LAKIREDDY BALIREDDY COLLEGE OF ENGINEERING (AUTONOMOUS)

(Approved by AICTE, Accredited by NBA,
Affiliated to JNTUK, Kakinada and ISO 9001: 2008 Certified)

ACADEMIC REGULATIONS, COURSE STRUCTURE AND DETAILED SYLLABUS

2010 - 2011

M.TECH – THERMAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

L.B.Reddy Nagar, MYLAVARAM – 521 230
Krishna District, Andhra Pradesh State

M.TECH(ME – THERMAL ENGINEERING) - COURSE STRUCTURE
(Applicable for the batches admitted from 2010-11)

I-SEMESTER

Code No.	Name of the Course	Scheme of Instruction			Scheme of Examination		Total	credits
		Periods per Week			Maximum Marks			
		Lectures	Tutorial	Lab	Internal	External		
MME101	Advanced Mathematics	4	--	--	40	60	100	4
MME102	Advanced Thermodynamics	4	--	--	40	60	100	5
MME103	Advanced Heat & Mass Transfer	4	--	--	40	60	100	5
MME104	IC Engine Combustion & Pollution	4	--	--	40	60	100	4
	ELECTIVE – I							
MME1051	Gas Dynamics	4	--	--	40	60	100	4
MME1052	Energy Conservation and Management							
MME1053	Environmental Engineering & Pollution Control							
	ELECTIVE – II							
MME1061	Solar Energy	4	--	--	40	60	100	4
MME1062	Turbo Machines							
MME1063	Finite Element Method							
MME151	Thermal Engineering – I Laboratory	--	--	3	40	60	100	2
MME152	Mini Project	--	--	3	50	--	50	2
	TOTAL	**24**	**--**	**6**	**330**	**420**	**750**	**30**

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II-SEMESTER

Code No.	Name of the Course	Scheme of Instruction			Scheme of Examination		Total	credits
		Periods per Week			Maximum Marks			
		Lecture	Tutorial	Lab.	Internal	External		
MME201	Instrumentation, Measurements & Experiments in Fluids	04	--	--	40	60	100	4
MME202	Non-conventional Sources of Energy	04	--	--	40	60	100	4
MME203	Refrigeration & Air Conditioning	04	--	--	40	60	100	5
MME204	Design of Heat Transfer Equipment	04	--	--	40	60	100	5
MME2051 MME2052 MME2053	**ELECTIVE – III** Thermal And Nuclear Power Plants Computational Fluid Dynamics Convective Heat & Mass Transfer	04	--	--	40	60	100	4
MME2061 MME2062 MME2063	**ELECTIVE – IV** Jet Propulsion And Rocketry Cryogenic Engineering Advanced Optimization Techniques	04	--	--	40	60	100	4
MME251	Thermal Engineering – II Lab.	--	--	3	40	60	100	2
MME252	Term Paper	--	--	3	50	--	50	2
	TOTAL	**24**	**--**	**6**	**330**	**420**	**750**	**30**

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III SEMESTER

Code No.	Name of the Course	Scheme of Instruction			Scheme of Examination		Total	credits
		Periods per Week			Maximum Marks			
		Lecture	Tutorial	Lab.	Internal	External		
MME351	Technical Seminar	--	--	6	50		50	8

IV SEMESTER

Code No.	Name of the Course	Scheme of Instruction			Scheme of Examination		Total	credits
		Periods per Week			Maximum Marks			
		Lecture	Tutorial	Lab.	Internal	External		
MME451	Dissertation	--	--	15	50	150	200	20

TOTAL CREDITS : 88	
I Semester : 30 II Semester : 30	III Semester : 08 IV Semester : 20

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I SEMESTER

MME101: ADVANCED MATHEMATICS

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Solution of Simultaneous Linear Algebraic Equations: Introduction, Engineering Applications, Vector and Matrix Norms, Basic Concepts of Solution, Linearly Independent Equations, Ill-Conditioned Equations. Graphical Interpretation of the Solution, Solution Using Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Procedure, LU Decomposition Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method, Simultaneous Linear Equations, Matrix Inversion, Homogeneous Equations. Comparative Efficiencies of Various Methods and Recommendations, Choice of the Method.

UNIT - II

Solution of Matrix Eigen value Problem: Introduction, Engineering Applications, Conversion of General Eigen value Problem to Standard Form, Methods of Solving Eigen value Problems, Solution of the Characteristic Polynomial Equations,
Numerical Differentiation: Introduction, Engineering Applications, Definition of the Derivative, Basic Finite-Difference Approximations, Difference Operators, Approximation of Derivatives Using Difference Operators, Using Differentiation of Interpolating Polynomials.

