SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS)
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech (Thermal Engineering)
COURSE STRUCTURE

I Year – I Semester

S.No.	Course code	Subject	L	T	P	CP
1.	16ME8801	Advanced Thermodynamics	4	0	-	4
2.	16ME8802	Advanced Heat & Mass Transfer	4	0	-	4
3.	16ME8803	Turbo Machines	4	0	-	4
4.	16ME8804	Fuels, Combustion & Environment	4	0	-	4
5.	16ME8805	FEA in Thermal Engineering	4	0	-	4
ELECTIVE-I						
6.	16ME8806	Refrigeration & Air Conditioning	4	0	-	4
7.	16ME8807	Equipment design for Thermal Systems				
8.	16ME8808	Optimization Techniques & its Applications				
LABORATORY						
9.	16ME8809	Advanced Thermal Engineering Lab	-	-	4	2
Contact periods / week			24	0	4	26
			Total/Week 28			

I Year – II Semester

S.No.	Course code	Subject	L	T	P	CP
1.	16ME8810	Energy Management	4	0	-	4
2.	16ME8811	Advanced I.C. Engines	4	0	-	4
3.	16ME8812	Computational Fluid Dynamics	4	0	-	4
4.	16ME8813	Thermal Measurements and Process Controls	4	0	-	4
5.	16ME8814	Alternative Energy Sources	4	0	-	4
ELECTIVE- II						
6.	16ME8815	Cryogenics Engineering	4	0	-	4
7.	16ME8816	Thermal & Nuclear Power Plants				
8.	16ME8817	Jet Propulsion & Rocketry				
LABORATORY 1						
9.	16ME8818	Computational Fluid Dynamics Lab	-	-	4	2
Contact Periods / Week			24	0	4	26
			Total/Week 28			

II YEAR (III & IV Semesters)

S. No	Subject Code	Subject	Credits
1	16ME8819	Seminar	2
2	16ME8820	Project work	16

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M.Tech-I Year- I Sem (TE)

L	T	P	C
4	0	0	4

(16ME8801) ADVANCED THERMODYNAMICS

UNIT - I:

Availability Analysis and Thermodynamic Property Relations: Reversible work - availability - irreversibility and second – law efficiency for a closed system and Steady – state control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwell relations. Generalized relations for changes in entropy - internal energy and enthalpy - generalized relations for Cp and CV Clausius Clayperon equation, Joule – Thomson coefficient. Bridgeman tables for thermodynamic relations.

UNIT-II

Real Gas Behavior and Multi – Component Systems: Different equations of state – fugacity – compressibility - principle of corresponding States - Use of generalized charts for enthalpy and entropy departure - fugacity coefficient, Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition. Partial molar properties. Real gas mixtures - Ideal solution of real gases and liquid - activity - equilibrium in multi phase systems - Gibbs phase rule.

UNIT – III:

Chemical Thermodynamics and Equilibrium: Combustion – Combustion Reactions – Enthalpy of Formation – Entropy of Formation – Reference Levels for Tables – Energy of formation – Heat of Reaction – Adiabatic flame Temperature- General problems– Enthalpies – Equilibrium. Chemical Equilibrium of Ideal Gases –.The VantHoff's Equation. The chemical potential and phase Equilibrium

UNIT - IV:

Irreversible Thermodynamics: Onsagar Reciprocity Relation – Applicability of the phenomenological Relations – Heat Flux and Entropy Production – Thermodynamic phenomenon – Thermo electric circuits.

UNIT - V:

Direct Energy Conversion- introduction – Fuel Cells – Thermo-electric energy – Thermo-ionic power generation -Thermodynamic devices Magneto Hydrodynamic Generators – Photo voltaic cell

TEXT BOOKS:

1. Fundamentals of Thermodynamics, Sonntag, Borgnakke and Van Wylen, Wiley, 6th Edition, 2003.
2. Thermo dynamics, Doolittle, Messe, 2008.
3. Basic and Applied Thermodynamics, P.K. Nag, TMH, 2013.

REFERENCE BOOKS:

1. Thermo dynamics, Holman, McGraw Hill, 4th Edition, 1988.
2. Irreversible Thermo Dynamics, HR De Groff, 1974.
3. Engineering Thermo dynamics, PL, 2013.

