DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH (THERMAL SYSTEM DESIGN)

SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY

Ichchhanath, Surat- 395007, Gujarat, India

www.svnit.ac.in

VISION AND MISSION OF INSTITUTE

Vision statement

To be one of the leading technical institutes disseminating globally acceptable education, effective industrial training and relevant research output.

Mission statement

To be a globally accepted centre of excellence in technical education catalyzing absorption, innovation, diffusion and transfer of high technologies resulting in enhanced quality for all the stake holders.

VISION AND MISSION OF MECHANICAL DEPARTMENT

Vision statement

Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat perceives to be globally accepted center of quality technical education based on innovation and academic excellence.

Mission statement

Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat strives to disseminate technical knowledge to its undergraduate, post graduate and research scholars to meet intellectual, ethical and career challenges for sustainable growth of humanity, nation, and global community.

Programme Educational Objectives(PEOs)

Master of Technology in Thermal System Design imbibes in students excellent technical capabilities in the area of thermal engineering and allied systems, effective communication skill, ensuring successful career and continuing their professional advancement through life-long learning.

The programme educational objectives of Master of Technology in Thermal System Design are

PEO1 : Excel students in analytical, computational and experimental skills to solve thermal engineering related problems.

PEO2 : Have high level of technical competency combined with research and problem solving ability to generate innovative solutions in thermal engineering or related areas.

PEO3 : Enjoy successful career in industry and/or academia with an ethic for lifelong learning.

PEO4 : Graduates will have inculcated to maintain high professionalism and ethical standards, effective technical presentation and writing skill and to work as a part of team on research projects.

Programme Outcomes (POs)

Following are the programme outcomes for M.Tech. (Thermal System Design)

By the time of post graduation:

a. Student will be able to demonstrate and apply in depth technical knowledge of engineering in design and operation of various thermal systems.

b. Student will be able to design and conduct experiments, as well as to organize, analyze and interpret data to produce meaningful conclusions and recommendations.

c. Student will be able to design thermal systems or components or process to meet desired need within realistic constraints such as economic, environmental, social, safety, manufacturability and sustainability.

d. Student will be able to work individually or as a member with responsibility to function on multi-disciplinary team.

e. Student will be able to identify, formulate and solve engineering problems.

f. Student will be able to understand professional, legal, and ethical issues and responsibilities.

g. Student will be able to convey thoughts effectively on the basis of acquired soft skills and self confidence with peers, subordinates and higher authority for the consistent and effective knowledge sharing process.

h. Student will be sensitive towards the impact of engineering solutions in a global, economic, environmental and societal context.

i. Student will be able to understand the need for, and an ability to engage in life-long learning and continual updating of professional skills.

j. Student has knowledge about current issues/advances in engineering practices.

k. Student will be able to use the techniques, skills and modern engineering tools necessary for engineering practices.

Course Structure for M.Tech. (Thermal System Design)

COURSE STRUCTURE FOR M. TECH.
(THERMAL SYSTEM DESIGN)

SEMESTER – I

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 603	Advance Heat Transfer	3	0	2	2	100	-	50	150	4
ME 721	Advance Thermodynamics & Combustion	4	0	0	2	100	-	-	100	4
ME 723	Thermal Power Plant Engineering -I	3	0	0	2	100	-	-	100	3
ME 725	Computational Methods in Fluid Flow & Heat Transfer	3	0	0	2	100	-	-	100	3
ME 727	Software Practice	0	0	4	-	-	-	100	100	2
	Elective – I	3	0	0	2	100	-	-	100	3
ME 650 **ME 729** **ME 731**	Optimization Techniques. Residual Life Assessment of Boiler Plant Equipments Analysis & Design of I.C. Engines									

SEMESTER – II

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 682	Design of heat exchangers	3	0	2	2	100	-	50	150	4
ME 722	Exergy analysis of Thermal Systems	4	0	0	2	100	-	-	100	4
ME 726	Design of Refrigeration & Air-conditioning systems	3	0	2	2	100	-	50	150	4
ME 724	Thermal Power plant Engineering– II	3	0	0	2	100	-	-	100	3
ME 728	Laboratory Practice	0	0	2	2	-	-	50	50	1
	Elective – II	3	0	0	2	100	-	-	100	3
ME 732 **ME 734** **ME 736**	Non-conventional Energy Systems Analysis & Design of Thermal Turbomachines Theory & Design of Cryogenic Systems									

SEMESTER – III

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 801	Dissertation Preliminaries	0	0	16	-	-	-	400	400	8
ME 803	Seminar	0	0	4	-	-	-	100	100	2

SEMESTER - IV

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 802	Dissertation	0	0	24	-	-	-	600	600	12

CURRICULAM
SEMESTER-1

M. Tech (THERMAL SYSTEM DESIGN), Semester – I **L T P C**
ME 603 : Advanced Heat Transfer **3 0 2 4**

- Modes of heat transfer. **(02 Hours)**

- Conduction, Factors affecting thermal conductivity of solids, liquids & gases, General three dimensional heat conduction equation in Cartesian, Cylindrical & spherical coordinates, Initial condition and various boundary conditions. Heat source systems, Critical thickness of insulation. Different types of fins & their analysis, Two dimensional steady state conduction, Electrical analogy, Graphical & numerical methods, Transient heat conduction with & without temperature gradients within the system, Heat flow in semi infinite solids. Application of Heisler charts. **(12 Hours)**

- Free & forced convection, Similarity & simulation of convection heat transfer, Boundary layer theory. Turbulent flow heat transfer, Analogy between momentum & heat transfer, Heat transfer with liquid metals, Heat transfer in high velocity flow, Recent developments in the theory of turbulent heat transfer, Natural convection under different situations, Empirical relations in convection heat transfer. **(14 Hours)**

- Boiling & condensation. **(03 Hours)**

- Regimes of boiling heat transfer, Heat transfer in condensation, Drop wise & film condensation, Empirical equations. **(2 Hours)**

- Radiation heat transfer properties, Laws of thermal radiation, Shape factors, Radiation heat transfer between black, diffuse & gray surface, Electrical network method of solving radiation problems, Radiosity approach, Gas emission & absorption, Bulk radiations.

