		X				
CO2		X				
CO3		X				

Unit 1: Planning and Preparation

Word Order and Breaking up long sentences - Structuring Paragraphs and Sentences - Being Concise and Removing Redundancy - Avoiding Ambiguity and Vagueness

Unit 2: Clarifying Who did What

Highlighting your Findings - Hedging and Criticizing - Paraphrasing and Plagiarism - Sections of a Paper - Abstracts Introduction

Unit 3: Review of Literature

Methods – Results – Discussion – Conclusions - The Final Check

Unit 4: Key skills needed when writing a Title

Key skills needed when writing an Abstract - Key skills needed when writing an Introduction - Skills needed when writing a Review of Literature

Unit 5: Skills needed when writing the Methods

Skills needed when writing the Results - Skills needed when writing the Discussion - Skills needed when writing the Conclusion

Unit 6: Useful phrases

How to ensure paper is as good as it could possibly be for the first-time submission

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Writeand Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

M.Tech. (THERMAL ENGINEERING) I Year - I Sem

RESEARCH METHODOLOGY & IPR

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7W105

Course Objectives:

This course is intended to familiarize the students with effective procedures and methodologies to conduct research and to gain an understanding of intellectual property.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Gain an understanding of how to write research proposals and reports
5. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
6. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular
7. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X					
CO2	X					
CO3	X				X	
CO4	X	X			X	
CO5					X	
CO6					X	
CO7	X				X	

Unit I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit II:

Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit III:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit IV:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit V:
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit VI:
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
ADVANCED THERMAL ENGINEERING LABORATORY

L	T	P	C
-	-	4	2

CIE Marks:30, SEE Marks:70

CODE: 7M171

Course Outcomes:

At the end of the course, the student will be able to:

1. Gain practical experience in carrying out thermal engineering related experimental activities.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X	X				

1. Compressibility factor measurement of different real gases.
2. Dryness fraction estimation of steam.
3. Performance test and analysis of exhaust gases of an I.C. Engine.
4. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
5. COP estimation of vapour compression refrigeration test.
6. Performance analysis of Air conditioning unit.
7. Performance analysis of heat pipe.
8. Solar Flat Plate Collector
9. Evacuative tube concentrator.
10. Performance analysis of Air Compressor

M.Tech. (THERMAL ENGINEERING) I Year - I Sem
TECHINCAL SEMINAR-I

L	T	P	C
-	-	4	2

CIE Marks:100

CODE: 7M172

Course Objective:
To give sufficient technical lifelong skills to learn impact various engineering solutions in global products and process industries.

Course Outcomes:
At the end of the course, the student will be able to:
1. Identify a research topic
2. Collect literature
3. Present seminar
4. Discuss the queries

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X					
CO2	X	X				
CO3		X			X	
CO4		X				

There shall be two seminar presentations during I year I semester and I year II Semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee, which shall consist of the Head of the Department, a senior Faculty Member and the Supervisor and will jointly evaluate the report and presentation. For each Seminar there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% to be declared successful.

In the First semester the report must be in the form of the review paper with a format used by IEEE / ASME etc. In the Second semester Technical Seminar in the form of Independent Review Paper must be of high quality fit for publication in a reputed conference / journal.

The evaluation format for seminar is as follows:

Selection of topic, literature survey Review by the guide	10 marks
Final report and viva	10 marks
Level of content	15 marks
Presentation	20 marks
Discussion & Involvement	15 marks
Class notes	15 marks
Attendance	15 marks
Total	**100 Marks**

Contents:

- Identification of specific topic
- Analysis
- Organization of modules
- Naming Conventions
- Writing style
- Figures
- Feedback
- Miscellaneous

REFERENCES:

Teach Technical Writing in Two Hours per Week by Norman Ramsey

For Technical Seminar the student must learn few tips from sample seminars and correcting himself, which is continues learning process

NOTE: A student can use any references for this process, but must be shared in classroom.

M.Tech. (THERMAL ENGINEERING) I Year - II Sem
ADVANCED HEAT AND MASS TRANSFER
(PROFESSIONAL CORE)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M207

Course Objectives:
The course is intended to
1. Apply the principles of heat transfer in the design of thermal systems
2. Learn how to calculate heat conduction using shape factors
3. Understand usage of empirical correlations for different convective heat transfer systems
4. Gain knowledge about boiling and condensation heat transfer
5. Apply the laws governing radiation heat transfer under real time situations
6. Relate and understand the mass transfer phenomenon and the governing non- dimensional number

Course Outcomes:
At the end of the course, the student will be able to:
1. Mathematically model heat and mass transfer and fluid flow problems and to be able to apply different boundary conditions
2. Solve the simple heat and mass transfer and fluid flow problems using analytical methods and appreciate the need of numerical methods to solve complicated problems
3. Apply semi empirical formulae to determine the heat transfer parameters and use different techniques, viz., experimental, analytical and semi empirical methods to design the thermal systems.
4. Solve the radiation heat transfer related problems with and without participating medium
5. Understand the importance of different non dimensional numbers governing mass transfer phenomenon
6. Design/Construct simple heat transfer equipment by taking to consideration all the three modes of heat transfer

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			X
CO2			X		X	
CO3			X		X	X
CO4			X		X	
CO5			X		X	
CO6	X		X			X

UNIT-I:
Introduction to Different Modes of Heat Transfer: Governing Laws and mathematical models -Initial and boundary conditions. Heat Conduction – Development of Governing equation for 1D, 2D and 3D; Heat transfer through Fins.
2D Steady State Heat conduction – Use of conduction shape factors – Use of analytical method for temperature distribution in a slab for simple boundary conditions.