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L	T	P	C
4	0	0	4

(16ME8802) ADVANCED HEAT AND MASS TRANSFER

UNIT- I:
Brief Introduction to different **modes of heat transfer**; Conduction: General heat conduction equation. **Steady State Heat Transfer**: Simplified heat transfer in 1D and 2D–Fins.**Transient heat conduction**; Lumped system analysis- Heisler's charts-semi infinite solid-use of shape factors in conduction - 2D transient heat conduction – problem solutions

UNIT - II:
Forced Convection: Flow over a flat plate: Critical Reynolds Number - - Methods to determine heat transfer coefficient: Analogy between heat and momentum transfer - Similarity Parameters - Analytical Methods - Exact and Integral methods - Application of empirical relations to various geometries for Laminar and Turbulent flows
Internal flows: use of empirical correlations. Reylolds – Colburn Analogy - Application of empirical relations to various geometries for Laminar and Turbulent flows.
Free convection: Integral analysis on laminar free convective heat transfer – Different geometries – combined free and forced convection

UNIT - III:
Boiling and condensation: Pool Boiling–Boiling regimes-Correlations. Nusselt's theory of film condensation on a vertical plate – Assumptions and correlations of film condensation for different geometrics.
Heat Exchangers: Design procedure - LMTD and NTU methods–Crossflow and 1 shell 2,4,6,8 pass heat exchangers – Use of charts and empirical correlations.

UNIT - IV:
Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting, reflecting and absorbing media, specular surfaces, gas radiation – radiation from flames.

UNIT-V
Mass Transfer: Concepts of mass transfer–Diffusion and convective mass transfer Analogies –Combined heat and mass transfers-heat transfer correlations in various applications like I.C. engines - compressors and turbines.

TEXT BOOKS:
1. Heat Transfer, Necati Ozisik (TMH), 1984.
2. Introduction to Heat Transfer, Frank P. Incropera, David P. Dewitt, Wiley, 4th Edition, 2006.
3. Heat and Mass Transfer, O P Single (Macmillan India Ltd), 2008.

REFERENCE BOOKS:

1. Heat Transfer, P.S. Ghoshdastidar (Oxford Press), 2004.
2. Holman.J.P, Heat Transfer, Tata McGraw Hill, 2002.
3. Heat Transfer, A basic approach – Yunus Cengal MH, 2008.
4. Heat and Mass Transfer, D.S. Kumar, 2012.
5. Heat Transfer, P.K. Nag(TMH), 1987.
6. Principle of Heat Transfer, Frank Kreith &Mark. Bohn, 1959.
7. Convective Heat and Mass Transfer, W.M.Kays & M.E.Crawford (TMH), 1975.
8. Radiation Heat Transfer, G.M.Sparrow & R.D.Cess, 1987.

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M.Tech-I Year- I Sem (TE)

L	T	P	C
4	0	0	4

(16ME8803) TURBO MACHINES

UNIT – I:

Fundamentals of Turbo machines: Classification, Applications, Thermodynamic analysis; Isentropic flow, Energy transfer; Efficiencies; Static and Stagnation conditions;
Continuity equation; Euler's flow through variable cross sectional area; **Unsteady flow** in turbo machines.

UNIT-II

Steam Nozzles: Convergent and Convergent–Divergent nozzles; Energy balance; effect of backpressure on the analysis;
Steam Turbines : Types; work done and velocity triangles; Efficiencies; Constant Reaction Blading; Design of blade passages, angles and height;

UNIT – III

Gas Dynamics: Fundamentals: Thermodynamic concepts; Isentropic conditions; Mach number and Area – Velocity relation; Dynamic pressure; normal shock relations for perfect gas; supersonic flow, oblique shock waves ; normal shock recovery ; detached shocks ; Aerofoil theory.

UNIT-V

Centrifugal Compressor: Blade passagedesign; Diffuser and pressure recovery; slip factor; Stanitz and Stodolas formulae; Effect of inlet mach number; pre-whirl; performance.

Axial Flow Compressors:;Thermodynamic analysis; stage pressure rise; Degree of reaction; stage loading; general design, effect of velocity incidence; performance.
Cascade Analysis: Geometry and Terminology; Blade forces, Efficiency; losses; free andforced vortex blades.

UNIT – V

Axial Flow Gas Turbines: Work done; velocity triangles and efficiencies;thermodynamic flow analysis; degree of reaction; Zweifels relation; Design cascade
analysis – Soderberg – Hawthrone – ainley-correlations; secondary flow; Free-vortex blades; Blade angles for variable degree of reaction; Actuator disc theory;
Stresses in blades; Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance

TEXT BOOKS:

1. Fundamentals of Turbo machines ,Shephard, 1969.
2. Practise on Turbomachines , G. Gopalakrishnan& D. Prithviraj, SciTech Publishers, Chennai, 1998.
3. Elements of Gas Dynamics ,Yahya, prentice hall of India, new Delhi, 2001.