(12 Hours)
(Total Lecture Hour 45)

PRACTICALS:

1. Calibration of thermocouple
2. Heat transfer in natural convection
3. Heat transfer in forced convection
4. Thermal conductivity of insulating powder
5. Heat transfer from pin fin apparatus
6. Heat transfer through composite wall

BOOKS RECOMMENDED:

1. J.P.Holman, "Heat Transfer", McGraw Hill Book Co. Special Indian 9th Edition, 2008
2. Oziski, M. N. "Heat Transfer – A Basic Approach", McGraw Hill, N. Y., 2001.
3. Roshenow, W., Hartnett, J., Ganic, P., "Hand Book of Heat Transfer ", Vol. 1 & 2, McGraw Hill, N. Y., 2002.
4. Incropera & Hewitt, "Fundamentals of Heat and Mass Transfer", John Wiley , 2000.
5. S.P.Sukhatme, "Heat Transfer", Orient Longman, 2001

M. Tech (THERMAL SYSTEM DESIGN), Semester – I **L T P C**
ME 721 : Advance Thermodynamics & Combustion **4 0 0 4**

- Review of fundamentals availability, Entropy, Carnot theory, Entropy of the ideal gas, TS diagram, Entropy and reversibility, Entropy and irreversibility, Irreversible part of the second law, Heat and entropy in irreversible processes, Entropy and Non equilibrium states, Principle of increase of entropy, Application of the entropy principle, Entropy and disorder, Exact differentials. **(10 Hours)**

- Chemical thermodynamics and flame temperatures, Heat of reaction and formation, Free Energy and equilibrium constants, Flame temperatures and equilibrium composition. **(08 Hours)**

- Chemical kinetics, Order of reaction, Rate of reactions, Simulations independent and chain reactions, Pseudo First order reactions, Partial equilibrium, Pressure and temperature effects**.** **(08 Hours)**

- Explosive and oxidative characteristics of fuels, Criteria for explosion, Explosion limits and oxidation of hydrogen, Carbon monoxide and hydrocarbons**.** **(10 Hours)**

- Premixed flames, Laminar flame structure, Laminar flame speed, Flame speed measurements, Stability limits of laminar flames, Turbulent flames, The turbulent flame speed, Flame stabilization in turbulent flows**.** **(10 Hours)**

- Diffusion flames, Gaseous fuel tests, Turbulent fuel tests, Burning of condensed phases, Droplet combustion**.** **(06 Hours)**

- Modeling of coal combustion and emissions shrinking core model, Theory of formation of NOx, CO2, SOx and particulate emissions**.** **(08 Hours)**

(Total Lecture Hours : 60)

BOOKS RECOMMENDED:

1. S. P. Sharma and Mohan C., "Fuels & Combustion", McGrawHill2007.
2. Irvin Glassman,"Combustion", 2nd Edition, Academic Press, Inc. Harcourt Brace Jovanorich Pub., Orlando, 2002.
3. Strehlow, R. A., "Combustion Fundamentals", McGraw Hill Book Co., N. Y., 2002
4. Phil Attard, "Thermodynamics and Statistical Mechanics", Australian Research Council, University of South Australia, 2002.
5. Mark W. Zemansky and Richard H. Dittman, "Heat and Thermodynamics", McGraw Hill International Editions, 7th Edition, 2003.

- Classification of boilers, Description of boilers, Boiler specifications, Natural circulation boilers and forced circulation for subcritical and supercritical boilers**.** **(08 Hours)**

- Types of fuels, Fuel preparation for coal fired boilers, Features of boiler furnaces, coal fired, Gas fired, Oil fired, Pulverized fuel**.** **(07 Hours)**

- Fluidized bed combustion chambers, Burners, Combustion calculations, Economizers, Airpreheaters, Superheaters, Desuperheaters, Reheaters. **(10 Hours)**

- Forced and induced draft fans and blowers, Boiler feed pumps, Steps for boiler design, Steam system materials, Heat balance sheet, Electrostatic precipitators, Cogeneration and combined cycle, Boiler efficiency, Thermodynamics and power plant cycle analysis**.** **(20 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED:

1. Shields, C. D., “Boilers”, McGraw Hill, New York, 2001
2. Babcock Wilcox manual on “Steam”
3. Vandagriff, R.L “Practical guide to boiler systems”, Marcel Dekker, 2000
4. Oliver, K.G “Industrial boiler management, an operations guide, Industrial Press, New York. 2002
5. El Wakil M. M., “Power Plant Technology”, McGraw Hill, 2001.

M. Tech (THERMAL SYSTEM DESIGN), Semester –I **L T P C**
ME 725 : Computational Methods in Fluid Flow & Heat Transfer **3 0 0 3**

- REVIEW OF GOVERNING EQUATIONS CONNECTIVE FLUID FLOW AND HEAT TRANSFER
  Conservation of mass, Newton's second law of motion, Expanded forms of Navier-Stokes equations, Conservation of energy principle, Special forms of the Navier-Stokes equations, Classification of second order partial differential equations, Initial and boundary conditions, Governing equations in generalized coordinates**.** **(08 Hours)**

- FINITE DIFFERENCE, DISCRETIZATISON, CONSISTENCY, STABILITY AND FUNDAMENTAL OF FLUID FLOW MODELING
  Elementary finite difference quotients, Basic aspects of finite difference equations , Errors and stability analysis, Some nontrivial problems with discretized equations , Applications to heat conduction and convection**.** **(10 Hours)**

