M.Tech Thermal Engineering

Scheme & Syllabus

Semester I

Sl. no.	*Course code*	*Course Title*	*Credits*
1	TE101	Computational Methods for Engineers	3
2	TE102	Applied Thermodynamics	3
3	TE103	Advanced Heat Transfer	3
4	TE104	Advanced Fluid Mechanics	3
5		Elective 1	3
6		Elective 2	3
7	TE111	Thermal Engineering Laboratory	1
8	TE112	Seminar I	1
		Total credits for semester I	**20**

ELECTIVE I

1. TE 105 Solar Thermal Engineering
2. TE 106 Advanced Refrigeration & Air-conditioning
3. TE 107 Environmental Pollution and Control

ELECTIVE II

4. TE 108 Alternative Fuels for I.C Engines
5. TE 109 Modern Energy Conversion Systems
6. TE 110 Theory and Technology of Fuel Cells

Semester II

Sl. No.	*Course code*	*Course Title*	*Credits*
1	TE201	Principles of Turbomachinery	3
2	TE202	Computational Methods in Fluid Flow and Heat Transfer	3
3	TE203	IC Engines & Combustion	3
4	TE204	Propulsion	3
5		Elective 3	3
6		Elective 4	3
7	TE211	Computational Lab	1
8	TE212	Seminar II	1
		Total credits for semester II	**20**

Elective III

1. TE 205 Design of Heat Transfer Equipments
2. TE 206 Analysis of Thermal Power Plant Cycles and Systems
3. TE 207 Cryogenic engineering

Elective IV

4. TE 208 Measurements in Thermal Sciences
5. TE 209 Energy Conservation and Management
6. TE 210 Research Methodology

Semester III

Sl. No.	***Course code***	***Course Title***	***Credits***
1	TE301	Project Phase I	15
		Total credits for semester III	**15**

Semester IV

Sl. No.	***Course code***	***Course Title***	***Credits***
1	TE401	Project Phase II	17
		Total credits for semester IV	**17**

	Credits
Grand total credits (Semester I to IV)	**72**

TE 101 Computational Methods in Thermal Engineering

Module 1

Approximations**:** Accuracy and precision, definitions of round off and truncation errors, error propagation.

Algebraic equations**:** Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods (GaussSiedel), convergence of iteration methods, Eigen values and Eigen vectors.

Module 2

Interpolation methods**:** Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials

Differentiation and Integration: High accuracy differentiation formulae, extrapolation, derivatives of unequally spaced data, Gauss quadrature and integration

Module 3

Transform techniques: Continuous Fourier series, frequency and time domains, Laplace transform Fourier integral and transform, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT)

Differential equations**:** Initial and boundary value problems, Eigen value problems, solutions to elliptical and parabolic equations, partial differential equations

Module 4

Regression methods: Linear and nonlinear regression, multiple linear regression, general linear least squares

Statistical methods: Statistical representation of data, modeling and analysis of data, tests of hypotheses, Introduction to optimization methods**:** Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function.

References

1. Numerical methods for engineers - Steven.C.Chapra & Raymond P Canale
2. Probability and statistics for engineers - Miller and Freund's
3.Mathematical methods - Merlic C potter , Jack Goldberg
4.Differential equations and boundary value problemsEdwards and penney

TE 102 Applied Thermodynamics

Module 1

Review of the fundamentals of classical thermodynamics- First law applied to unsteady flow systems. Thermodynamic property relations. Second law analysis of steady and unsteady flow systems. Entropy. Availability. Loss of Available energy. Gas Power cycles and analysis. Rankine cycle, Binary vapor cycle, Stirling cycle, Erricsson cycle, Brayton cycle.

Module 2

Thermodynamics of Combustion. Equations of combustion – stoichiometric. Analysis by mass, volume and their conversion. First and second law analysis of reacting systems. Adiabatic fame temperature. Introduction to thermochemistry – Heat of reaction and its effect on temperature and pressure.

Module 3

Fundamentals of Statistical Thermodynamics **-** Micro and Macro States **-** Thermodynamic Probability. Partition Function and evaluation of thermodynamic properties –**-** Statistical interpretation of heat, work and entropy.

Module 4

Microscopic approach to thermodynamics. Kinetic theory of gases and distribution of molecular velocities. Absolute temperature of gas, Van der Walls equation of state, Average Root mean square and most probable speed. Principle of Equipartition energy.