UNIT- II:
Transient heat conduction: Lumped system analysis-Infinite Bodies - Heisler charts-semi infinite solid. infinite solid - 2D transient heat conduction using product solutions
Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept

of exact solution. Approximate method-integral analysis. Use of empirical correlations for determination of laminar heat transfer coefficient for flow over flat plate.

UNIT-III:
External flows: Flow over a flat plate: Application of empirical relations to various geometries for laminar and turbulent flows.
Internal flows: Flow Classification based on hydrodynamic &thermal entry lengths- Fully developed flow: Laminar heat transfer coefficient-constant wall temperature and constant heat flux boundary conditions; use of empirical correlations for determination of heat transfer coefficient and friction factor for different types of internal flow applications.

UNIT-IV:
Free Convection: Approximate analysis on laminar free convective heat transfer-boussinesque approximation-different geometries-combined free and forced convection.
Boiling and condensation: Boiling curve-correlations-Nusselts theory of film condensation on a vertical plate-assumptions & correlations of film condensation for different geometries.

UNIT-V:
Radiation Heat Transfer: Radiation- specular & diffuse surfaces, Radiant heat exchange in grey, non-grey bodies, with transmitting, Reflecting and absorbing media, gas radiation-radiation from flames.

UNIT-VI
Mass Transfer: Concepts of mass transfer-diffusion & convective mass transfer analogies – different non-dimensional numbers- significance of non-dimensional numbers.

REFERENCES:

1. Convective Heat & Mass Transfer – Ghiaasiaan – Cambridge
2. Fundamentals of Heat & Mass Transfer – Thirumaleshwar – Pearson
3. Heat Transfer – Gregory Nellis & Sanford Klein – Cambridge University Press
4. Principals of Heat Transfer/Frank Kreith/Cengage Learning
5. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012
6. Heat Transfer/RK Rajput/S.Chand
7. Introduction to Heat Transfer/SK Som/PHI
8. Engineering Heat & Mass Transfer/Mahesh Rathore/Lakshmi Publications
9. Heat Transfer / Necati Ozisik / TMH
10. Heat Transfer / Nellis & Klein / Cambridge University Press / 2012.
11. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press
12. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai
13. Heat Transfer/ P.K.Nag /TMH

M.Tech. (THERMAL ENGINEERING) I Year - II Sem

STEAM ENGINEERING

(PROFESSIONAL CORE)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M208

Course Objective:

This course is intended to make students learn techniques, skills, and modern engineering tools necessary to analyze steam flow through various engineering systems

Course Outcomes:

At the end of the course, the student will be able to:

1. Explain working of different boilers and significance of mountings and accessories.
2. Use techniques, skills, and modern engineering tools necessary for boiler performance assessment.
3. Gain a theoretical and practical background in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation.
4. Design a steam piping system, its components for a process and also design economical and effective insulation.
5. Analyze a thermal system for sources of waste heat design and systems for waste heat recovery.
6. Design and develop controls and instrumentation for effective monitoring of the process.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			X
CO2			X		X	X
CO3	X		X		X	
CO4			X			X
CO5			X	X	X	
CO6			X			X

UNIT I:

Introduction: Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers ,Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards

UNIT II:

Piping & Insulation : Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

UNIT III:

Steam Systems: Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems.

UNIT IV:

Boiler Performance Assessment: Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

UNIT V:
Energy Conservation and Waste Minimization: Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization.

UNIT VI:
Instrumentation & Control : Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection

REFERENCES:

1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons
3. Yunus A. Cengel and Boles, "Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co. Ltd
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency
5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency
6. Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company
7. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGrawHill Education Pvt Ltd, N Delhi

M.Tech. (THERMAL ENGINEERING) I Year - II Sem

COMPUTATIONAL FLUID DYNAMICS

(PROFESSIONAL CORE)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M209

Course Objectives:

The course is intended to:

1. Familiarize the students with the problems involved in acquiring solutions to complex differential equations
2. Give the students an understanding of finite difference and finite volume methods to solve non-linear PDEs
3. Familiarize the students with the basics involved in solving Navier-Stokes equations

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand the basics driving the necessity of computational methods
2. Develop an understanding of finite difference method and gain a practical application experience
3. Develop an understanding of finite volume method and its application in solving simple PDEs
4. Gain on-hand knowledge in applying FVM to solve flow and heat related problems
5. Apply FVM to discretize and solve Navier-Stokes equations using SIMPLE algorithm
6. Gain an understanding of improved schemes used in solving NS equations

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			X
CO2			X		X	X
CO3			X		X	X
CO4			X		X	
CO5			X		X	
CO6	X		X		X	X

UNIT - I

Introduction to CFD: Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods - Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations

Governing Equations: Review of Navier-Stokes Equation and simplified forms - Solution Methodology: Introduction to Finite Difference Method and Finite Volume Method - Stability, CFL number - Convergence and Accuracy

UNIT – II

Finite Difference Method: Domain discretization, types of mesh, mesh quality - Explicit schemes for 1D and 2D steady state heat conduction - Direct solution with Gaussian elimination method - Implicit and Crank-Nicholson methods for 1D and 2D transient heat conduction solution - Tridiagonal algorithm - Alternate Direction Implicit method - FD formulation and solution of 1D wave equation