- SOLUTIONS OF VISCOUS INCOMPRESSIBLE FLOWS BY STREAM FUNCTION , VORTICITY FORMULATION
  Two dimensional incompressible viscous flow, Incorporation of upwind scheme, Estimation of discretization error, Application to curvilinear geometries, Derivation of surface pressure and drag. **(07 Hours)**

- SOLUTION OF NAVIERSTOKES EQUATIONS FOR INCOMPRESSIBLE FLOWS USING MAC AND SIMPLE ALGORITHMS
  Staggered grid, Solution of the unsteady Navier Stokes equations, Solutions of energy equation, Formulation of the flow problems, Simple algorithm**.** **(06 Hours)**

- INTRODUCTION TO FINITE VOLUME METHOD
  Integral approach, discretization & higher order schemes, Application to complex geometry.
  (07 Hours)
- 1INTRODUCTION TO FINITE ELEMENT METHOD
  Stiffness matrix, Isoparametric elements, Formulation of finite elements for flow and heat transfer problems **(07 Hours)**

(Total Lecture Hours : 45)

BOOKS RECOMMENDED:

1. Anderson D.A., Tannehill J.C., Pletcher R.H., "Computational Fluid Mechanics and Heat Transfer ", Hemisphere Publishing Corporation, New York, U.S.A. 2004.
2. Ankar S.V., "Numerical Heat Transfer and Flow" Hemisphere Publ., Corporation, 2001.
3. H.K.Versteag and W.Malalsekara, "An Introduction to Computational Fluid Dynamics", Longman, 2000.
4. Carnahan B., "Applied Numerical Methods", John Wiley & Sons 2001.
5. Patankar, "Numerical heat transfer and fluid flow", McGraw Hill, 2002.

- Generation velocity profile for laminar flow
- Generation of velocity profile for turbulent flow
- Friction factor for laminar flow
- Friction factor for turbulent flow
- Shear stress distribution for a flow in horizontal duct
- Nusselt number determination for a flow with constant it edition
- Nusselt number determination for a flow with heat edition at constant temperature
- Determination of drag for a flow over a body
- Analysis of 2D transient heat flow over a plate

M. Tech (THERMAL SYSTEM DESIGN), Semester I, Elective-I **L T P C**
ME 650 : Optimization Techniques **3 0 0 3**

- Single and multivariable optimization methods, constrained optimization methods, Kuhn, tucker conditions, necessary& Sufficiency theorems. **(10 Hours)**

- Linear programming, Traveling salesman problem and transshipment problems, Post optimization analysis**.** **(10 Hours)**

- Integer programming all integer, Mixed integer and zero, one programming **(08 Hours)**

- Geometric programming - concept - degree of difficulty - solution of unconstrained & constrained non linear problems by geometric programming**.** **(09 Hours)**

- Dynamic programming**.** **(08 Hours)**

(Total Lecture Hours : 45)

BOOKS RECOMMENDED:

1. Rao S.S., "Optimization Theory &Applications", Wiley Eastern 2000.
2. Deb. K, "Optimization for Engineering Design", Prentice Hall of India, 2002
3. Reklaitis G.V., Ravindram A., Ragsdell K.M., "Engineering Optimization Methods & Application", Wiley, 2001.
4. Verma, A. P,. "Operation Research", S. K. Kataria and Sons, 2007.
5. Vora, N. D, "Quantitative techniques", Tata Mc-Graw Hill, 2006.

M. Tech (THERMAL SYSTEM DESIGN), Semester I, Elective I **L T P C**
ME 729 : Residual Life Assessment of Boiler **3 0 0 3**

- General approval to the analysis of metallurgical objective of failure analysis, Factors related to failures, Stages of analysis, Collection of back ground data & selection of sample. **(08 Hours)**

- METAL FATIGUES
  Fatigue failure life, Cause & prevention of fatigues failures. **(07 Hours)**

- CORROSION RELATED FAILURES
  Introduction to corrosion, Types of corrosions, Environmental factors, Preventive measures. **(07 Hours)**

- ELEVATED TEMPERATURE FAILURE **:**
  Creep, Elevated temperature fatigue, Thermal fatigue prevention. **(07 Hours)**

- RESIDUAL STRESSES
  Thermal residual stresses, Metallurgical residual stresses, Mechanical residual stresses, Chemical effects on residual stress. **(08 Hours)**

- Remaining Life Assessment (RLA) of critical components relevance of RLA, RLA methodology, Application of Non Destructive Testing, Risk based inspections, Case study on boiler tube & its accessories failure. **(08 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED:

1. Towe, H. C., “Life Extension & Assessment of Fossil Power Plant” ,McGraw Hill, 2005.
2. Webster, G. A., Anisworth, R.A., “High Temperature Component life assessment”, McGraw Hill, 2004.
3. Hozel, Deiter K., “Methods to Extend Mechanical Components life”, AIAA Publication, Washington, 2004.
4. Oliver, K.G “Industrial boiler management, an operations guide", Industrial Press, New York. 2002
5. El Wakil M. M., “Power Plant Technology”, McGraw Hill, 2003.

M. Tech (THERMAL SYSTEM DESIGN), Semester I, Elective I **L T P C**
ME 731 : Analysis & Design of I.C. Engines **3 0 0 3**

- Review of thermodynamic cycles ideal, fuel air and real cycles **(06 Hours)**
- Engine heat transfer and friction **(06 Hours)**
- Gas exchange processes: flow through valves, phase of the flow, turbulence, analysis of suction and exhaust processes, manifold tuning**.** **(07 Hours)**
- Analysis of compression and expansion processes. **(06 Hours)**
- Modeling of combustion in S.I. and C.I. engines**.** **(05 Hours)**
- Digital simulation of complete engine cycle**.** **(04 Hours)**
- Design of engine components piston, cylinder, piston rings, connecting rod, crankshaft etc **(08 Hours)**
- Theory of super chargers / turbo chargers **(03 Hours)**
- Similarity considerations, balancing and vibrations of engines **(04 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED:

1. Maleev, “I. C. Engines: Theory and Practice”, Mc-Graw Hill2000.
2. Heywood, J. B., “Internal Combustion Engine Fundament als”, Mc-Graw Hill International Edition, 2002.
3. Richard, Stone, “Introduction to Internal Combustion Engines”, 2nd Edn. McMillan Press, 2003.
4. Taylor, C. F., “Internal Combustion Engine in Theory and Practice”, Vol. 1 & 2, M. I. T. Press, Cambridge, USA, 2003.
5. Juvinall, R. C., and Marshek, K. M., “Fundamental of Machine Component Design”, John Wiley & Sons, N.Y., 2001.