REFERENCE BOOKS :

1. Gas Turbines, Theory and practice, Zucrow, 1976.
2. Turbines, Pumps, Compressors, Yahya, 2010.
3. Axial Flow Compressors, Horlock, 1988.
4. Gas Turbines- Cohen, Roger & Sarvanamuttu, 1957.

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M.Tech-I Year- I Sem (TE)

L	T	P	C
4	0	0	4

(16ME8804) FUELS, COMBUSTION AND ENVIRONMENT

UNIT – I

Fuels – Detailed classification– Characteristics of Fuels-Conventional and Unconventional Solid, Liquid, gaseousfuels and nuclear fuels – **Coal –** Origin of Coal – Analysis of coal-Carbonization, Gasification and liquification – Types of coals-Lignite, Anthracite, Bituminous, Peat : petroleum based fuels – problems associated with very low calorific value gases; Coal Gas – Blast Furnace Gas, Alcohols and Biogas.

UNIT – II

Chemical kinetics – Rate of reaction – Reaction order – Molecularity – Zeroeth, First, Second and Third order reactions - complex reactions – chain reactions. Theories of reaction-Kinetics – General oxidation behavior of HC's.

UNIT – III

Thermodynamics of combustion–Enthalpy of formation–Heating value of fuel -Adiabatic flame Temperature – Equilibrium composition of gaseous mixtures.

Laminar and turbulent flames propagation and structure–Flame stability–Burningvelocity of fuels – Measurement of burning velocity – factors affecting the burning velocity.

UNIT-IV

Principles of combustion–Chemical composition–Flue gas anlaysis–dew point ofproducts – Combustion stoichiometry.

Combustion of fuel, droplets and sprays – Combustion systems – Pulverised fuel furnaces – fixed, Entrained and Fluidised Bed Systems.

UNIT – V

Combustion Equipments–Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion.

TEXT BOOKS:

1. Combustion Fundamentals , Roger A, Strehlow, McGraw Hill, vol.23, 1985.
2. Fuels and combustion , Sharma and Chander Mohan, Tata McGraw Hill, 1987.
3. Combustion Engineering and Fuel Technology ,Shaha A.K., Oxford and IBH, 1974.

REFERENCE BOOKS:

1. Principles of Combustion ,KannethK.Kuo, Wiley and Sons, 2005.
2. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990.
3. Combustion ,Sarkar, Mc. Graw Hill, 1976.
4. An Introduction to Combustion, Stephen R. Turns, Mc. Graw Hill International Edition, 1976.

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M.Tech-I Year- I Sem (TE)

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(16ME8805) FINITE ELEMENT ANALYSIS IN THERMAL ENGINEERING

UNIT - I:

Introduction to FEM: basic concepts, application of FEM, general description, advantages of FEM, comparison of FEM with other methods : finite difference method, variational method, Galerkin Method, basic element shapes, interpolation function. Virtual energy principle, treatment of boundary conditions, solution of system of equations, basic equations of elasticity, strain displacement relations.

UNIT - II:

1-D structural problems: axial bar element, stiffness matrix, load vector, temperature effects, quadratic shape function, analysis of trusses – plane truss and space truss elements. **Analysis of beams, frames** –Hermite shape functions, stiffness matrix, load vector problems, analysis.

UNIT - III:

2-D problems –CST, force terms, stiffness matrix and load vector, boundary conditions, Iso-parametric element, Quadric element, shape functions, Numerical Integration, 3-D problems – Tetrahedron element, Jacobian matrix, stiffness matrix.

UNIT - IV

Scalar field problems –Generalized Heat Conduction Equation–Variation Principle– Boundary Conditions – Internal heat generation, heat flux and convection - 1-D Steady state Heat conduction – Thermal load vector - 1-D fin element – Quadratic fin elements I D unsteady state heat conduction – Thermal load vector - 2-D steady state heat conduction – Concepts of 3D heat conduction. Finite Element Formulation of Torsion, Potential flow, seepage and fluid flow in ducts.

UNIT-V

Computer Implementation: Pre-processing, mesh generation, elements connecting, boundary conditions, input of material and processing characteristics – solutions and post processing- overview and application packages

TEXT BOOKS:

1. Finite Element Methods, Alavala, PHI, 2008.
2. Introduction to finite elements in engineering ,Tirupathi K. Chandrapatla and Ashok D.Belagundu, 2008.