UNIT - III

Numerical Integration: Introduction, Engineering Applications, Simpson's Rule, Richardson's Extrapolation, Romberg Integration, Gauss Quadrature, Numerical Integration of Improper Integrals.
Ordinary Differential Equations: Initial-Value Problems: Introduction, Engineering Applications, Solution Concept, Euler's Method, Improvements and Modifications of Euler's Method, Runge-Kutta Methods.

UNIT - IV

Ordinary Differential Equations and Boundary-Value Problems: Introduction, Engineering Applications, Finite-Difference Methods, Solution of Nonlinear Boundary-Value Problems, Solution of Eigen value Problems.

UNIT – V

Partial Differential Equations: Introduction, Engineering Applications, Initial and Boundary Conditions, Solution of Partial Differential Equations by using Numerical Methods

REFERENCES

1. **Applied Numerical Methods -** Singeresu S. Rao. Pearson Education Inc.,2001.
2. **Numerical methods for scientific and engineering computation -**M.K. Jain, S.R.K. Iyengar and R.K. Jain New age international publication 5th ed., 2007.
3. Numerical Analysis - Francis Scheid 2nd ed., Schaum`s Series.
4. Advanced Mathematics for Engineers & Scientists by M.R.Spiegel. Schaum`s Series. Mcgraw Hill publishers, New Delhi, 2010.

MME102: ADVANCED THERMODYNAMICS

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 5**	**External Examination**	**: 3 Hrs**

UNIT - I

Basic Concepts: Thermodynamics - Temperature and Zeroth law of thermodynamics - first law of thermodynamics - limitations of first law - concept of internal energy - second law of thermodynamics - concept of entropy-Third law of Thermodynamics.
Thermodynamic Relations : Introduction – Reciprocity and cyclic relations – The Maxwell's relations – The Gibbs and Helmholtz relations - The Clapeyron Equation – General relations for du, dh, ds - co-efficient of volumetric expansion - isothermal compressibility.

UNIT - II

Exergy : Introduction - availability of heat - availability of a closed system - availability function of the closed system - availability of steady flow system - availability function of open system.
Irreversibility: Introduction - irreversibility for closed and open system - steady flow process - effectiveness

UNIT - III

Non Reactive Gas Mixtures : Introduction - basic definitions for gas mixtures - PVT relationship for mixtures of ideal gases - properties of mixtures of ideal gases - entropy change due to mixing - mixtures of perfect gases at different initial pressure and temperatures.
Reactive Gas Mixtures: Introduction- fuels and combustion, theoretical and actual combustion processes, enthalpy of formation and enthalpy of reaction, first and second law analysis of reacting systems.

UNIT – IV

Thermodynamics of Compressible Flow: Introduction- stagnation properties, speed of sound and mach number, 1 – D isentropic flow and property relations for isentropic flow for perfect gases.
Kinetic Theory of an Ideal Gas: Introduction- equation of state of an ideal gas, collision frequency and mean free path, velocity and speed distribution function.

UNIT – V

Thermodynamic cycles: Vapor power cycles:- second law analysis of vapor power cycles, cogeneration, binary vapor cycles, combined gas vapor power cycles.
Gas power cycles:- ideal jet propulsion cycles- second law analysis of gas power cycles.

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REFERENCES

1. Fundamentals of Thermodynamics: Sonnatag, Borgnakke, Van Wyllan , TMH
2. Thermodynamics (An Engineering Approach) :- Yunus Cengel & Boles, TMH
3. Fundamentals of Thermodynamics: E .Rathakrishnan.,PHI Publishers.
4. Engineering Thermodynamics: P.K.Nag, TMH
5. Thermodynamics : Holman , TMH

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MME103: ADVANCED HEAT AND MASS TRANSFER

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 5**	**External Examination**	**: 3 Hrs**

UNIT - I

Introduction: Brief Introduction to different Modes of heat transfer- Conduction- General heat conduction equation – Boundary conditions – Steady simplified heat transfer in Cartesian coordinates – Finned surfaces-
1-D Heat transfer with internal heat generation.

UNIT – II

Transient heat conduction: Lumped system analysis – Heisler charts – Semi infinite solid – Product solution- 2D – steady state heat conduction – Use of conduction shape factors- - Transient heat conduction – Analytical solution- Finite Difference methods for Heat Conduction Problems- 1 D & 2 D steady state and Unsteady heat conduction – Implicit and Explicit methods.