Semester – II

M. Tech (THERMAL SYSTEM DESIGN), Semester II **L T P C**
ME 682 : Design of Heat Exchangers **3 0 2 4**

- Review of heat transfer principles & convection correlation. **(03 Hours)**
- Introduction to heat exchangers and classification **(03 Hours)**
- Basic design methodologies, Net Transferable Units method and Logarithmic Mean Temperature Deference method **(04 Hours)**
- Design of double pipe heat exchangers **(05 Hours)**
- Shell & tube type heat exchangers, nomenclature, J-factors, conventional design methods, bell , Delware method **(05 Hours)**
- Compact heat exchangers, J-factors, design method **(08 Hours)**
- Condensers classification and design methods for surface condensers **(05 Hours)**
- Evaporators Classification and design methods **(03 Hours)**
- Plate type Heat exchangers **(03 Hours)**
- Regenerators **(03 Hours)**
- Furnace design **(03 Hours)**

(Total Lecture Hours: 45)

PRACTICALS:

1. Thermal aspects of heat exchanger design
2. Design of double pipe Heat exchanger
3. Timkers model & TEMA standards
4. Bell Deware’s method for shell and tube type heat exchanger design
5. Design of Reboilers and estimation of loss of energy in the pipe
6. Analysis and design regenerative heat exchanger
7. Circulated fluidized bed combustion boiler
8. Design of compact heat exchanger
9. Design of plate type heat exchanger
10. Heat exchange networking

BOOKS RECOMMENDED:

1. Saunders, E.A.D., “Heat Exchangers Selection Design and Construction”, Longmann Scientific and Technical, N.Y., 2001.
2. Kays, V.A. and London, A.L., “Compact Heat Exchangers” , McGraw Hill, 2002.
3. Holger Martin, “Heat Exchangers” Hemisphere Publ. Corp. , Washington, 2001.
4. Kuppan, T., “Heat Exchanger Design Handbook”, Macel Dekker, Inc., N.Y. , 2000
5. Seikan Ishigai, “Steam Power Engineering , Thermal and Hydraulic Design Principles”, Cambridge Univ. Press, 2001.

M. Tech (THERMAL SYSTEM DESIGN), Semester – II **L T P C**
ME 722 : Exergy Analysis of Thermal Systems **4 0 0 4**

- Basic concepts of energy analysis of thermal systems **(08 Hours)**

- **Basic exergy concepts**
  Classification of forms of exergy, concepts of exergy, exergy concepts for a control region, physical exergy, chemical exergy, exergyconcepts for closed system analysis. **(15 Hours)**

- **Elements of plant analysis**
  Control mass analysis, Control region analysis, Criteria of performance, Pictorial representation of exergy balance, Exergy based property diagram. **(11 Hours)**

- **Exergy analysis of processes**
  Expansions process, Compression processes, Heat transfer process, Mixing & separation Process, Chemical process including combustion. **(15 Hours)**

- **Energy analysis of thermal systems**
  Gas turbine plant, Thermal power plant, Cogeneration plant, Captive power plant, Combined cycle power plant, Refrigeration plant, Chemical plant Linde air liquification plant, Heat exchanger. **(11 Hours)**

(Total Lecture Hours : 60)

BOOKS RECOMMENDED:

1. Kotas J.J., “The Exergy Methods of Thermal Plant Analysis ”, 2nd Ed., Krieger Publ. Corp. U.S.A., 2000.
2. Larry, C.W., Schmidt, P.S., and Schmidt, P.S. and David, R.B., “Industrial Energy Management and Utilization”, Hemisphere Pub. Corp., Washingto n, 2001.
3. Seikan, Ishigai, “Steam Power Engineering , Thermal and Hydraulic Design Principles”, Cambridge Univ., Press, 2000.
4. Turner, W.C., (Ed.), “Energy Management Handbook”, John Wiley & Sons, N.Y., 2002.
5. Dryden, I.G.C., “The Efficient use of Energy”, Butterworths, London, 2000

M. Tech (THERMAL SYSTEM DESIGN), Semester II **L T P C**
ME 726 : Design of Refrigeration and Air Conditioning Systems **3 0 2 4**

- Review of basic principles of refrigeration -Vapour compression and vapour absorption cycles, Ecofriendly refrigerants. **(03 Hours)**
- Low temperature refrigeration, Martinovesky, Dubinsky machine, Capitza air liquifier; Cap Phillips machines, Gifford models. **(04 Hours)**
- Refrigerator using solid CO_2as working media. **(03 Hours)**
- Magnetic refrigeration systems. **(03 Hours)**
- Design aspects of refrigeration system components. **(04 Hours)**
- Design of water coolers, Ice plant, Cold storage plants. **(03 Hours)**
- Review of air conditioning principles. **(05 Hours)**
- Psychrometry of various air conditioning processes. **(05 Hours)**
- Cooling load calculations for air conditioning systems. **(04 Hours)**
- Design aspects of various components of an air conditioning system such as fans, Cooling coils, Heating coils, Ducts and air, Distribution system. **(04 Hours)**
- Analysis and design of air Washers and cooling towers. **(03 Hours)**
- Design of residential, commercial and industrial air conditioning plants. **(04 Hours)**