REFERENCE BOOKS :

1. An Introduction to Finite Element Methods, S.S. Rao ,Pegamon, New York, 1982.
2. The Finite element method in Engineering science, O.C. Aienkowitz, Mc. Graw Hill,1971.
3. Concepts and applications of finite element analysis, Robert Cook, 2001.
4. Finite Element Methods in Engineering analysis, K.J. Bathe, 1976.
5. The finite element method in Heat transfer analysis- Lewis R.W, Morgan.K, Thomas H.R. and Seetharaman K.N, John Wiley, 1994

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M.Tech-I Year- I Sem (TE)

L	T	P	C
4	0	0	4

(ELECTIVE-I)
(16ME8806) REFRIGERATION AND AIR CONDITIONING

UNIT – I:

Vapor Compression Refrigeration: Analysis and Performance of Complete vapour compression Refrigeration system. Components of Vapour Compression Refrigeration System; Refrigerants – Properties–.**Compound Compression**: Need; Compounding with external inter cooling, Flash mixing Flash inter-cooling – liquid flash internal cooling – Multi Pressure-(Multistage) systems. Cascade System – Applications

UNIT – II:

Vapor absorption Refrigeration 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 systems:** working principles of Thermo-electric Refrigeration – Vortex tube.

UNIT – IV

Air–conditioning: Psychrometric properties and processes–Construction of Psychrometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature. Cooling load Estimation: Occupants, equipments, heat gain due to- infiltration, fan load, Fresh air load (Ventilation). Summer , Winter and year round air – conditioning systems.

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. **Components:** Humidification and dehumidification equipment– Grills and diffusers – Fans and blowers

TEXT BOOKS:

1. Refrigeration and Air Conditioning, C.P. Arora (TMH), 2009.
2. Refrigeration and Air Conditioning, Manohar Prasad, 2005.
3. Refrigeration and Air Conditioning, Stoecker, McGraw Hill, 1982.

REFERENCE BOOKS :

1. Principles of Refrigeration, Dossat (Pearson), 2001.
2. Refrigeration and Air Conditioning, Arora & Domkundwar, DhanpatRai, 2007.
3. Refrigeration and Air Conditioning, Ananthanarayana (TMH), 2005.
4. Refrigeration and Air Conditioning, Jordan and , Prentice Hall, Preister,1969.

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M.Tech-I Year- I Sem (TE)

L	T	P	C
4	0	0	4

(ELECTIVE-I)
(16ME8807) EQUIPMENT DESIGN FOR THERMAL SYSTEMS

UNIT - I:

Classification of heat exchangers: Introduction, Recuperation and Regeneration–Tubular heat exchangers: double pipe, shell and tube heat exchanger, Plate heat exchangers, Gasketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin.

Basic Design Methods of Heat Exchangers: 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 - II:

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 and 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 calculation of shell and tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of 2-4 exchangers.

UNIT - III:

Condensation of single vapors: Calculation of a horizontal condenser, vertical condenser, De-superheater condenser– sub-cooler–vertical reflux type condenser, condensation of steam.

Vaporizers, Evaporators and Reboilers: Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of a reboiler.

UNIT - VI

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 - V:

Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb and dewpoint 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 and Design of cooling towers,

TEXT BOOKS:

1. Process Heat Transfer, D.Q. Kern, TMH, 1965.
2. Cooling Towers, J.D. Gurney, 1966.
3. Heat Exchanger Design, A.P.Fraas and M.N. Ozisick. John Wiely& sons, New York, 1964.

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M.Tech-I Year- I Sem (TE) **L T P C**
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(ELECTIVE-I)
(16ME8808) OPTIMIZATION TECHNIQUES AND ITS APPLICATIONS

UNIT- I:

Introduction: Engineering Applications of optimization- statement of an optimization problem – Classification of optimization problems. **Single Variable Non-Linear Unconstrained Optimization:** One dimensional Optimization methods-Uni-modal function, elimination methods, Fibonacci method, golden section method, interpolation methods – quadratic and cubic interpolation methods.

UNIT- II:

Multi variable non-linear unconstrained optimization: Direct search method–Uni variant 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:

Linear Programming –Graphical method-Simplex method- Dual simplex method-Revised simplex method- Parametric linear programming- Goal Programming Simulation- types of simulations- Applications of simulations to inventory, queuing and thermal systems. **Integer Programming**- Introduction–formulation–Gomory cutting plane algorithm–Zero or one algorithm, branch and bound method

UNIT-IV

Stochastic Programming: Basic concepts of probability theory, random variables-distributions-mean, variance, correlation, co variance, joint probability distribution-stochastic linear, dynamic programming**: Geometric Programming:** Polynomials–arithmetic - geometric inequality–unconstrained G.P- constrained G.P

UNIT- V

Non Traditional Optimization Algorithms: Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm and Traditional Methods. Simulated Annealing- Working Principle-Simple Problems.Application in production problems.