UNIT – III

Finite Volume Method: Domain discretization, types of mesh, mesh quality - Formulation of algebraic cell-center equations for Generalized Transport Equation - Evaluation of interface properties and variables - Treatment of source term and treatment of non-linearity - FV formulation and solution of steady state and transient heat conduction

UNIT - IV

FVM to Convection and Diffusion: General Form of Governing Equations for Fluid Flow and Heat transfer - Burgers equation - 1D steady state convection-diffusion - Discretization Schemes and their assessment - Finite Volume Treatment of Boundary Conditions

UNIT - V

Flow Field Simulations - I: Discretized algebraic formulation of NS equations - Treatment of flow-specific boundary conditions - Problems encountered in flow field representation - Staggered grid method - Pressure correction method - Pressure-Velocity coupling - SIMPLE algorithm for solving NS equations

UNIT - VI

Flow Field Simulations - II: Comparison of staggered grid vs. collocated grid methods for solution of NS equations - Improvements on SIMPLE method: SIMPLER and SIMPLEC algorithms

REFERENCES:

1. Computational Fluid Dynamics: Basics with Applications - John D. Anderson - McGraw Hill
2. Numerical Heat Transfer and Fluid Flow - Suhas V. Patankar - McGraw Hill
3. Computational Fluid Flow and Heat Transfer - Muralidaran - Narosa Publications
4. Fundamentals of Computational Fluid Dynamics - Tapan K. Sengupta - Universities Press
5. Introduction to Computational Fluid Dynamics - Anil W. Date - Cambridge
6. Introduction to Computational Fluid Dynamics - Niyogi, Chakrabartty & Laha - Pearson
7. Computational Fluid Dynamics - Tu, Yeoh and Liu - Elsevier
8. Computational fluid Dynamics - T. J. Chung - Cambridge University Press - 2002
9. Textbook of Fluid Dynamics - Frank Choriton - CBS Publishers & Distributors - 1985
10. Introduction to Theoretical and Computational Fluid Dynamics - C. Pozrikidis - Oxford University Press - 2nd Edition

M.Tech. (THERMAL ENGINEERING) I Year - II Sem

REFRIGERATION AND CRYOGENICS

(PROFESSIONAL ELECTIVE-II)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M210

Course Objective:

To have a detailed study of the basics of cryogenic systems, its cycle and application in aerospace engineering.

Course Outcomes:

At the end of the course, the students should be able to:

1. Understand properties of material at low temperature.
2. Know about Pressure, temperature, flow, fluid quality and liquid level measurement at low temperature.
3. Gain knowledge about different types of cryogenic insulations.
4. Gain knowledge about different cryogenic applications.
5. Learn about low temperature hazard

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			X
CO2			X		X	X
CO3			X			X
CO4			X			X
CO5			X	X		X

UNIT -I:

Introduction to Cryogenic Systems: Mechanical Properties at low temperatures. Properties of Cryogenic Fluids.

Gas Liquefaction: Minimum work for liquefaction. Methods to protect low temperature. Liquefaction systems for gages other than Neon. Hydrogen and Helium.

UNIT II:

Liquefaction Systems for Neon, Hydrogen and Helium: Components of Liquefaction systems. Heat exchangers. Compressors and expanders. Expansion valve, Losses in real machines.

UNIT-III:

Gas Separation and Purification Systems: Properties of mixtures, Principles of mixtures, Principles of gas separation, Air separation systems.

UNIT-IV:

Cryogenic Refrigeration Systems: Working Medium, Solids, Liquids, Gases, Cryogenic fluid storage & transfer.

UNIT-V:

Cryogenic storage systems, Insulation, Fluid transfer mechanisms, Cryostat, Cryo Coolers

UNIT-VI:

Applications: Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.

REFERENCES:

1. Cryogenic Systems/ R.F.Barren/ Oxford University Press
2. Cryogenic Research and Applications: Marshal Sitting/ Von Nostrand/ Inc. New Jersey
3. Cryogenic Heat Transfer/ R.F.Baron
4. Cryogenic Engineering Edit / B.A. Hands/ Academic Press, 1986
5. Cryogenic Engineering/ R.B.Scottm Vin Nostrand/ Inc. New Jersey, 1959
6. Experimental Techniques in Low Temperature Physics- O.K. White, Oxford Press, 1968
7. Cryogenic Process Engineering/ K.D. Timmerhaus & TM Flynn/ Plenum Press, 1998
8. Hand Book of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 1998

M.Tech. (THERMAL ENGINEERING) I Year - II Sem
DESIGN OF HEAT EXCHANGERS
(PROFESSIONAL ELECTIVE-II)

L	T	P/D	C
3	-	0	3

CIE Marks:30, SEE Marks:70

CODE: 7M211

Course Objectives:
The course is intended to
1. Design and analyze the heat exchangers parallel flow, counter flow, multipass and, cross flow heat exchanger
2. Design and analyze the Shell and tube heat exchanger
3. Enable to carryout the performance of heat exchanger with the extended surfaces.
4. Design and analyze the cooling towers.

Course Outcomes:
At the end of the course, the student will be able to:
1. Understand the physics and the mathematical treatment of typical heat exchangers.
2. Apply LMTD and Effectiveness methods in the design of heat exchangers and analyze the importance of LMTD approach over AMTD approach.
3. Analyze the performance of double-pipe counter flow (hair-pin) heat exchangers.
4. Design and analyze the shell and tube heat exchanger.
5. Understand the fundamental, physical and mathematical aspects of boiling and condensation.
6. Classify cooling towers and explain their technical features.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X		X	
CO2	X		X		X	
CO3	X		X			
CO4			X		X	X
CO5	X		X			
CO6			X			X

UNIT-I:
Classification of Heat Exchangers: Introduction, Recuperation & regeneration, Tabular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate fin and Tabular fin.