(Total Lecture Hours: 45)

PRACTICALS:

1. Performance test on vapour compression refrigeration system using different expansion devices.
2. To determine the C.O.P. of vapour absorption system.
3. Performance test on heat pump.
4. To determine the adiabatic efficiency of an air cooler
5. Performance test on air conditioning plant.
6. To determine the C.O.P. of an ice plant

BOOKS RECOMMENDED:

1. Stocker, W. F. and Jones, J. W., “Refrigeration and Air Conditioning” , McGraw Hill, N. Y. 1986.
2. Dossat, R. J., “Principles of Refrigeration”, John Wiley and Sons, 1988.
3. Threlked, J.L., “Thermal Environmental Engineering”, Prentice Hall, N. Y. , 1970.
4. Baron, R. F., “Cryogenics Systems”, Oxford Press, USA, 1985.
5. ASHRAE Fundamentals, Applications, Systems and Equipment, 1999 .

M. Tech (THERMAL SYSTEM DESIGN), Semester II **L T P C**
ME 724 : Thermal Power Plant Engineering – II **3 0 0 3**

- Steam turbines, Classification, Compounding of steam Turbines, Arrangements of steam turbines, Governing of steam turbines. **(08 Hours)**

- Steam cycle heat exchangers (Condensers), Concept of heat recovery steam generators, Reheaters, Regenerative feed heaters Fans and blowers, Boiler feed pumps, Condensate extraction pumps, Air pumps**.** **(15 Hours)**

- Circulating water systems, Cooling towers**.** **(05 Hours)**

- Natural and mechanical draught and their design calculations. **(07 Hours)**

- Energy auditing, Environmental considerations, Ash handling systems, Air pollution control. **(10 Hours)**

(Total Lecture Hours : 45)

BOOKS RECOMMENDED:

1. Black and Vetach, “Power Plant Engineering”, Chapman and Hall, International Thomson Publishing Co., 2001.
2. El, Wakil, ”Power Plant Technology”, McGraw Hill, 2003.
3. Gebhartt, G. F.,”Steam Power Plant Engineering”, John Wiley & Sons, 2002.
4. Kearton, ”Steam Turbine Theory and Practice”, ELBS, 2001.
5. Burger R., “Cooling Tower Technology”, Lilburn, 2004.

M. Tech (THERMAL SYSTEM DESIGN), Semester – II
ME 728 : Laboratory Practice

L	T	P	C
0	0	2	1

- To determine specific fuel consumption & thermal efficiency of S. I. Engine
- To determine specific fuel consumption & thermal efficiency of C. I. Engine
- To determine Thermal conductivity of Insulating Material
- To determine valve timing diagram of I. C. Engine
- To determine the boiler efficiency
- To study various aspects of thermal power plant

M. Tech (THERMAL SYSTEM DESIGN), Semester II, Elective II **L T P C**
ME 732 : Nonconventional Energy Systems **3 0 0 3**

- Solar energy, Solar thermal systems, Solar cells, Thermal storage, Solar heating & cooling of buildings, Solar economics. **(12 Hours)**

- Wind energy conversion systems, Scientific chulhas, Biogas plant & their design, Microbiological aspects of biogas generation and alcohol fermentation, Production of liquid fuels, Pyrolysis, gasification. **(10 Hours)**

- Fuel cell technology & hybrid vehicles. **(10 Hours)**

- Hydrogen energy & Its future impact**.** **(07 Hours)**

- Geothermal energy **(06 Hours)**

(Total Lecture Hours : 45)

BOOKS RECOMMENDED:

1. Duffie, J.A., and Bechman, "W. A., "Solar Engineering of Thermal Processes", John Wiley, N. Y., 2002.
2. Maths, D. A., "Hydrogen Technology for Energy", Noyes Data Corp., 2002.
3. Freris, L. L. "Wind Energy Conversion System", Prentice Hall, 2001.
4. Spera, D.A., "Wind Turbine Technology , Fundamental Concepts of Wind Turbine Engineering", ASME Press. N. Y. 2001.
5. Twidell, J.W., and Weir, A.D., "Renewable Energy Resources", ELBS, 2000

- Design of compressors, Centrifugal compressor, Inlet section, Impeller passages, Effect of impeller blade shape on performance, Impeller channel, Vaneless and vaned diffusers , Effect of mach number, Design procedure**.** **(07 Hours)**

- Axial flow compressor, stage characteristics, Blading efficiency, Design parameters, Blade loading, Lift coefficient and solidity, Three dimensional flow considerations , Radial equilibrium design approach, Actuator disc theory approach , Design procedure and calculations. **(08 Hours)**

- Design of turbine flow passages, Introduction, Isentropic velocity ratio, Energy distribution in turbines, Effect of carryover velocity on energy distribution. **(06 Hours)**

- Impulse turbine flow passages, Blade pitch and width, Blade height, B lade entrance and exit angles, Geometry of impulse blade profiles , Losses in impulse blade passages , Design procedure for single stage and multistage impulse turbines. **(08 Hours)**

- Reaction turbine flow passages, Reaction blade profiles, Blade angles, Gauging and pitch, Blade width and height, Losses in reaction blade passages , Degree of reaction, design procedure for impulse, reaction turbines, Calculations for axial thrust , Turbines for optimum capacity. **(08 Hours)**

- Flow passage with radial equilibrium, The free vortex turbine, Turbine with constant specific mass flow, Turbines with constant nozzle angle , comparison of radial equilibrium design , off design performance using radial equilibrium theory , Actuator disc theory, Single parameter analysis, Stream line curvature methods**.** **(08 Hours)**

(Total Lecture Hours : 45)

BOOKS RECOMMENDED:

1. Lee J.E., “Steam & Gas Turbine”, McGraw Hill city, 2001.
2. Shlyakhin P., “Steam Turbines, Theory & Design”, Peace Publications, Moscow, 2000.
3. Frank P. Beleier, “Fan Hand Book Selection”, Application and Design”, Wiley, 2003.
4. Saravanamootoo, H.I.H., & Rogers, G.F.C., “Gas Turbine Theory” , Pearson Pub. Company, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi 2001.
5. Dixon, “Theory and thermodynamics of turbomachinery”, Elsevier Science and Technological series, 5th Edition2005.