TEXT BOOKS:

1. Optimization theory and Applications,S.S.Rao,New Age International, 2001.
2. Optimization for Engineering Design, Kalyanmoy Deb, PHI, 2004.

REFERENCE BOOKS:

1. Operations Research, S.D.Sharma, 1972.
2. Operation Research, H.A.Taha ,TMH, 2005.
3. Optimization in operations research, R.LRardin, 1982.
4. Optimization Techniques, Belagundu&Chandraputla, Pearson Asia, 2002.

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M.Tech-I Year- I Sem (TE)

L	T	P	C
0	0	3	2

(16ME8809) ADVANCED THERMAL ENGINEERING LABORATORY

1. Performance of Heat Exchangers
2. Flame propagation analysis of gaseous fuels.
3. Emission measurement of an I.C. Engine.
4. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
5. Performance test on variable compression ratio of diesel engines.
6. COP estimation of vapour compression refrigeration test rig.
7. Performance analysis of Air conditioning unit.
8. Performance analysis of heat pipe.
9. Solar Flat Plate Collector Performance
10. Calibration of temperature measurement apparatus.

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L	T	P	C
4	0	0	4

(16ME8810) ENERGY MANAGEMENT

UNIT - I:

Introduction: Principles of Energy Management–Managerial Objectives–Energy Management in Functional Areas like Manufacturing Industry, Process Industry, and Commerce -Government- Role of Energy Manager in each of this organization. Initiating, Organizing and Managing, Energy Management Programs

UNIT - II:

Energy Audit: Definition and Concepts, Types of Energy Audits–Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques.

Energy Conservation: Technologies for Energy Conservation , Design for Conservation of Energy materials – energy flow networks – critical assessment of energy usage – formulation of objectives and constraints – synthesis of alternative options and technical analysis of options – process integration.

UNIT - III:

Economic Analysis: Scope, Characterization of an Investment Project – Types of Depreciation – Time Value of money – budget considerations, Risk Analysis.

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 methods of analysis – replacement analysis. Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria-Energy Regulatories- Institutions.

UNIT-V:

Alternative Energy Sources: Solar Energy – Types of devices for Solar Energy Collection – Thermal Storage System – Control Systems-Wind Energy – Availability – Wind Devices – Wind Characteristics – Performance of Turbines and systems.

TEXT BOOKS:

1. Energy Management Hand book, W.C. Turner (Ed), 2007.
2. Management, H.Koontz and Cyrill O Donnell, 1972.
3. Financial Management, S.C. Kuchhal, 1982.
4. Financial Management, I M Panday, 2010.

REFERENCE BOOKS:

1. Energy Management, W.R.Murphy and G.Mc Kay, 2007.
2. Energy Management Principles, CB Smith,2015.

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L	T	P	C
4	0	0	4

(16ME8811) ADVANCED I.C. ENGINES

UNIT - I:

Introduction – Historical Review – Engine Types – Design and operating Parameters. **Cycle Analysis:** Thermo-chemistry of Fuel–Air mixtures, properties Ideal Models of Engine cycles – Real Engine cycles.

UNIT - II:

Gas Exchange Processes: Volumetric Efficiency–Flow through ports–Supercharging and Turbo charging.

Charge Motion: Mean velocity and Turbulent characteristics–Swirl, Squish–Pre-chamber Engine flows.

UNIT - III:

Combustion in S.I engines: Combustion and Speed–Cyclic Variations–Ignition–Abnormal combustion Fuel factors, MPFI, SI engine testing.

Pollutant Formation and Control: Nature and extent of problems–Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate

UNIT-IV

Combustion in CI engines: Essential Features–Types off Cycle. Pr. Data–Fuel
Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system

Emissions –Measurement–Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

UNIT - V:

Alternative Fuels: Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications. **SI and CI Engine Simulation and Modern Trends in IC Engines:** Lean Burning and Adiabatic concepts - Rotary Engines - Modification in I.C engines to suit Bio – fuels - HCCI and GDI concepts

TEXT BOOKS:

1. I.C. Engines Fundamentals, Heywood, McGraw Hill, 2011.
2. Computer Simulation of Compression Ignition Engine Processes, V. Ganesan, Universities Press, 1996.
3. Computer Simulation of Spark Ignition Engine Processes, V. Ganesan, Universities Press, 1966.