UNIT-II:
Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multipass, cross flow heat exchanger design calculations:

UNIT-III:
Double Pipe Heat Exchanger: Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements.
Shell & Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.

UNIT-IV:
Condensation of Single Vapours: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser. Condensation of steam.

UNIT-V:
Vaporizers, Evaporators and Reboilers: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces: Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger.

UNIT-VI:
Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

REFERENCES:

1. Process Heat Transfer/D.Q.Kern/ TMH
2. Heat Exchanger Design/ A.P.Fraas and M.N.Ozisick/ John Wiely & sons, New York.
3. Cooling Towers / J.D.Gurney and I.A. Cotter/ Maclaren

M.Tech. (THERMAL ENGINEERING) I Year - II Sem
THERMAL AND NUCLEAR POWER PLANTS
(PROFESSIONAL ELECTIVE-II)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M212

Course Objectives:
The course is intended to

1. Provide in awareness about resources of energies available in India for Power Production by Thermal and Nuclear Processes.
2. Understand and know the requirements for a Thermal Power Plant and Nuclear Power Plant, from sources to consumption and economics of power plants.
3. Study and learn the processes and cycles followed in Thermal Power Plants and nuclear power plants and components used in the power plants
4. Gain the knowledge on steam power plants, steam generators and gas turbine power plants, their analyses on fuel and fluidized bed combustion, ash handling systems,
5. Learn the practices followed in Thermal Power Plant and Nuclear Power Plants, to bette environmental conditions and the safety measures.
6. Gain the knowledge on Power Load calculation, distribution and optimum loading. Etc.,
7. Know various methods for the Economies of Power Generation and power plant instrumentation.

Course Outcomes:
At the end of the course, the student will be able to:

1. Describe how fission is accomplished and the basics of how a nuclear reactor produce energy
2. Discuss the thermal cycle and describe heat transfer and fluid flow
3. Identify the major components of a nuclear power plant including generators, turbines, and cooling systems
4. Examine nuclear power plant safety systems and the concepts of redundancy and defense in-depth
5. Describe the requirements associated with a refuel outage and nuclear fuel reload

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X		X	
CO2			X		X	
CO3			X			X
CO4			X		X	
CO5			X			X

UNIT-I
Introduction: Sources of energy, Type of Power plants. Direct energy conversion system, Energy sources in India, Recent developments in power generation, Combustion of coal, Volumetric analysis, Gravimetric analysis. Fuel gas analysis. Steam power plant: Introduction. General layout of steam power plant, Modern coal. Fired Steam, Steam power plant. Power plant cycle, Fuel Handling, Combustion equipment, Ash handling, Dust collectors.

UNIT-II
Steam Generators: Types, Accessories. Feed water heaters, Performance of boiling, Water treatment, Cooling towers. Steam turbines. Compounding of turbines, Steam condensers, Jet and surface condensers.

UNIT-III

Gas Turbine Power Plant: Cogeneration. Combined cycle power plant, Analysis, Waste heat recovery, IGCC power plant, Fluidized bed, Combustion, Advantages, Disadvantages

UNIT-IV

Nuclear Power Plant: Nuclear physics, Nuclear Reactor, Classification, Types of reactors, Site selection. Method of enriching uranium. Application of nuclear power plant. Nuclear Power Plant Safety: Bi-Product of nuclear power generation, Economics of nuclear power plant, Nuclear power plant in India, Future of nuclear power.

UNIT-V

Economics of Power Generation: Factors affecting the economics, Loading factors, Utilization factor, Performance and operating characteristics of power plant, Point economic load sharing, Depreciation. Energy rate, Criteria for optimum loading. Specific economic energy problem

UNIT-VI

Power Plant Instrumentations: Classification, Pressure measuring instrument, Temperature measurement and Flow Measurement, Analysis of combustion gases, Pollution types, Methods of control.

REFERENCES:

1. Power Plant Engineering / P.K.Nag / TMH
2. Power Plant Engineering / R.K.Rajput/ Lakshmi Publications.
3. Power Plant Engineering / P.C.Sharma/ Kotearia Publications.
4. Power Plant Technology / Wakil.

M.Tech. (THERMAL ENGINEERING) I Year - II Sem
ADVANCED MATHEMATICAL METHODS IN ENGINEERING
(PROFESSIONAL ELECTIVE-III)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M213

Course Objectives:
The course is intended to:

1. Numerical optimization techniques for single variable and multi variable non- linear optimization problems.
2. Sensitivity analysis on LPP queuing.
3. Simulation of annexing problem & inventory problem.
4. Geometry cutting plane method & branch bound method for linear IPP.
5. Meaning of stochastic programming problem simple problems for finding mean variance of random variables chance constrained algorithm.
6. Formulation of GP model and solving it using arithmetic geometric inequality theorem.
7. State of art nontraditional optimization technique, namely genetic algorithm simulated annealing & particle swarm optimization

Course Outcomes:
At the end of the course, the student will be able to:

1. Apply appropriate optimization techniques and solve based on the type of optimization problem like single variable or multivariable.
2. Make sensitivity analysis to study effect of changes in parameters of LPP on the optimal solution without reworking.
3. Simulate the system to estimate specified performance measures.
4. Solve integer programming problem by either geometry cutting plane algorithm or branch band method.
5. Apply chance constrained algorithm and solve stochastic linear programme.
6. Formulate GP model and solve it.
7. Solve given optimization problem by genetic algorithm or simulated annealing or PSO.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X				X	
CO2	X					X
CO3	X				X	X
CO4	X				X	
CO5	X				X	
CO6	X				X	
CO7	X				X	X

UNIT- I
Single Variable Non-Linear Unconstrained Optimition: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

UNIT - II
Multi Variable Non -Linear Unconstrained Optimization: Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. Variable metric method.