M. Tech (THERMAL SYSTEM DESIGN), Semester II, Elective II **L T P C**
ME 736 : Theory & Design of Cryogenic Systems **3 0 0 3**

- Introduction and application. **(03 Hours)**
- Cryogenics Fluids: Properties of air, Oxygen, Nitrogen, Hydrogen, Helium and its isotopes. **(04 Hours)**
- Cryogenics refrigeration systems : Recuperative & regenerative cycles, Joule Thomson cycle ; Gifford, Mcmohan cycle, Stirling cycle, Pulse Tube refrigeration, Magneto caloric refrigeration, Vuilleumier refrigerator. **(04 Hours)**
- Gas liquefaction systems: Ideal systems, Linde, Linde dual pressure system, Claude, Heylandt, Kapitza systems, Cascade cycle. **(04 Hours)**
- Cryogenic insulation: Vacuum insulation, Multilayer insulation (MLI), Methods of measuring effective thermal conductivity of MLI, Liquid & vapour shield, Evacuated porous insulation, Gas filled powders and fibrous materials, Solid foams. **(03 Hours)**
- Cryogenic instrumentation: Peculiarities of cryogenic strain measurement, Pressure, Flow, Density, Temperature and liquid level measurement for cryogenic application. **(03 Hours)**
- Purification and separation of gases, Liquefied natural gas: Principles of gas separation: Separation by condensation & flashing, Separation by distillation. Air separation system: Linde single column system, Linde doubleColumn systems etc., Liquefaction of Natural Gas. **(04 Hours)**
- Storage & handling systems: Dewar vessel design, Piping, Support systems, Vessel safety devices and storage systems, Industrial storage systems. **(03 Hours)**
- Transfer systems: Transfer from storage, Uninsulated transfer lines, Insulated lines, Transfer system components. **(04 Hours)**
- Properties and selection of Materials: Study of material properties & their selection for cryogenic application. **(05 Hours)**
- Vacuum Systems, Cryo pumping. **(03 Hours)**
- Equipments for low temperature systems: Heat exchangers, Compressor, Expanders. **(05 Hours)**

(Total Lecture Hours : 45)

BOOKS RECOMMENDED:

1. Hastlden, C., “Cryogenic Fundamentals”, Academic Press, 2001.
2. Barron R., “Cryogenic Systems”, Plenum Press, 2001 .
3. Walker, “Cryocoolers”, Vol. 1 & 2, Plenum Press, 2000 .
4. Mikulin, Y., “Theory and Design of Cryogenic systems”, MIR Publication, 2002.
5. Barron, R. F., “Cryogenics Systems”, Oxford Press., USA, 2002.

Course Objectives

Year/ sem.	Subject Code	Course	Course Objectives
1st semester	ME 603	Advance Heat Transfer	1. To enable the students apply the fundamentals of heat transfer modes such as conduction, convection and radiation in various heat transfer applications. 2. To enable the students apply analytical and semi analytical approach towards the solution of Heat Transfer problems. 3. To prepare the students more competitive for thermal design of process equipment.
	ME 721	Advance Thermodynamics & Combustion	1. To enable the students to extract in-depth knowledge on fundamental and applied thermodynamics and a firm grasp, clear understanding of basic principles of energy, entropy and work and energy conversion as well as their applications in advanced thermodynamic cycles. 2. To describe the different combustion mechanisms, how these can be efficiently used in engineering applications e.g. power generation. 3. To illustrate the elementary chemical and physical processes of combustion phenomena, and how they influence the development of combustion, the energy release, and the nature of combustion products. 4. To describe simple mathematical models for flame ignition, propagation, and extinction, how they can help understanding combustion phenomena,

			and their limitations in describing combustion in real applications. 5. To illustrate the different type of pollutants generated by combustion, their effects on health and on the environment, the methods to reduce their formation during combustion and to mitigate their effects once they have been produced. 6. To give basic notions about combustion processes in engineering devices, and how these help us in designing burners for different types of fuels and combustion chambers.
	ME 723	Thermal Power Plant Engineering - I	1. To enable students to list boiler specifications, types, describe mechanism of subcritical and supercritical boilers, Natural and forced circulation boilers, fluidized bed combustion boilers, design steps for boilers, 2. To enable students to describe types of fuels, types of combustion chambers and fuel preparation for burners 3. To enable students to assess combustion mechanism, combustion equipments and firing methods 4. To enable student to carry out design and analyse heat exchangers of boilers like economisers preheater, feed water heaters, superheaters, reheaters etc. 5. To enable students to evaluate complete steam generator plant to improve performance based on heat balance sheet describing energy distribution 6. To enable students to appraise ash handling systems, feed water treatment, forced and induced draught fans, electrostatic precipitators,

			deaeration, fabric filters and bag houses in thermal power plant.
	ME 725	Computational Methods in Fluid Flow & Heat Transfer	1. To comprehend the governing equation pertinent to the fluid flow and Heat Transfer field. 2. To develop the numerical skill towards the understanding and solution of fluid flow and heat transfer field. 3. To encourage the student to take a complex problem based on the numerical solution techniques
	ME 727	Software Practice	1. To analyze and solve thermal engineering related problems with the help of latest Computational Fluid Dynamics Tools such as GAMBIT, FLUENT, ANSYS–CFX, etc.
	ME 731	Analysis and Design of I C Engines (E1)	1. To make students familiar with the basic thermodynamic cycles - ideal, fuel-air and real cycles 2. To describe the engine friction and heat transfer issues of modern Internal Combustion Engine 3. To make the students to present the design considerations for engine components like valves, piston, cylinder, rings. 4. To apply modelling and simulation techniques to the complex phenomenon of engine combustion 5. To introduce students the importance of gas exchange processes 6. To introduce students the balancing and vibrations issues in an engine
2nd Semester	ME 682	Design of Heat exchangers	1. To introduce different kind of Heat Exchangers used in industry. 2. To introduce the preliminary design and selection of Heat exchanger based on application.