REFERENCES:

1. The I.C. Engine in theory and Practice Vol.I, And Vol.II, Teylor, IIT Prof, 1984.
2. I.C. Engines, Obert,Int , Text Book Co, 1950.
3. Combustion Engine Processes, Lichty, 1967.
4. I.C. Engines, Ferguson, 2001.
5. Scavenging of Two stroke Cycle Engines, Switzer, 1946.

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M.Tech I Year-II Sem (TE)

L	T	P	C
4	0	0	4

(16ME8812) COMPUTATIONAL FLUID DYNAMICS

UNIT - I:

Introduction to Numerical Methods - Finite Difference, Finite Element and Finite Volume Methods – Classification of Partial Differential Equations – Solution of Linear Algebraic Equations – Direct and Iterative Approaches **Finite difference methods:** Taylor's series – FDE formulation for 1D and 2D steady state heat transfer problems –Errors associated with FDE - Explicit Method – Implicit Method – Crank Nickolson method

UNIT-II:

Finite Volume Method: Formation of Basic rules for control volume approach using 1Dsteady heat conduction equation – Interface Thermal Conductivity. Extension of General Nodal Equation to 2D and 3D Steady heat conduction and unsteady heat conduction

UNIT -III:

FVM to Convection and Diffusion: Concept of Elliptic, Parabolic and Hyperbolic Equations applied to fluid flow – Governing Equations of Flow and Heat transfer – Steady 1D Convection Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions

UNIT - IV:

Calculation of Flow Field: Vorticity and Stream Function Method - Staggered Grid as Remedy for representation of Flow Field: Pressure and Velocity Corrections – Pressure Velocity Coupling - SIMPLE and SIMPLER (revised algorithm) Algorithm.

UNIT - V:

Turbulent Flows: Direct Numerical Simulation, Large Eddy Simulation and RANS Models.
Compressible Flows: Introduction - Pressure, Velocity and Density Coupling.

TEXT BOOKS:

1. Numerical heat transfer and fluid flow, S.V. Patankar (Hemisphere Pub. House), 1980.
2. An Introduction to Computational Fluid Dynamics, FVM Method , H.K. Versteeg, W. Malalasekhara (PHI), 2007.
3. Computational Fluid Flow and Heat Transfer , Muralidharan&Sundararajan (Narosa Pub), 2001.

REFERENCES:

1. Computational Fluid Dynamics, Hoffman and Chiang, Engg Education System, 4th Edition, 2000.
2. Computational Fluid Dynamics, Anderson (TMH), 2012.
3. Computational Methods for Fluid Dynamics, Ferziger, Peric (Springer), 1999.
4. Computational Fluid Dynamics, T.J. Chung, Cambridge University, 2002.
5. Computational Fluid Dynamics, A Practical Approach, Tu, Yeoh, Liu (Elsevier), 2012.

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M.Tech I Year-II Sem (TE)

L	T	P	C
4	0	0	4

(16ME8813) THERMAL MEASUREMENTS AND PROCESS CONTROLS

UNIT-I:

General concepts – fundamental elements of a measuring instrument. Static and dynamic characteristics – errors in instruments – Different methods of measurement and their analysis – Sensing elements and transducers.

UNIT-II

Measurement of pressure – principles of pressure measurement, static and dynamic pressure, vacuum and high pressure measuring – Measurement of low pressure, Manometers, Calibration methods,

UNIT-III:

Measurement of Flow: Obstruction meters, variable area meters. Pressure probes andtheir classification and applications .compressible fluid flow measurement, Thermal anemometers, calibration of flow measuring instruments.

UNIT-IV:

Temperature Measurement: Different principles of Temperature Measurement, use of bimetallic thermometers – Mercury thermometers, Vapor Pressure thermometers

Thermo positive elements, thermocouples in series and parallel, measurement of heat flux, calibration of temperature measuring instruments. Measurement of thermal conductivity of solids, liquids and gases

UNIT-V:

Level Measurement: Direct and indirect methods, manometric methods, float level meters, electrical conductivity, Capacitive, Ultrasonic, and Nucleonic Methods. Measurement of density – Hydrometer, continuous weight method, Gamma rays, Gas impulse wheel

Velocity Measurement – Coefficient of viscosity, Ostesld method, free fall of piston under gravity, torque method

TEXT BOOKS:

1. Measurement System, Application and Design, E.O. Doeblin, 1990.

REFERENCES:

1. Mechanical and Industrial Measurements, R.K. Jain, Khanna Publishers, 1983.
2. Mechanical Measurements, Buck &Beckwith, Pearson, 6th Edition, 2006.