UNIT - III

Geometric Programming: Polynomials – arithmetic – geometric inequality – unconstrained G.P – constrained G.P

Dynamic Programming: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

UNIT- IV

Linear Programming: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints.

Simulation: Introduction – Types – Steps – application – inventory – queuing – thermal system.

UNIT- V

Integer Programming: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

UNIT- VI

Stochastic Programming: Basic concepts of probability theory, random variables – distributions mean, variance, Correlation, co variance, joint probability distribution – stochastic linear, dynamic programming.

REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springer
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia
7. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia

M.Tech. (THERMAL ENGINEERING) I Year - II Sem
ADVANCED FINITE ELEMENT ANALYSIS
(PROFESSIONAL ELECTIVE-III)

L	T	P	C
3	-	-	3

CIE Marks:30, SEE Marks:70

CODE: 7M214

Course Objectives:
The course is intended to:
1. Gain a fundamental understanding of the finite element method for solving 1-D structural problem.
2. Formulate the finite element equations for truss and beam elements.
3. Study two-dimensional problems such as plain stress and plain strain elasticity problems.
4. Learn finite element analysis of 1-D and 2-D heat conduction and torsion problem.
5. Analyse the structures by considering the mechanical vibrations.

Course Outcomes:
At the end of the course, the student will be able to:
1. Establish the mathematical models for the complex analysis problems and predict the nature of solution.
2. Formulate element characteristic matrices and vectors.
3. Identify the boundary conditions and their incorporation in to the FE equations.
4. Solve the problems with simple geometries, with hand calculations involving the fundamental concepts.
5. Interpret the analysis results for the improvement or modification of the system.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X				X	
CO2	X					X
CO3	X					X
CO4	X					X
CO5	X				X	X

UNIT-I:
Introduction to FEM, basic concepts, applications of FEM, general procedure, comparison of FEM with other methods, variational approach, Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations 1-D structural axial bar element – load vectortemperature effects and shape functions and characteristics, Basic equations of elasticity, straindisplacement relations, quadratic shape functions.

UNIT-II:
ANALYSIS OF TRUSSES: Plane Trusses and Space Truss elements and problems
ANALYSIS OF BEAMS: Hermite shape functions – stiffness matrix – Load vector – Problems.

UNIT-III:
2-D PROBLEMS: CST, force terms, Stiffness matrix and load vectors, boundary conditions,Isoparametric elements – quadrilateral element, shape functions – Numerical Integration.

UNIT IV:
Finite element modeling of Axi-symmetric solids subjected to Axi symmetric loading with triangular elements.
3-D PROBLEMS: Tetrahedran element – Jacobian matrix – Stiffness matrix.

UNIT-V:
SCALAR FIELD PROBLEMS: 1-D Heat conduction formulations -Slabs – fins - 2-D heat conduction problems

UNIT-VI:
Dynamic considerations, Dynamic equations – consistent mass matrix for bar triangular elements – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis.

TEXT BOOKS:

1. The Finite Element Methods in Engineering by SS Rao, Pergamon.
2. Introduction to Finite Elements in Engineering by Chandrupatla, Ashok and Belegundu, Prentice, Hall.

REFERENCE BOOKS:

1. Finite Element Methods: Basic Concepts and applications by Alavala, PHI
2. Applied Finite Element Analysis by Segerlind – Wiley India
3. Finite Element Modeling and Simulation with ANSYS Workbench by Chen & Lui, CRC
4. Finite Element Method by Zincowitz, Mc Graw Hill
5. Introduction to Fininte element analysis by S.Md.Jalaludeen, Anuradha Publications, print 2012
6. A First Course in the Finite Element Method by Daryl L Logan, Cengage Learning, 5th Edition
7. Finite Element Analysis – Theory & Programming by Krishna Moorthy, McGraw Hill
8. Finite Element Analysis by Bathe, PHI
9. Finite Element Method by Dhanraj & Nair, Oxford

M.Tech. (THERMAL ENGINEERING) I Year - II Sem
TECHINCAL SEMINAR-II

L	T	P	C
-	-	4	2

CIE Marks:100

CODE: 7M273

Course Objective:
To give sufficient technical lifelong skills to learn impact various engineering solutions in global products and process industries.

Course Outcomes:
At the end of the course, the student will be able to:

1. Identify a research topic
2. Collect literature
3. Present seminar
4. Discuss the queries

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X					
CO2	X	X				
CO3		X			X	
CO4		X				

There shall be two seminar presentations during I year I semester and I year II Semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee, which shall consist of the Head of the Department, a senior Faculty Member and the Supervisor and will jointly evaluate the report and presentation. For each Seminar there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% to be declared successful.

In the First semester the report must be in the form of the review paper with a format used by IEEE / ASME etc. In the Second semester Technical Seminar in the form of Independent Review Paper must be of high quality fit for publication in a reputed conference / journal.