			3. To encourage the student to modify and analyse the existing design procedure in the field of Heat Exchanger.
	ME 722	Exergy Analysis of Thermal System	1. Appreciate the concept of exergy in engineering system 2. To enable students to evaluate physical exergy and chemical exergy for closed system 3. To enable students to make the pictorial representation of exergy balance 4. To enable students to carry exergy analysis of various processes like compression, expansion, mixing and separation 5. To enable students to formulate conservation laws for mass and energy to various thermal systems
	ME 726	Design of Refrigeration & Air-conditioning Systems	1. To enable students select alternate new azeotrope and mixed refrigerants based on application in a various refrigeration system. 2. To enable students to analyse low temperature refrigeration systems 3. To enable students to present design aspects of various refrigeration systems and its components 4. To enable students to evaluate refrigeration systems to improve the performance 5. To enable students to assess psychometrics of various air conditioning processes, determination and calculation of various cooling loads and heating loads for air conditioning systems, cold storage plants etc. 6. To enable students use design aspects air distribution system components for air conditioning plants.

	ME 724	Thermal Power Plant Engineering - II	1. To learn about classification, compounding, governing and arrangement of steam turbines. 2. To learn about working of co-generation and combined cycle power plant and its comparison with normal plant, advantages & disadvantages of different arrangement, types of co-generation system, economical feasibility 3. To learn about various types of steam/power cycles, computing various kind of efficiency reheat & regeneration cycle combination of both, do analytical study. 4. To learn about working and design of condenser, re-heater regeneration feed heater, Boiler pumps, and cooling towers. 5. To learn about natural & mechanical draught, Combination of mechanical draught, design of forced and induced draught system, Numerical analysis of Natural & Mechanical draught. 6. To learn about energy conservation in power plant, various techniques, important components for energy conservation
	ME 728	Laboratory Practice	1. To enable students to develop experimental skill and interpret experimental data of thermal systems. 2. Exposure to state of art laboratories like cryogenics Lab., Gas dynamics Lab, Sophisticated instrumentation lab, I.C Engines Lab., Refrigeration Lab., and Heat transfer Lab.
	ME 734	Theory & Design of cryogenic systems	1. Understanding applications of cryogenics. 2. Understanding properties of cryogens like He, H_2, Ar, Ne, N_2, O_2 etc. and materials for cryogenic application.

			3. Understanding fundamentals and theory of gas liquefaction system and cryogenic refrigeration system including cryocoolers. 4. Providing knowledge of cryogenics insulation materials and their properties, merits & demerits. 5. Study of cryogenics instrumentation for measurement of temperature, pressure, liquid level etc. 6. Understanding theory of purification and separation of gases using cryogenics technology. 7. Providing knowledge of transfer, storage, and handling system of cryogens. 8. Studying theory of vacuum and knowledge of different vacuum system.
3rd semester	ME 801	Dissertation Preliminaries	1. To enable students to indentify problem/area and to plan methodology to solve it. 2. To make students to use knowledge of various literature sources for research. 3. To enable students to develop technical writing and presentation skill
	ME 803	Seminar	1. To enable students to aware about recent areas and technologies in thermal engineering and related area. 2. To enable students comprehend importance of system up gradation, improvement and application of new findings for human life. 3. To enable students to write technical report and presenting seminar work.
4th semester	ME 802	Dissertation	1. To enable students to solve identified technical problem using resources of knowledge. 2. To enable students to use latest equipments-instruments, software tools, infrastructure and

			learning resources to solve project problem. 3. To enable students to interpret theoretical/experimental findings and to use available tools for same.

Course Outcomes (COs)

Year/ Sem.	Course and subject code	Course Outcomes
1st semester	Advance Heat Transfer (ME 603)	At the end of the course, Students will be able to: a. Apply the fundamentals of heat transfer modes such as conduction, convection and radiation in various heat transfer applications. b. Apply the concept of steady state and transient heat conduction problems and various methods towards exact solution of heat conduction applications. c. Apply fundamental knowledge of convection, its classification and solution strategy to determine heat transfer coefficient in various application. d. Appraise fundamental and advance level knowledge of radiation mode of heat transfer and its application. e. Comprehend the fundamentals of phase change processes such as boiling and condensation, its available correlations and methods to determine heat transfer coefficient in such complex mode of heat transfer.
	Advance Thermodynamics & Combustion (ME 721)	At the end of the course, Students will be able to: a. Apply principle of mass, energy and entropy to analyze thermal systems. b. Determine operating conditions for thermodynamic cycles in order to optimize power or efficiency. c. Explain the basic concepts of combustion chemistry, the thermodynamic reasons that make a combustion reaction possible and the factors that affect the reaction rate. d. Distinguish different types of flames from their morphology, and explain how different combustion mechanisms are related to macroscopic qualitative features (colour, shape, etc.).