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(16ME8814) ALTERNATIVE ENERGY SOURCES

UNIT-I

Solar Energy : Solar Radiation–Capturing Solar Radiation- Types of Collectors–Concentric Solar Power (CSP)- Applications.

Wind Energy: Wind Energy Characteristics–Site Location Factors–Wind EnergyConversion Systems – Betz Model-Applications

UNIT-II

Geothermal Energy : Availability of Geothermal Energy-size and Distribution , Various Types of Systems to use Geothermal Energy , Direct heat applications , Power Generation using Geothermal Heat, Sustainability of Geothermal Sources, Status of Geothermal Technology , Economics of Geothermal Energy.

Tidal and Wave Energy –Performance Limits- Ocean Thermal Energy Conversion(OTEC Technology)

UNIT-III

Hydrogen Energy - Hydrogen as a renewable energy source, Hydrogen Fuel for Vehicles. **Hydrogen Production:** Direct electrolysis of water, thermal decomposition of water ,biological and bio chemical methods of hydrogen production.

Storage of Hydrogen : Gaseous, Cryogenic and Metal hydride.

UNIT IV

Fuel Cell- Principle of working various types of fuel cells, construction and applications , limitations.

UNIT V

Hydro power: Potential, Hydropower Generation and Distribution, Mini and Micro hydel Power (MHP) Generation : Classification of Hydel plants , efficiency, Status in India.

Nuclear Energy: Potential of Nuclear Energy, International Nuclear Policies and Regulations. Nuclear Energy Technologies – Fuel enrichment, Different types of Nuclear Reactors, Nuclear Waste Disposal and Nuclear Fusion.

REFERENCES:

1. Renewable Sources of Energy and Conversion Systems, N.K.Bansal and M.K Kleeman, 2007.
2. Principles of Thermal Process, Duffie, Beckman, 5th Edition, 1980.
3. Solar Energy Handbook, Kreith and Kreider (McGrawHill), 1981.
4. Suitable Energy, Choosing Among Options,Jefferson, 1989.
5. Renewable Energy Sources, John Twidell& Tony Weir, Taylor & Francis, 2000.
6. Hydrogen Technology for Energy, D.A.Maths (Noyes Data Corp.), 2010.
7. Handbook, Batteries and Fuel cell, Linden (MC. Graw Gill), 2008.
8. Batteries Volume (I) and (II), Collins

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(ELECTIVE-II)
(16ME8815) CRYOGENIC ENGINEERING

UNIT-I

Introduction necessity of low temperature - Multistage Refrigeration system -Cascade system - Manufacture of dry ice-Joule Thompson coefficient.

Liquification of air - Linde system- Analysis- Dual pressure cycle analysis-Liquefaction of Hydrogen and Helium-problems.

UNIT-II.

Application of Lower temperatures- Effects on the properties of metals-strength-Thermal properties-super conductivity-super fluidity.

UNIT-III

Applications like expansion fitting - cryobiology-cryosurgery - space research-computers under ground power lines.

UNIT- IV.

Low temperature insulation- Reflective insulation-Evacuated powders-Rigid foams-Super insulation.

UNIT-V.

Cooling by adiabatic de-magnetization - Gas separation and cryogenic systems-Air separating- single and double columns Air separation plant. Storage and handling of cryogenic liquids

TEXT BOOKS:

1. Cryogenic Systems, R.F. Barron, Oxford University Press, 2nd Edition, 2006.
2. Cryogenic Research and Applications, Marshall Sitting, Von NostrandInc, New Jersey, 1959.
3. Cryogenics Engineering Edit by B.A.Hands, Academic Press, 1986

REFERENCE BOOKS:

1. Cryogenics Engineering, R. B. Scott, Von NostrandInc, New Jersey, 1959
2. Cryogenics process Engineering, K.D.Timmerhaus& TM Flynn, Plenum press, 1998
3. Cryogenic Engineering – Thomas M. Flynn, 1987.
4. Safety in Handling of Cryogenic Fluids, Fredrick J. Edeskutty and Watter F. Stewart, Plenum Press, 1996
5. Hand Book of Cryogenic Engineering, J.G.Weisend–II, Taylor and Francis, 1998
6. Refrigeration and Air-conditioning, S.Domkundwar, 2009.