The evaluation format for seminar is as follows:

Selection of topic, literature survey Review by the guide	10 marks
Final report and viva	10 marks
Level of content	15 marks
Presentation	20 marks
Discussion & Involvement	15 marks
Class notes	15 marks
Attendance	15 marks
Total	**100 Marks**

Contents:

- Identification of specific topic
- Analysis
- Organization of modules
- Naming Conventions
- Writing style
- Figures
- Feedback
- Miscellaneous

REFERENCES:

Teach Technical Writing in Two Hours per Week by Norman Ramsey

For Technical Seminar the student must learn few tips from sample seminars and correcting himself, which is continues learning process

NOTE: A student can use any references for this process, but must be shared in classroom.

M.Tech. (THERMAL ENGINEERING) I Year - II Sem

CFD LABORATORY

L	T	P	C
-	-	4	2

CIE Marks:30, SEE Marks:70

CODE: 7M274

Course Objectives:

The course is intended to familiarize the students with the use of computational fluid dynamics software.

Course Outcomes:

At the end of the course, the student will be able to generate varying geometries, meshes and solve complex problems involving fluid flow, species transport, and multiphase transport.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X		X			

List of experiments:

1. 2D Backward Facing Step
2. Steady State and Transient Heat Conduction
3. Convective Heat Transfer Modelling - Fin Cooling
4. Couette Flow with Pressure Gradient
5. Laminar Flow over a Cylinder
6. Turbulent Flow over an Airfoil
7. Internal Flow with Turbulence
8. Internal Flow with Turbulence and Heat Transfer
9. Species Transport - No Chemical Reaction
10. Species Transport - Chemical Reaction
11. Two-phase Flow - Filling of a Tank
12. Flow through Porous Media

All experiments to be carried out using ANSYS Fluent.

M.Tech. (THERMAL ENGINEERING) I Year - II Sem
COMPREHENSIVE VIVA

L	T	P	C
-	-	2	1

CIE Marks:30, SEE Marks:70

CODE: 7M275

Course Objectives:

At the end of the course, the student will be able to:

1. Be prepared to face interview both at the academic and the industrial sector.
2. Exhibit the strength and grip on the fundamentals of the subjects studied in I year.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1		X				
CO2		X				

There shall be a Comprehensive Viva-Voce Examination in second semester of I year. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is aimed to assess the students' understanding in various subjects, he/she studied during the M.Tech I Year II Sem course of study, The Comprehensive Viva-Voce is valued for 100 marks. There are30 marks to be evaluated by the internal committee and 70 marks for the end semester evaluation by a committee constituted with internal members and external evaluator. A candidate has to secure a minimum of 50% of total marks subject to securing a minimum of 40% mark in external examination to be declared successful.

M.Tech. (THERMAL ENGINEERING) II Year - I Sem
DESIGN OF SOLAR AND WIND SYSTEMS
(PROFESSIONAL CORE)

L	T	P/D	C
3	0	0	3

CIE Marks:30, SEE Marks:70

CODE: 7M315

Course Objectives:
The course is intended to
1. introduce to the technology of renewable sources of energy
2. learn about the solar radiation, its applications and radiation measuring instruments
3. learn the methods of energy extraction from the wind.
4. learn to the technology of direct energy conversion methods

Course Outcomes:
At the end of the course, the student will be able to:
1. Identify the renewable energy sources and their utilization.
2. Understand the basic concepts of the solar radiation and analyze the solar Thermal systems for their utilization.
3. Understand the principle of working of solar cells and their modern manufacturing techniques.
4. Understand the energy conversion from wind energy.
5. Outline the methods of energy storage and identify the appropriate methods of energy storage for specific applications

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X	X		
CO2			X	X		
CO3			X	X		
CO4			X	X		
CO5			X	X		X

UNIT I:
Solar radiation: Nature of solar radiation, solar radiation spectrum, solar constant, extraterrestrial radiation on a horizontal surface, attenuation of solar radiation, beam, diffuse and global radiation. Measurement of global, diffuse and beam radiation. Prediction of solar radiation; Angstrom model, Page model, Hottel's model, Liu and Jordan model etc. Insolation on an inclined surface, angle of incidence, Illustrative problems

UNIT II:
Solar concentrating collectors: Classification of solar concentrators, Basic definitions such as concentration ratio, angle of acceptance etc., Tracking of the sun; description of different tracking modes of a solar collectors and the determination of angle of incidence of insolation in different tracking modes.

UNIT III:
Solar thermal systems: Principle of working of solar water heating systems, solar cookers, solar desalination systems, solar ponds, solar chimney power plant, central power tower power plants etc

UNIT IV:
Photovoltaic energy conversion: Introduction. Single crystal silicon solar cell, i-v characteristics, effect of insolation and temperature on the performance of silicon cells. Different types of solar cells. Modern technological methods of producing these cells. Indian and world photovoltaic energy scenario.

UNIT V:
Wind energy: Origin of winds, nature of winds, wind data measurement, wind turbine types and their construction, wind-diesel hybrid system, environmental aspects, wind energy programme in India and the world . Wind energy, Direct Energy conversion- PV, MHD

UNIT VI:
Energy storage: Necessity for energy storage. Classification of methods of energy storage. Thermal energy storage; sensible heat storage, latent heat storage. Reversible chemical reaction storage. Electromagnetic energy storage. Hydrogen energy storage. Chemical battery storage. Pumped hydel energy storage etc.