References

1. Thermodynamics – J. P. Holman
2. Thermodynamics – Michael A Saad
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics –F.W. Sears & G. L. Salinger.
4. Basic and applied thermodynamics P. K. Nag

TE 103 Advanced Heat Transfer

Module 1

Review of heat transfer fundamentals; Conduction heat transfer – heat equation in Cartesian, cylindrical and spherical coordinates - boundary conditions; Heat conduction equation for anisotropic medium; Extended surfaces - Steady state analysis and optimization - longitudinal fin of rectangular profile radiating to free space; Transient heat conduction - Exact solution - use of Heisler and Grober charts.

Module 2

Forced convection heat transfer – Flow over flat plates, similarity and integral solution of the thermal boundary layer, wedge flow; non-similar boundary layer, flow over bodies with boundary layer separation, boundary layer analogies, friction and heat transfer analogy, heat and mass transfer analogy.

Heat transfer in turbulent flow – internal and external flows, fully developed velocity and temperature profiles, low and high Prandtl number flows, convective heat transfer at high velocities, compressibility effects, influence of Mach number, Reynolds analogy for turbulent heat transfer.

Module 3

Free convection - Boundary layer equations – vertical semi-infinite plate, constant and variable wall temperatures, effect of suction and blowing, variable fluid properties; integral solution of the free convection boundary layer; free convection flow regimes; free convection between heated plates; combined free and forced convection.

Module 4

Radiation Heat Transfer - Fundamental laws of thermal radiation - surface properties – radiation heat exchange among diffuse, gray and non-gray surfaces separated by nonparticipating media - gas radiation and radiation transfer in enclosures containing absorbing and emitting media - interaction of radiation with conduction and convection.

References

1. Ozisik, M.N., Heat Transfer - A Basic Approach, McGraw-Hill, 1987.
2. Incropera, P.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 5th ed., John Wiley, 2002.
3. Vedat. S Arpaci, Conduction Heat Transfer, Addison-Wesley, 1996
4. Kraus, A.D., Aziz, A., and Welty, J., Extended Surface Heat Transfer, John Wiley, 2001.
5. Kakac, S. and Yener, Y., Convective Heat Transfer, CRC Press, 1995.
6. Kays, W. M. and Crawford, M. E., Convective Heat and Mass Transfer, Third Edition, McGraw Hill, 1993.
7. Modest, M. F., Radiative Heat transfer, Second Edition, Academic Press, 2003

TE104 Advanced Fluid Mechanics

Module 1

Review of Basic concepts- continuum, control volume, Eulerian and Lagrangian methods of description of fluid flow; Reynolds transport equation – integral and differential forms of continuity, momentum, and energy equations, Navier-Stokes equations and boundary conditions.

Module 2

Exact solutions of Navier-Stokes Equations-Parallel flow in a straight channel, Couette flow, Hagen-Poiseulli flow, flow between concentric rotating cylinders. Low Reynolds number flow, Theory of Hydrodynamic lubrication, Low Reynolds number flow around a sphere.

Module 3

Laminar Boundary Layers - Derivation of Prandtl Boundary Layer Equations-Similarity solutions for two dimensional flow-Free Shear flows-Momentum Integral Equations-Karman Pohlhausen method for approximate solution to momentum integral equation.

Module 4

Two-dimensional Turbulent Boundary layer Equations- Turbulent Flows in Pipes -Turbulent Boundary Layer on a Flat Plate- Universal velocity distribution, Turbulence Modeling in Two-Dimensional Flow-Concept of Eddy viscosity- Prandtl Mixing length Hypothesis-Turbulence Modeling.

Compressible flow: 2D compressible flow – Governing Equations – Linearised solutions to subsonic and supersonic flows. Method of characteristics. Introduction to Hypersonic flows.

References

1. White, F. M., Viscous Fluid Flow, Third Edition, McGraw-Hill, 2006
2. Currie, LG., Fundamental Mechanics of Fluids, 3rd ed., CRC Press, 2002
3. Ockendon, H. and Ockendon, J., Viscous Flow, Cambridge Uni. Press, 1995.
4. Som and Biswas, Introduction to Fluid Mechanics and Fluid Machines, 2^{nd} ed, McGraw-Hill, 2004

TE 105 Solar Thermal Engineering

Module 1

Introduction, solar radiation- solar radiation data, solar radiation geometry, empirical equations for predicting solar radiation, solar radiation on tilted surfaces, instruments for measuring solar radiation.

Module 2

Methods of collection and thermal conversion-Liquid flat plate collectors, solar air heaters, concentrating collectors.

Module 3

Thermal energy storage- sensible heat storage, latent heat storage , thermochemical storage.

Module 4

Solar pond, solar refrigeration, solar thermal electric conversion, other applications.
Economic analysis of solar thermal conversion.