UNIT – III

Forced Convection: Concept of boundary layer- Hydrodynamic and Thermal boundary layer concepts-Equations of Motion and Energy-Methods to determine heat transfer coefficient- Dimensional Analysis –Importance of Non – Dimensional numbers –Analogies between Heat and Momentum Transfer-External flows and integral methods for flow over a flat plate-Application of empirical relations to various geometrics.
Free convection: Dimensionless parameters of Free convection-An Approximate Analysis of Laminar Free Convection on a Vertical Plate-Free convection on a Horizontal Plate, Cylinder and Sphere- Combined free and forced convection.

UNIT – IV

Boiling and condensation: Boiling curve – Correlations – Nusselt's theory of film condensation on a vertical plate – Assumptions & correlations of film condensation for different geometrics.
Radiation: Concept of View factor- Methods of Determining View factors-Radiant heat exchange in Grey, Non- Grey bodies with Transmitting, Reflecting and Absorbing media- Specular surface, gas radiation –Radiation from flames.

UNIT – V

Mass Transfer: Introduction- Analogy between heat and mass transfer-Mass diffusion- Fick's law of diffusion-Boundary conditions-Steady mass diffusion through a wall-Mass convection-Analogy between friction, heat transfer and mass transfer coefficients- Significance of Non – Dimensional numbers.

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REFERENCES

1. Heat Transfer – Necati Ozisik ,TMH
2. Heat Transfer a basic approach – Yunus Cengel (MH)
3. Heat Transfer – Holman ,TMH
4. Heat Transfer by P.S. Ghoshdastidar (Oxford Press)
5. Heat & Mass Transfer P. K Nag(TMH)
6. Principle of Heat & Mass Transfer – Frank Kreith & Mark. Bohn

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MME104: IC ENGINE COMBUSTION & POLLUTION

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Engine Types and Their Operation:
Introduction and Historical perspective – Engine classifications - Engine components - Two stroke and four stroke engines – S.I. Engine operation – C.I. Engine operation – Stratified charge engine – working - Rotary Engine –working - Relative merits and demerits - Engine design and operating parameters.

UNIT - II

Combustion in Spark – Ignition Engines :
Introduction – Stages of combustion in SI Engine - Flame front propagation– Factors influencing flame speed - Rate of pressure rise – Analysis of cylinder pressure data – Heat release analysis - Cyclic variations in combustion, partial burning and misfire – Abnormal combustion and knocking – Effects of detonation - Effect of engine variables on detonation – SI Engine combustion chamber design principles – Types of combustion chambers.

UNIT – III

Combustion in Compression – Ignition Engines :
Introduction – Stages of combustion in CI Engine – Ignition delay – Factors effecting ignition delay – Knocking in CI Engine – Factors affecting knowing - Types of Diesel Combustion systems – Direct injection systems - Indirect injection systems, comparison of combustion Systems - Combustion in direct injection multi spray – Analysis of cylinder pressure data - Heat release analysis.

UNIT –IV

Engine Performance and Testing:
Introduction - Parameters of performance – Engine performance characteristics – variables affecting performance characteristics - Pressure- Volume measurement and combustion Analysis- Performance test – heat balance test problems
Alternate Fuels: Necessity of Alternative fuels – Biodiesels-Transesterification process – Use of Alcohols – Gaseous fuels -CNG – LPG – Hydrogen and Biogas. Dual fuel operation.

UNIT – V

Pollutant Formation and Control:
Nature and extent of problem-Pollution Norms- Types of pollutants-Nitrogen Oxides – Carbon Monoxide – Unburned Hydrocarbons – Particulate Emissions – Measurement of Emissions – Oxides of Nitrogen, carbon monoxide, Unburned Hydrocarbons and smoke – Exhaust gas treatment – Catalytic converters – Thermal reactors – Particulate traps.