Reference Books:

1. Solar Energy-Principles of Thermal Collection and Storage by S.P.Sukhatme and J.K.Nayak, TMH, 2008
2. Solar Energy Thermal Processes by J.A.Duffie and W.A.Beckman, John Wiley, 2010
3. Non conventional Energy Resources by B.H.Khan, Tata McGraw Hill, New Delhi, 2012
4. Energy Technology: Non-Conventional, Renewable and Conventional by S.Rao and B.B.Parulekar, Khanna Publishers, 2010
5. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2000
6. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994
7. Bansal and others, "Non-Conventional Energy Sources", J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981
8. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

COST MANAGEMENT OF ENGINEERING PROJECTS

(OPEN ELECTIVE)

L	T	P/D	C
3	0	0	3

CIE Marks:30, SEE Marks:70

CODE: 7ZC32

Course objective: To provide the insights of various project management and cost control techniques for successful implementation and completion of the project.

Course Outcomes:

At the end of the course, the student will be able to:

1. Gain an insight into the costing system and its management.
2. Analyze costing and profits involved in engineering projects.
3. Understand various types of budgetary planning.an
4. Learn project management and evaluation techniques.
5. Make use of quantitative methods and simulation for project cost management.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1						X
CO2						X
CO3						X
CO4						X
CO5						X

UNIT I

INTRODUCTION AND OVERVIEW OF THE STRATEGIC COST MANAGEMENT PROCESS: Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

COST BEHAVIOR AND PROFIT PLANNING MARGINAL COSTING; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis (Theory). Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.

UNIT III

BUDGETARY CONTROL: Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing

UNIT IV

PROJECT MANAGEMENT TECHNIQUES: Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.

UNIT V

PROJECT EVALUATION:. Meaning of Project, Detailed Engineering activities. Pre project execution main clearances and documents Project team : Role of Project Manager. Importance Project site. Project execution Project cost control. Bar charts and Network diagram.

UNIT VI

QUANTITATIVE TECHNIQUES: For cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Text Books Recommended:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting

References:

1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
2. Ashish K. Bhattacharya, Principles & Practices of CostAccounting A. H. Wheeler publisher
3. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

BUSINESS ANALYTICS

(OPEN ELECTIVE)

L	T	P/D	C
3	0	0	3

CIE Marks:30, SEE Marks:70

CODE: 7ZC31

Course Objectives:

The course is intended to make the students:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc

Course Outcomes:

At the end of the course, the student will be able to:

1. Demonstrate knowledge of data analytics.
2. Think critically in making decisions based on data and deep analytics.
3. Use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Translate data into clear, actionable insights

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X					X
CO2	X					
CO3						X
CO4	X					X

UNIT I - BUSINESS INTELLIGENCE:

Definition and importance in organizations, Evolution of BI , BI at all levels in organization, Future of BI. Components of BI, BI applications.

UNIT II - BUSINESS ANALYTICS:

Definition and importance, Business analytics Process, Relationship between BA and Organization decision making process, BA's at strategic level to gain competitive advantage ,an overview of BA models.

UNIT III - DATA WAREHOUSE:

Definition of DW, Importance and goals of DW, DW Architecture, and Online Analytical Processing: Concepts of OLTP and OLAP, multidimensional analysis - MOLAP, ROLAP

UNIT IV - DATA MINING:

Introduction to Data Mining: Concept, KDD process, benefits of data mining, steps in data mining, data mining for business problems. Data Mining Tasks - Trend analysis, cluster analysis, text mining, web mining, etc.

UNIT V - DECISION MODELS:
Descriptive, Predictive, Prescriptive Introduction to R software - Introduction and importance in analytical environment ,costs and benefits using R ,R in BA, Data mining ,Business Dashboards and reporting and few examples.

UNIT VI - BIG DATA:
Concept of big data, significance - business applications of big data - Introduction to Apache Hadoop, business performance management - performance measurement, metrics, KPIs and Business Activity Monitoring (BAM).

Text Books Recommended

1. Prasad, R. N., &Seema Acharya, "Fundamentals of Business Analytics", Wiley India, New Delhi, 2014
2. Gert H. N. Laursen, Jesper Thorlund, Business Analytics for Managers: Taking Business Intelligence Beyond Reporting,Wiley

Essential Recommended:

1. Peter C. Bell, Gregory S. Zaric , Analytics for Managers: With Excel,Routledge
2. Ohry,R for Business Analytics ,Springer

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

INDUSTRIAL SAFETY

(OPEN ELECTIVE)

L	T	P/D	C
3	0	0	3

CIE Marks:30, SEE Marks:70

CODE: 7WC17

Unit-I:

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit-II:

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III:

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV:

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V:

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance.

Unit-VI:

Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

REFERENCES

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

OPERATIONS RESEARCH

(OPEN ELECTIVE)

L	T	P/D	C
3	0	0	3

CIE Marks:30, SEE Marks:70

CODE: 7WC18

Course Outcomes:

At the end of the course, the student will be able to

1. Apply the dynamic programming to solve problems of discreet and continuous variables.
2. Apply the concept of non-linear programming
3. Carry out sensitivity analysis
4. Model the real world problem and simulate it.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X					X
CO2	X					
CO3	X					X
CO4	X					X

UNIT-1:

Optimization Techniques, Model Formulation, Models, General LR Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT-2:

Formulation of a LPP - Graphical solution, Revised simplex method - Duality Theory - Dual Simplex method - Sensitivity Analysis - Parametric Programming

UNIT-3:

Nonlinear Programming Problem - Kuhn-Tucker conditions, Min. cost flow problem - Max flow problem - CPM/PERT

UNIT-4:

Scheduling and Sequencing - single server and multiple server models.