References

1. F Kreith and J F Kreider: Principles of Solar thermal Engg.
2. J A Diffie and W A Beckman: Solar Engineering of Thermal processes
3. A B Meinel and F P Meinel: Applied Solar Engineering
4. S P Sukhatme: Solar Energy

TE 106 Advanced Refrigeration & Air-conditioning

Module 1

Actual vapor compression system – Multi pressure vapor compression system - cascade system. Refrigerants-Mixture refrigerants-LPG and other alternatives

Module 2

Absorption refrigeration system – Three fluid absorption system – comparison of absorption with compression system - Analysis of multistage systems-Use of solar power for absorption system

Module 3

System components-Design of compressors- condensers-evaporators-expansion devices-components matching

Module 4

Advanced psychometric calculations - Cooling load calculations – Determination of U factor – short method calculation

Room air distribution – Friction losses in ducts - Duct design, Air filters clean rooms – Air Curtain

References:

1. Arora, C.P., Refrigeration and Air Conditioning Tata McGraw-Hill,
2. Stoeker, W.P. and Jones, J.W., Refrigeration and Air Conditioning, Tata McGrawHill
3. Manohar Prasad, Refrigeration and Air Conditioning, New Age International
4. Gosney, W.B., Principles of Refrigeration, Cambridge Uni. Press
5. Air conditioning principles and systems: an energy approach

TE 107Environmental Pollution and Control

Module 1

Air pollution - Classification and properties of Air pollutants - Sampling and analysis of air pollutants –Control of air pollution.

Dispersion of air pollutants - Gaussian plume model- Control of gaseous pollutants - Volatile organic compounds - Control of gaseous emission - Air pollution laws and standards.

Module2

Water pollution - Sampling and analysis of waste treatment – Advanced waste water treatments by physical, chemical, biological and thermal methods - Effluent quality standards.

Module 3

Solid waste management - Classification and their sources - Health hazards - Handling of toxic and radioactive wastes - Incineration and verification.

Module 4

Pollution control in process industries namely Cement, Paper, Petroleum and petrochemical, Fertilizers and distilleries, thermal power plants and automobiles.

References

1. Manster, G.M., Introduction to Engineering and Science, 2nd ed., Pearson Publishers, 2004.
2. Rao, E.S., Environmental Pollution Control Engineering, Wiley Eastern Ltd., 1991.
3. Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw-Hill, 1985.
4. Crawford, M., Air Pollution Control Theory, TMH, 1976.

TE 108Alternative Fuels for I.C Engines

Module 1

Availability and Suitability to Piston Engines, Concept of conventional fuels, potential alternative fuels-Alcohol, Methanol, DEE/DME-Hydrogen, LPG, Natural gas, Producer gas,
Bio-gas and vegetable oils-Use in IC engines-Merits and demerits of various fuels.

Module 2

Technical Background of Diesel/Bio-diesel fuels-Oil feed stocks- Transesterification-Bio-diesel production from Vegetable oils and waste cooking oil-High blend levels of bio-diesel-Testing
Bio diesel-Oxidation stability-Performance in Engines, Properties of bio-fuels and their importance in the context of IC Engines.

Module 3

Initiation of combustion, flame velocities, Normal and abnormal combustion, Knocking combustion, pre-ignition-Knock and engine variables,-Features and design consideration of combustion chambers- stratified charge combustion- concepts of lean burn engines. Spray formation and combustion in diesel engines.

Module 4

Types-Air flow, Fluid flow, Temperature, Speed, Oxygen, Detonation, Position, Principle of operation, Arrangement and material. Cylinder pressure measurement.
Atmospheric pollution from piston engines, Global warming, Pollutant Formation in IC Engines-Emission measurement-control of Engine pollution–driving cycles and Emission standards.

References

1. John B.Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book Company1988.
2. Taylor, C.P., The Internal Combustion Engines in Theory and Practice, Vol-2, MIT press, 1985.
3. RichardL.Bechtold, Automotive Fuels Guide Book, SAE Publications, 1997.
4. Ashley S. Campbell, "Thermodynamic Analysis of Combustion Engines", John Wiley and Sons, USA, 1979.
5. E. F. Obert, "Internal Combustion Engines and Air pollution", Harper and Row Publication Inc., New York, 1973.

TE 109Modern Energy Conversion Systems

Module 1

Direct Energy conversion systems: Basic principles of thermoelectric generation and Thermionic generation-Seebeck effect, Peltier effect and Thomson effect. The Diode-selection of materials-elementary principles of design.
Principles of Fuel cells-Thermodynamics of the Fuel cells-Selection of fuel and operating conditions-constructional features-practical problems-state of the art and prospects.