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(ELECTIVE-II)
(16ME8816) THERMAL AND NUCLEAR POWER PLANTS

UNIT - I:
Introduction –types of Power Plants, Direct Energy ConversionSystem, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis.

UNIT - II:
Steam Power Plants : Basics of typical power plant utilities - Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system - Rankine Cycle – thermodynamic analysis. Cycle improvements – Superheat, Reheat, Regeneration

UNIT - III:
Gas Turbine Power Plant: Cogeneration, Combined cycle Power Plants, Analysis,Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages.

UNIT -IV:
Nuclear Power Plants: Nuclear Physics, Nuclear Reactors, Classification–Types ofReactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants. Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.

UNIT -V:
Economics of Power Generation: Factors affecting the economics, Load Factor,Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems.

TEXT BOOKS:
1. Power Plant Technology, El Wakil, 1985.
2. Power Plant Engineering, P.C.Sharma, Kotaria Publications, 2009.
3. Power Plant Engineering, P.K. Nag, TMH, 2002.
4. Arora and Domkundwar, A course in power Plant Engineering, DhanpatRai and CO, 2004.

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(ELECTIVE-II)
(16ME8817) JET PROPULSION AND ROCKETRY

UNIT - I:

Turbo Jet Propulsion System: Gas turbine cycle analysis–layout of turbo jet engine. Turbomachinery- compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis

Flight Performance: Forces acting on vehicle–Basic relations of motion–multi stagevehicles.

UNIT - II:

Principles of Jet Propulsion and Rocketry: Fundamentals of jet propulsion, Rocketsand air breathing jet engines – Classification – turbo jet , turbo fan, turbo propulsion, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

Nozzle: Theory and Characteristics and Parameters**:** Theory of one dimensionalconvergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, A_c / A_t of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

UNIT - III:

Aero Thermo Chemistry of The Combustion Products: Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.

UNIT-IV

Solid Propulsion System: Solid propellants–classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Solid propellant rocket engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer considerations in solid rocket motor design.

UNIT-V

Liquid Rocket Propulsion System: Liquid propellants–classification, Mono and Bipropellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine

– system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

TEXT BOOKS:

1. Mechanics and Dynamics of Propulsion, Hill and Peterson, 1992.
2. Rocket propulsion elements, Sutton, 2012.

REFERENCES BOOKS:

1. Gas Turbines, B.Ganesan (TMH), 2010.
2. Gas Turbines and Propulsive Systems, Khajuria & Dubey (Dhanpatrai), 2013.
3. Rocket propulsion, Bevere, 2010.
4. Jet propulsion, Nicholas Cumpsty, 2nd Edition, 2003.

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(16ME8818) COMPUTATIONAL FLUID DYNAMICS LAB

1. Simulation of Plane Poiseuille flow through long Parallel and Stationary Plates and Plotting Velocity Contours and Velocity Variation along the horizontal central line . Take the distance between the plates as 4 cm. Properties of fluid are v=0.000217 m^2/s p=800 kg/m^2

2. Simulation of Couette flow when the upper plates is moving with a velocity of 40 m/s. Take the distance between the plates as 4 cm properties of fluid are v=0.000217 m^2/s, p=800 kg/m^3 . Make simulations for a pressure gradient of 0-30000 $N/m^2/m$ and 20000 N m^2/m and report the variation of velocity contours for each case.

3. Simulation of a channel flow (Tube flow) for a tube of diameter. 5 cm and take the fluid as water at 30^0C at the entry of the tube of length 0.7m. A heat flux of 3000 W/m^2 is imposed along a wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.

4. Simulation of a channel flow (Tube flow) for a tube of diameter 5 cm and take the fluid as water at 30^0C at the entry of the tube length 0.7m . A Constant wall temperature of 300^0C is imposed along the wall. Obtain the contours of Velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.

5. Unsteady simulation of compressible flow of air through 2D a convergent – Divergent nozzle, with inlet and outlet of 0.2m size and both are joined by a throat section where the flow area is reduced by 10% and is of sinusoidal shape. Air enters the nozzle at a pressure of 0.9 bar and leaves at 0.73 bar. Obtain the contours of velocity, pressure and Mach number.

6. Simulation of flow over a circular cylinder of size 5 cm for different Reynold's number values of air and plotting the contours of velocity and vorticity

7. Simulation of temperature counters for a square plate of size 0.2m subjected to different types of boundary conditions.

8. Simulation of temperature counters for a pin fin in natural and forced convective conditions