UNIT-5:

Deterministic Inventory Models - Probabilistic inventory control models - Geometric Programming.

UNIT-6:

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

REFERENCES

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

COMPOSITES

(OPEN ELECTIVE)

L	T	P/D	C
3	0	0	3

CIE Marks:30, SEE Marks:70

CODE: 7WC19

UNIT–I: INTRODUCTION

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – II: REINFORCEMENTS

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Iso-stress conditions.

UNIT – III:

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications.

UNIT–IV:

Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–V:

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – VI:

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCES:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

WASTE TO ENERGY

(OPEN ELECTIVE)

L	T	P/D	C
3	0	0	3

CIE Marks:30, SEE Marks:70

CODE: 7MC17

Course Objectives:

The course is intended to:

1. Give the students an understanding of the significance of waste management and energy retrieval.
2. Explain the processes involved in the manufacture and treatment of solid, liquid, and gaseous fuels from waste materials.
3. Provide the students with the system knowledge of utilizing various biofuels.
4. Give the students in-depth knowledge of the chemical properties and processes involved in extraction of energy from biofuels.

Course Outcomes:

At the end of the course, the student will be able to:

1. Appreciate the importance of using waste as fuel.
2. Understand the processes involved in gaining fuels from bio-waste.
3. Understand the properties and processes involved in production biofuels.
4. Gain insights into the processes and applications of converting biofuels to energy.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1				X	X	
CO2				X		
CO3			X	X		
CO4			X	X		

UNIT-I: INTRODUCTION TO ENERGY FROM WASTE:

Classification of waste as fuel - Agro based, Forest residue, Industrial waste - MSW - Conversion devices - Incinerators, gasifiers, digestors.

UNIT-II: BIOMASS PYROLYSIS:

Pyrolysis - Types, slow, fast - Manufacture of charcoal - Methods - Yields and application - Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III: BIOMASS GASIFICATION:

Gasifiers - Fixed bed system - Downdraft and updraft gasifiers - Fluidized bed gasifiers - Design, construction and operation - Gasifier burner arrangement for thermal heating - Gasifier engine arrangement and electrical power - Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV: BIOMASS COMBUSTION:

Biomass stoves - Improved chullahs, types, some exotic designs - Fixed bed combustors, Types, inclined grate combustors - Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V: BIOGAS:

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion.

UNIT-VI:

Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants - Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

REFERENCES:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

MINI PROJECT WITH SEMINAR

L	T	P	C
-	-	6	3

CIE Marks:30, SEE Marks:70

CODE: 7M376

In II year I semester, a mini-project review shall be done by PRC for 100 marks and 3 credits. The students shall take up an industry-oriented mini-project between I year II semester and II year I semester.

The evaluation of the mini-project shall be done following the submission of a report by the students at the beginning of the II year I semester. The evaluation process shall carry 30 marks for continuous review of project progress and 70 marks for the report and a presentation of a seminar by the students covering the mini-project. The committee shall examine the project scope, the work done, and the knowledge gained by the students during the project time period. A candidate shall secure a minimum of 50% to be declared successful in Mini-Project.

M.Tech. (THERMAL ENGINEERING) II Year - I Sem

PROJECT PHASE-I WITH SEMINAR

L	T	P	C
-	-	10	5

CIE Marks:30, SEE Marks:70

CODE: 7M377

In II year I semester, a project work review shall be done by PRC for 100 marks and for 5 credits. The evaluation for the project reviews shall be done in 4 stages (not less than 4 weeks between two consecutive stages) including end semester evaluation.

Each stage project review shall carry 30 marks and the end semester review shall carry 70 marks. The Supervisor and External Examiner will examine the Problem Definition, Objectives, Scope of Work, Literature Survey and design in Project Phase I. A candidate shall secure a minimum of 50% to be declared successful in Project Phase I. If candidate fails to fulfill minimum marks, he has to reappear during the supplementary examination.

M.Tech. (THERMAL ENGINEERING) II Year - II Sem

PROJECT PHASE-II WITH SEMINAR

L	T	P	C
-	-	12	6

CIE Marks:30, SEE Marks:70

CODE: 7M478

In II year II semester, a project work review shall be done by PRC for 100 marks and for 6 credits. The evaluation for the project reviews shall be done in 4 stages (not less than 4 weeks between two consecutive stages) including end semester evaluation.

Each stage project review shall carry 30 marks and the end semester review shall carry 70 marks . The Supervisor and External Examiner will examine the Problem Definition, Objectives, Scope of Work, Literature Survey and design in Project Phase II. A candidate shall secure a minimum of 50% to be declared successful in Project Phase II. If candidate fails to fulfill minimum marks, he has to reappear during the supplementary examination.

M.Tech. (THERMAL ENGINEERING) II Year - II Sem
DISSERTATION AND DEFENCE VIVA

L	T	P	C
-	-	-	7

CIE Marks:30, SEE Marks:70

CODE: 7M479

For Project Evaluation (Viva Voce) in II Year II Sem., there are external marks of 200 for 7 credits. HoD shall submit a panel of 3 examiners, eminent in that field. Principal will appoint one of them as examiner.

The thesis shall be adjudicated by examiner selected by the College. If the report of the examiner is not favorable, the candidate shall revise and resubmit the Thesis. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected.

If the report of the examiner is favorable, Project Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis. Candidate has to secure minimum of 50% marks in Project Evaluation (Viva-Voce) examination.