Module 2

Photoelectric conversion-conceptual description of photo-voltaic effect-the solar cell-the state of art of solar cells-materials and prospects.
Principle of MHD generation-the Faraday and Hall generators-choice of generator parameters-Magnetic field requirements-conductivity and ionization-effect of seeding-Recent developments in MHD power systems.

Module 3

Nuclear energy: Fission Reactors:- Classification and basic principles-fuels, moderators and reactor materials-constructional features, safety and waste disposal.
Nuclear Fusion;-Fuels and Reactions-sustained fusion reaction-practical aspects-containment-production of plasma-state of the art of fusion power.

Module 4

Renewable Energy sources: Solar energy:-Installation data-collectors and concentrators-design, fabrication and performance of flat plate collectors-solar thermal devices (stills, water heaters, furnaces, solar cookers, solar refrigerators)-solar thermal power generation systems-thermal storage.
Biomass: Methods of beneficiation and utilization – pyrolysis, wood distillation, briquetting, gasifiers.

References

1. R.A.Coombe: An introduction to Direct Energy Conversion
2. George Sutton: Direct Energy Conversion
3. Duffie and Beckmann: Solar Energy Thermal Processes
4. Meinel & Meinel: Solar Energy
5. Maheshwar Dayal: Energy-Today & Tomorrow
6. S P Sukhatme: Solar Energy

TE 110 Theory and Technology of Fuel Cells

Module 1

Introduction: Relevance, Principle, Various Configurations (Alkaline, Phosphoric Acid, Proton Exchange Membrane, Direct Methanol, Molten Carbonate and Solid Oxide Fuel Cells), Fuel Cell Applications.
Theory: Basic Electrochemistry, Electrochemical Energy Conversion, Electrochemical techniques.

Module 2

Thermodynamics of Fuel Cells, Heat and Mass Transfer in Fuel Cells, Single Cell Characteristics.
Modelling: Electrochemical Model, Heat and Mass Transfer Model, System Thermodynamic Model

Module 3

Low Temperature Fuel Cells: Proton Exchange Membrane Fuel Cell (PEMFC) and Direct Methanol Fuel Cell (DMFC), their special features and characteristics.
High Temperature Fuel Cells: Molten Carbonate Fuel Cell (MCFC) and Solid Oxide Fuel Cell (SOFC) for power generation, their special features and characteristics

Module 4

Fuels and Fuel Processing: Availability, production, and characteristics of Hydrogen, fossil fuel derived fuels and biomass derived fuels,
Principles of Design of PEMFC, DMFC and SOFC.

References

1. A.V. Da Rosa, 2005, Fundamentals of Renewable Energy Processes, Elsevier academic press.
2. W. Vielstich, A. Lamm and H.A. Gastieger, 2003, Handbook of Fuel Cells, vol. 1-4, John Wiley
3. G. Hogen ed. 2003, Fuel Cell Technology Handbook, crc press
4. Energy-Today & Tomorrow, Maheshwar Dayal
5. Direct Energy Conversion, George Sutton.

TE 111 Thermal Engineering Laboratory

Each student shall design his/her own experiment by suitably modifying one of the existing experimental set ups in any of the laboratories of Thermal Stream under the supervision of Faculty-in-Charge of the Class and Staff in- Charge, concerned Laboratory. He/she shall conduct the planned experiment and submit a detailed report on the experimental results obtained. The report shall also contain the detailed study carried out prior to designing the experiment. Marks will be awarded on the basis of the quality of the experiment conducted, the final report submitted, and oral examination conducted towards the end of the semester. Students also carried out experiments on following thermal systems.

1. CI and SI engines test rigs
2. Fluid Machine test rigs
3. Heat transfer test rigs
4. Refrigeration & Air conditioning test rigs
5. Air Compressor test rigs

TE 112 Seminar I

Each student shall prepare a seminar paper on any topic of his/her interest. However, the topic must be someway related to the core/elective courses being credited by him/her during the first or second semester. He/she shall get the seminar paper approved by the Programme Coordinator/Faculty Advisor/any of the faculty members in the concerned area of specialization and present it in the class in the presence of Faculty in-charge. Each student has to submit a seminar report. Every student shall participate in the seminar. Grade will be awarded on the basis of the quality of the paper, his/her presentation and participation in the seminar.

TE 201 Principles of Turbomachinery

Module 1

Basic concepts of turbomachines- Physical processes inside a turbomachinery stage, Turbine and compressor stages, Steady flow energy equation for turbomachines, stagnation state, adiabatic flow through nozzles and diffusers, turbomachinery process representation on h-s diagram and efficiencies, reheat and preheat, Multistage machines. Energy transfer in turbomachines, Forces on the rotor, components of energy transfer, Euler's work, Isentropic work, Actual work.