		e. Describe the features of flame propagation, estimate the flame velocity and thickness through simple calculations, explain the conditions that determine flame extinction. f. Demonstrate an awareness of the environmental impact of combustion processes, and understand the methods to reduce it. g. Execute simple calculations for the preliminary design of burners and combustion chambers, using the results of simple theories and empirical correlations in analytical or graphical form. h. Appreciate the importance of computational fluid dynamics in modelling combustion processes and its role as a tool for engineering design.
	Thermal Power Plant Engineering - I (ME 723)	At the end of the course, Student will be able to a. List boiler specifications and types, Apply knowledge of mechanism of subcritical and supercritical boilers, Natural and forced circulation boilers, fluidized bed combustion boilers, Ascertain design steps for boilers, b. Comprehend about types of fuels, types of combustion chambers and fuel preparation for boilers c. Apply knowledge of combustion mechanism, combustion equipments and firing methods in thermal power plant. d. Design and analyze heat exchangers of steam generator like economizers preheater, feed water heaters and superheaters, reheaters. e. Evaluate complete steam generator plant to improve performancebased on heat balance sheet describing energy distribution. f. Appraise ash handling systems, feed water treatment, forced and induced draught fans, electrostatic precipitators, deaeration, fabric filters and bag houses in thermal power plant
	Computational Methods in Fluid	At the end of the course, Student will be able to: a. Solve the basic governing equations and significance of these

	Flow & Heat Transfer (ME 725)	equations in the field of fluid flow and heat transfer. b. Implement different techniques and solution procedure using different discretization schemes for real field complex problem. c. Modify the available schemes and methods for multi-physics problem.
	Software Practice (ME 727)	At the end of the course, Student will be able to: a. Develop and implement the computer code. b. Demonstrate and use the commercial software in the field of fluid flow and heat transfer for various applications. c. Take up research projects based on the knowledge of commercial software and develop their own computer program.
	Analysis and Design of I C Engines (ME 731)	a. Student will be able to develop an appreciation for theoretical and practical limits to engine performance and fuel economy b. Students will be able to find out the maximum possible engine efficiency and ways to minimise losses from actual engine c. Students will be able to address the issue of effective heat transfer from engine with suitable material for better heat transfer and compatibility d. Students will be able to work out engine friction by different methods and will be able to learn that it is an important parameter to address engine efficiency e. Students will be able to work out the material property requirement on to the part of each component to suit the design requirement f. Students will be able to address real world engine design issues. g. Students will be able to develop an ability to optimize future engine designs for specific sets of constraint like efficiency, ecology and economy h. Develop skill to compare and contrast simulated results with experimental results i. Able to appraise an understanding of suction and exhaust processes, flow through valves

		j. Able to appraise an understanding to minimise the engine vibrations
2st Semester	Design of Heat exchangers (ME 682)	At the end of the course, Students will be able to: a. Apply the fundamental principles of heat transfer and associated correlations to heat exchangers. b. List different types of heat exchangers based on different attribute. c. Select and design various type of heat exchangers as per standard design methodology.
	Exergy Analysis of Thermal System (ME 722)	a. Student will be able to relate the exergy and its difference from energy b. Students will be able to work out physical and chemical exergy of a given system c. Students will be able to draw pictorial representation of exergy balance d. Students will be able to carry out exergy analysis of various thermal systems e. Student will be able to apply the first law and second law of thermodynamics to various thermodynamics systems
	Design of Refrigeration & Air-conditioning Systems (ME 726)	At the end of the course, Students will be able to a. Select appropriate new eco friendly refrigerants according to application in various types of refrigeration systems. b. Design and analyze low temperature refrigeration systems. c. Design and analyze the refrigeration systems for various applications d. Evaluate the refrigeration systems to improve the performance e. Compute various cooling loads and heating loads for air conditioning systems, cold storage plants etc. f. Design the residential, commercial and industrial air conditioning plants. g. Design air distribution systems for air conditioning plants.

	Thermal Power Plant Engineering - II (ME 724)	a. Student able to decide feasibility of co-generation system and match power plant for particular situation. b. Employ computer analysis of the steam cycle having reheat, regeneration or combined arrangement, decide the method of efficiency improvement c. Design natural, forced, induced draught system for given power plant/boiler. d. Student able to identify the leakage/losses of energy in power plant and Apply various methods to reduce/stop energy losses
	Laboratory Practice (ME 728)	a. Students will be able to develop experimental skill and skill to analyze the experimental data and to interpret the results of thermal systems for various applications b. Students will get exposure to state of art laboratories like cryogenics Lab., Reacting Gas dynamics Lab, Sophisticated instrumentation lab, I.C Engines Lab., Refrigeration Lab.,and Heat transfer Lab etc.
	Theory & Design of Cryogenic Systems Elective - II (ME736)	a. Awareness of applications of cryogenics for a common man, scientists & engineers. b. Selection of suitable cryogen and material for development of cryogenic system for a particular application. c. Design and analysis of gas liquefaction system and cryogenic refrigeration systems including cryocoolers. d. Selection of proper cryogenic insulating material and designing of cryogenic insulation. e. Selection of appropriate sensors and measurement system. f. Analysis and design of gas purification and separation system using cryogenics. g. Selection and designing of storage, handling and transfer systems for cryogens. h. Designing of vacuum system.

3rd Semester	Dissertation Preliminaries (ME 801)	a. Student will be able to identify technical problem and search related knowledge resources. b. Student will be able to demonstrate their technical and managerial skill for conducting experiments, analytical work and handling latest instruments and equipments. c. Student will be able to apply research plan methodology by latest packages. a. Student will be able to exhibit their communication and presentation skill for dissertation report.
	Seminar (ME 803)	a. Student will be able to identify topic for importance of presence. b. Student will be able to search knowledge resource related with topic and related areas. c. Student will be able to demonstrate skill of compiling data, subject matter, analysis of data and case studies. d. Student will be capable to communicate and present prepared report.
4th semester	Dissertation (ME 802)	a. Student will be able to identify problem and search related knowledge resources. b. Student will be able to demonstrate their technical and managerial skill for conducting experiments, analytical work and handling latest instruments and equipments. c. Student will be able to apply research plan methodology by latest packages. d. Student will be able to exhibit their communication and presentation skill for dissertation report.