Module 2

Blade theory-Aerofoil section, Drag and Lift, Blade terminology, Two dimensional cascades.

Turbine cascade-Nomenclature, velocity triangles, Blade forces, Zweifel's Criterion, Losses in turbine cascades. Compressor cascade- Nomenclature, Velocity triangles, Blade forces, pressure recovery coefficient, Cascade efficiency, Losses in compressor cascade. Annular cascades- suction and blower types, Radial cascades-outward flow, Inward flow.

Module 3

Axial turbine stages- stage velocity triangles, single impulse stage, Multistage velocity compounded impulse stage, Multistage pressure compounded impulse, Reaction stages, Enthalpy-entropy diagram, Stage efficiency, Degree of reaction.

Radial turbine stages- elements of a radial turbine stage, Stage velocity triangles, Cantilever blade IFR turbine, Ninety-degree IFR turbine, Enthalpy-entropy diagram, Spouting velocity, Stage efficiency, Degree of reaction, Stage losses.

Module 4

Axial compressor stages-Stage velocity triangles, Enthalpy-entropy diagram, Efficiencies, Degree of reaction, Flow through blade rows, Stage losses and efficiency, Work done factor

Centrifugal compressor stage-elements of a centrifugal compressor stage, Stage velocity triangles, Enthalpy-entropy diagram, Stage efficiency, Degree of reaction, Slip factor- Stodola's theory, Stanitz method, Balje's formula, Stage losses.

References

1. Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, 5th ed.,
Butterworths Heinemann, 2005.
2. Yahya, S.M., Turbines Compressors and Fans, 3rd ed., Tata Mcgraw-Hill, 2007
3. Lewis, R.I., Turbo machinery performance and analysis, Elsevier Science & Technology Books, 1996
4. Csanady, G.T., Theory of Turbomachines, McGraw Hill, 1964.
5. Prithvi Raj, D. and Gopalakrishnan, G., A Treatise on Turbomachines, Scitech
Publication, 2003.
6. Budugur Lakshminarayana, Fluid dynamics and Heat Transfer of Turbomachinery, John Wiley & Sons, Inc, 1996

TE 202 Computational Methods in Fluid Flow and Heat Transfer

Module 1

Experimental, theoretical and numerical methods of predictions; physical and mathematical classifications of partial differential equations; numerical stability; validation of numerical results; round-off-error and accuracy of numerical results; iterative convergence, condition for convergence, rate of convergence; under – and over – relaxations, termination of iteration; tridiagonal matrix algorithm; discretization – converting derivatives to their finite difference forms – Taylor's series approach, polynomial fitting approach; discretization error.

Module 2

Governing equations of fluid mechanics and heat transfer; fundamental equations – Continuity equation, Momentum equation, Energy equation, equation of state; Non-dimensional form of equations; Averaged equations for turbulent flows; Boundary layer equations for steady incompressible flows.

Module 3

Steady one-dimensional conduction in Cartesian and cylindrical coordinates; handling of boundary conditions; two – dimensional steady state conduction problems in Cartesian and cylindrical co-ordinates– point-by-point and line-by-line method of solution, dealing with Dirichlet, Neumann, and Robins type boundary conditions; formation of discretized equations for regular and irregular boundaries and interfaces.

Module 4

One-, two, and three-dimensional transient heat conduction problems in Cartesian and cylindrical co-ordinates – explicit, implicit, Crank-Nicholson and ADI schemes; stability criterion of these schemes; conservation form and conservative property of partial differential and finite difference equations

Finite volume method for diffusion and convection–diffusion problems – steady one-dimensional convection and diffusion; upwind, hybrid and power-law schemes, discretization of equation for two-dimension, false diffusion; computation of the flow field using Stream function.

References

1. Anderson, D. A, Tannehill, J. C., and R. H. Pletcher, R. H., Computational Fluid Mechanics and Heat Transfer, Second Edition, Taylor & Francis, 1995.
2. Muraleedhar, K. and T. Sundararaja, T. (eds.), Computational Fluid Flow and Heat Transfer, Second Edition, Narosa Publishing House, 2003.
3. Patankar, S. V., Numerical Heat Transfer and Fluid Flow, Hemisphere, 1980.
4. Versteeg, H. K. and W. Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Addison Wesley – Longman, 1995.
5. Hornbeck, R. W., Numerical Marching Techniques for Fluid Flows with Heat Transfer, NASA,SP– 297, 1973.
6. Klaus A. Hoffmann, Steve T. Chiang., Computational Fluid Dynamics, Fourth Edition, Volume I, Engineering Education System, 2000

TE 203 IC Engines & Combustion

Module 1

Engine operating parameters –Performance parameters and Characteristics, Engine power and Engine efficiency. Properties of working fluids.

Module 2

Fuel air cycles and their comparison. Actual cycles and their analysis. Super charging Types of super chargers and methods of super chargers. Turbo charging.

Module 3

Combustion in SI and CI engines – Carburetor and fuel injection systems –Squish pre chamber engine flows.

Module 4

Laminar premixed flames, Factors influencing flame velocity and thickness flame stabilization - Diffusion flames, Introduction to turbulent flames.

References

1. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.
2. Taylor, C.P., The Internal Combustion Engines in Theory and Practice, Vol-2, MIT press,1985.
3. Ganesan, V., Internal Combustion Engines, 2nd ed., Tata McGraw-Hill, 2003
4. Sharma, S.P. and Mohan, C., Fuels and Combustion, Tata McGraw-Hill, 1987
5. Willard W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine

TE 204 Propulsion

Module 1

Reaction principle – Essential features of propulsive devices – Momentum Theory applied to propulsive devices – performance of turboprop, turbojet and turbofan engines - combustion in jet engines – Augmentation of thrust, noise suppression.

Module 2

Comparison of Air Breathing and Rocket Propulsion Systems, Classification of Rockets, Performance parameters of Rockets, Thermodynamic evaluation of performance parameters, Nozzle Expansion, Real Nozzles, Ideal Thrust Equation, Escape velocity, Vehicle acceleration.

Module 3

Multistaging of Rockets, Space travel, Thrust vector control. Solid propellant Rocket Motors, Solid Propellant Formulations, Burning Rate, Temperature Sensitivity, Erosive burning.

Module 4

Combustion Instability, T Burner, Grain Design, Liquid Propellant Rocket Engines, Liquid Propellants, Feed systems, Injectors, Combustion Mechanisms, Combustion Instability,
Rocket Cooling, introduction to Electrical and Nuclear Rockets.

References

1.Sutton, G. P. and D. M. Ross, "Rocket Propulsion Elements", 4th Edn., John Wiley Publication, New York
2.M. J. Zucrow, "Aircraft & Missile Propulsion" , Vol. I & II John Wiley & Sons, New York
3.P. Hill and C. Peterson, "Mechanics and Thermodynamics of Propulsion" Addision Wesley, 1992 Edition.
4.A. H. Lefebvre, "Gas Turbine Combustion", Taylor & Francis, Philedelphia,
5.V. Babu, “Fundamentals of Propulsion”, Ane Publishers, 2008
6.Zucrow, M. J., "Aircraft and Missile Propulsion" , Vol. I & II, John Wiley & Sons, New York

TE 205 Design of Heat Transfer Equipments

Module 1

Classification of heat transfer equipment - Design of shell and tube heat exchanger - Finned surface heat exchanger – Selection of compact heat exchangers.

Module 2

Heat exchangers for special services – Fired heaters -Plate and spiral plate heat exchanger – plate heat exchanger for Dairy industry

Module 3

Thermal design of heat exchange equipments such as Air pre-heaters , Economizer – Super heater and condensers-horizontal and vertical condensers

Module 4

Analysis and design of cooling towers- Packing, spray design, selection of pumps, Fans and pumps - Heat Pipes, Cryogenic Storage & Transfer System.

References:

1. Ganapathy, v., Applied Heat Transfer, Pennwell Books, 1982.
2. Kays, W.M. and London, A.L., Compact Heat Exchangers, McGraw-Hill, 1998.
3. Dunn, P. and Reay, D.A., Heat Pipes, Pergamon, 1994.
4. Kakac, S. and Liu, H., Heat Exchangers, CRC Press, 2002
5. Barron Randall F Cryogenic Systems Oxford University
6. DQ Kern Process heat transfer McGraw Hill

TE 206 Analysis of Thermal Power Plant Cycles and Systems

Module1

Energy sources - Fossil fuels, Nuclear fuels, Solar and Conventional energy sources - Fuel storage, Preparation, Handling and Combustion - Combustion calculations - General layout of Conventional Thermal power plants - Design and Operation- Superheat, Reheat and Regeneration.

Module 2

Steam nozzles and Steam turbines - Working - Compounding - Governing of steam turbines - Condensers and Cooling towers - Cycles for Steam power plants - Rankine cycle and its analysis - Reheat cycle, Regenerative cycle and Binary power cycle - Steam piping - Waste heat management.

Module 3

Gas turbine and combined cycle analysis – Inter-cooling, reheating and regeneration - design for high temperature - Combined cycles with heat recovery boiler – Combined cycles with multi-pressure steam - STAG combined cycle power plant - Influence of component efficiencies on cycle performance – Energy transfer between a fluid and a rotor - Euler turbine equation.

Module4

Diesel electric power plant - working and fields of use - Different systems of diesel electric power plants and plant layout

Nuclear power plants – Introduction - Nuclear fuels - Atomic number and mass number - Atomic mass unit - Nuclear energy conversion - Chemical and nuclear equations - Nuclear reactions -Fission and fusion

References

1. D.G. Shepherd: Principles of Turbo Machinery, The Macmillan Company, 1956.
2. M. M. El-Wakil: Power Plant Technology, McGraw Hill, 1985
3. A. W. Culp Jr: Principles of Energy Conversion, McGraw Hill, 2001
4. H. A. Sorensen: Energy Conversion Systems, J. Wiley, 1983
5. T. F. Morse: Power Plant Engineering, Affiliated East West Press, 1978
6. M. M. El-Wakil: Nuclear Power Engineering, McGraw Hill, 1962
7. R. H. S. Winterton: Thermal Design of Nuclear Reactors, Pergamon Press, 1981
8. R. L. Murray: Introduction to Nuclear Engineering, Prentice Hall, 1961

TE 207CRYOGENIC ENGINEERING

Module 1

Introduction: Low temperature properties of engineering materials-Mechanical properties-Thermal properties-Electric and magnetic properties-Properties of cryogenic fluids.

Module2

Gas liquefaction systems: Introduction-Production of low temperatures-General liquefaction systems-Liquefaction systems for Neon, Hydrogen and Helium-Critical components of liquefaction systems.

Module3

Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigerators using liquids and gases as refrigerants-refrigerators using solids as working media.

Module4

Cryogenic fluid storage and transfer systems: Cryogenic fluid storage vessels-Insulation-Cryogenic fluid transfer systems.

Applications of Cryogenics: Super conducting devices-Cryogenics in Space Technology- Cryogenics in biology and medicine.

References:

1. Cryogenic Systems – Randall Barron
2. Cryogenic Engineering- R.B.Scott
3. Cryogenic Engineering – J.H.Bell Jr.
4. Refrigeration and Air Conditioning, Arora, C.P.
5. Refrigeration and Air Conditioning, Stoeker, W.P. and Jones, J.W.

TE 208Measurements in Thermal Sciences

Module 1

Characteristics of Measurement Systems - Elements of Measuring Instruments Performance characteristics - static and dynamic characteristics - Analysis of experimental data - Causes and types of experimental errors - Error & uncertainty analysis- statistical & graphical methods.

Module 2

Temperature measurements - Theory, Thermal expansion methods, Thermoelectric sensors, Resistance thermometry, Junction semiconductor sensors, Pyrometry, Temperature measuring problems in flowing fluids, Dynamic Response & Dynamic compensation of Temperature sensors.

Module 3

Laminar & Turbulent flow measurements - Determination of Reynolds stresses – Flow visualization techniques - Gross Volume Flow measurements - Measurement of Liquid level, Density, Viscosity, Humidity & Moisture.

Module 4

Pressure Measurements – Mechanical & Electrical types, High pressure & Low pressure measurements, Differential Pressure Transmitters

Thermal Analysis Techniques - Measurements in combustion: Species concentration, Reaction rates, Flame visualization.

References

1. J P Holman : Experimental methods for Engineers
2. Ernest O Doeblin : Measurement Systems - Application & Design
3. Donald P Eckman : Industrial Instrumentation
4. Willard, Mertt, Dean,Settle : Instrumental Methods of analysis
5. D. Patranabis : Principles of Industrial Instrumentation
6. Beckwith & Buck : Mechanical Measurements
7. Nakra & Chaudary : Industrial Instrumentation
8. Physical Measurements in Gas Dynamics and Combustion : High Speed Aerodynamics and Jet Propulsion Vol.IX

TE 209 Energy Conservation and Management

Module 1

The relevance of energy management profession; general principles of energy management and energy management planning; application of Pareto's model for energy management; obtaining management support; establishing energy data base; conducting energy audit; identifying, evaluating and implementing feasible energy conservation opportunities.

Module 2

Energy audit report; monitoring, evaluating and following up energy saving measures/ projects. Energy efficiency analysis; thermodynamics and energy; coefficient of performance; energy effectiveness; management of heating, ventilating and air-conditioning (HVAC) – principles, opportunities, case studies;

Module 3

Management of process energy- principles, opportunities, case studies, management of electrical load and lighting - management opportunities with electric drives, lighting, heating and electrolytic systems; electrical load analysis; peak demand control; computer-aided energy management;

Module 4

Financial evaluation of energy projects; cash flow model; time value of money; evaluation of proposals - payback method, average rate of return method, internal rate of return method, present value method, profitability index, life cycle costing approach, investment decision and uncertainty; consideration of income taxes, depreciation and inflation in investment analysis.

References

1.'Industrial energy conservation',Charles M Gottschalk, John Wiley & Sons, 1996

'2.Energy management principles', Craig B Smith,Pergamon Press

3. IEEE recommended practice for energy management in industrial and commercial facilities, IEEE std 739 – 1995 (Bronze book)

4.Optimizing energy efficiencies in industry',G G Rajan,Tata McGraw Hill, Pub. Co., 2001

5.'Energy management',Paul O'Callaghan,McGraw Hill Book Co

6.'Energy management Hand Book',Wayne C Turner,The Fairmount Press, Inc., 1997

7.'Energy Technology',S Rao and B B Parulekar,Khanna Publishers, 1999

TE 210 Research Methodology

Module 1

Introduction – Meaning of research – Objectives of research – Motivation in research – Types of research – Research approaches – Significance of research – Research methods vs Methodology – Criteria of good research.

Module 2

Defining Research Problem – What is a research problem – Selecting the problem – Necessity of defining the problem – Literature review – Importance of literature review in defining a problem – Critical literature review – Identifying gap areas from literature review

Module 3

Research design – Meaning of research design – Need– Features of good design – Important concepts relating to research design – Different types – Developing a research plan

Method of data collection – Collection of data- observation method – Interview method –Questionnaire method – Processing and analysis of data – Processing options – Types of analysis – Interpretation of results

Module 4

Report writing – Types of report – Research Report, Research proposal ,Technical paper – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Simple exercises – Oral presentation – Planning – Preparation – Practice – Making presentation – Answering questions - Use of visual aids – Quality & Proper usage – Importance of effective communication - Illustration

References

1. Coley S M and Scheinberg C A, 1990, "Proposal Writing", Newbury Sage Publications.

2. Leedy P D, "Practical Research : Planning and Design", 4th Edition, N W MacMillan Publishing Co.

3. Day R A, "How to Write and Publish a Scientific Paper", Cambridge University Press, 1989.

4. Berry, R.: How to Write a Research Paper. Second edn. Pergamon Press, Oxford (1986

5. O'Connor, M.: Writing Successfully in Science. Chapman & Hall, London (1995)

6. Swales, J.M.: Genre analysis: English in academic and research settings. Cambridge

Univ. Press, Cambridge (1993)

TE 211 Computational Laboratory

I. Programming assignments on the following topics
1. Roots of algebraic and transcendental equations
2. Solution of simultaneous algebraic equations
3. Curve fitting and optimization
4. Numerical integration of ordinary differential equations: Initial value problems
5. Numerical Solution of ordinary differential equations: Boundary value problems
6. Numerical solution of partial differential equations

II. Hands-on Training on the following Softwares:
a. Design, modeling and analysis: using ANSYS, PRO-E, GAMBIT
b. Computational fluid dynamics and heat transfer: FLUENT

TE 212 SEMINAR II

Each student shall prepare a seminar paper on any topic of his/her interest. However, the topic must be someway related to the core/elective courses being credited by him/her during the first or second semester. He/she shall get the seminar paper approved by the Programme Coordinator/Faculty Advisor/any of the faculty members in the concerned area of specialization and present it in the class in the presence of Faculty in-charge. Each student has to submit a seminar report. Every student shall participate in the seminar. Grade will be awarded on the basis of the quality of the paper, his/her presentation and participation in the seminar.

TE 301 Project Phase I

The student will be encouraged to fix the area of the project work and conduct the literature review during the second semester itself. The project work starts in the third semester. The topic shall be research and development oriented. The project has two parts (Phase I in semester III and Phase II in semester **IV).** The project can be carried out at the institute or in an industry/research organization. They are supposed to complete a good quantum of the work in the third semester. At the end of the third semester the student has to submit the phase I report for evaluation. The report shall be in soft bonded form. A presentation of the work under taken shall be done before the evaluation committee at the end of the semester.

TE 401 Project Phase II

The project work started in the third semester will be extended to the end of the fourth semester. The project can be carried out at the institute or in an industry/research organization**.** At the end of the fourth semester the student has to submit the full thesis for evaluation. The thesis shall include both phase I & II and be in hard bonded form. A presentation of the work under taken shall be done before the evaluation committee at the end of the semester. The final viva-voce examination will be conducted at the end of fourth semester.