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REFERENCES

1. "Internal Combustion Engine Fundamentals" John. B.Heywood, Mc Graw Hill
2. "Internal Combustion Engine and Air Pollution" Obert E.F, Harper and Row Publishers
3. "Internal Combustion Engines" V.Ganesan, Tata Mc Graw hill.
4. "Internal Combustion Engines" Maleeve V.L, Mc Graw Hill Book Company
5. "Internal Combustion Engines" Mathur & Sharma, Dhanpatrai Publishers.
6. "Internal Combustion Engines", Colin R.Ferguson, Allan T.Kirkpatrick, Wiley publishers

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MME1051: GAS DYNAMICS

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Basics of Compressible Flow: Introduction, Properties of fluids, Thermodynamic Properties, Thermodynamics of fluid flow, Laws of thermodynamics, Perfect gas, Compressibility, Basic Equations of compressible flow- Energy equation, Isentropic flow relations, Stagnation Properties, Speed of sound, Mach Number, Mach angle, Mach cone, Mach wave, Shock wave, Wave propagation

UNIT - II

Steady One-dimensional Flow: Introduction, Fundamental Equations, Discharge from a reservoir, Critical values, Stream tube area-velocity relation, Types of nozzles, Applications of nozzles, Area Mach number relation, Isentropic flow through nozzles, Diffusers, Dynamics head measurement in compressible flow, Compressibility correction to dynamics pressure, Pressure coefficient

UNIT - III

Normal Shock Waves: Introduction, Types of waves, Normal shock-equations of motion, The normal shock relations for perfect gas, Change of stagnation or total pressure across the shock, Hugoniot equation

UNIT – IV

Oblique Shock and Expansion Waves: Introduction, Oblique shock- relations, Relation between β-θ-M, Shock Polar, Supersonic Flow over a Wedge, Weak Oblique Shocks, Detached Shocks, Expansion waves, Flow with shocks and expansion waves at the exit of a convergent- divergent nozzle

UNIT- V

Flow with Friction and Heat Transfer: Introduction, Flow in constant Area Duct with friction, Adiabatic Constant area flow of a perfect gas, Fanno line Flow, Flow with heating and cooling in ducts, Rayleigh line relation.

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REFERENCES

1. Gas Dynamics, E. Rathakrishnan, Second Edition Prentice Hall of India pvt. Ltd, New Delhi
2. The dynamics and thermodynamics of compressible fluid flow Vol I by Ascher H. Shapiro, The Ronald press Co. New York, 1953
3. Elements of Gas Dynamics, H.W. Lipmann and A. Roshko
4. Compressible Fluid Dynamics, Thomson P.A ,McGraw-Hill, New York, 1972

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MME1052: ENERGY CONSERVATION AND MANAGEMENT

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

General energy problem, Energy uses patterns and scope of conversion.
Energy Management Principle: Need, Organizing and managing an energy management program.
Energy Auditing: Elements and concepts, Type of energy audits instruments used in energy auditing.

UNIT – II
Economic Analysis: Cash flows, Time value of money, Formulae relating present and future cash flows- single amount, uniform series.
Financial appraisal methods: Pay back periods, net present value, benefit cost ratio, internal rate of return and Life cycle cost / benefits.

UNIT – III
Thermodynamics of energy conservation: Energy conservation in Boilers and furnace, Energy conservation in stream and condensate system.

Cogeneration: Concepts, Type of cogeneration system, performance evaluation of a cogeneration system.

UNIT – V
Waste Heat Recovery: Potential, benefit, waste heat recovery equipments. Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conversation methods.

UNIT – V
Energy conservation in Electric Utility and Industry: Energy cost and two -part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illuminating system, Importance of power factor in energy conservation - Power factor improvement methods, Energy conservation in industries.

REFERENCES

1. **Electrical Energy Utilization and Conservation** - S.C. Tripathy, Tata McGraw-Hill, 1991.
2. **Energy management handbook** - Wayne C. Turner, CRC Press Publications, 2004.
3. **Industrial Energy Conversation** - D.A. Reay, Pergamon Press
4. **Industrial energy conservation Manuals**: MIT Press.

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MME1053: ENVIRONMENTAL ENGINEERING & POLLUTION CONTROL

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Environment: Environmental segments, The Natural cycles of environment: The Hydrological cycle, The Oxygen cycle, The Nitrogen cycle, The Phosphate cycle, The Sulphur cycle, Atmospheric structure.

UNIT – II

Introduction to Pollution: Green house effect, Ozone hole, Pollution of air, water, and soil; Effect of pollution on living systems, Minimum national standards.

Air Pollution: Sources and classification of pollutants, Effect of air pollution, Pollution from industries, Chemical reactions in a contaminated atmosphere, urban air pollution, Acid rain, Photo chemical smog, Meteorological aspects of air pollution.

UNIT - III

Air Pollution Sampling and Measurement: Collection of gaseous air pollutants, Collection of particulate pollutants, Analysis of air pollutants, Sulphur-dioxide, Nitrogen oxides, Carbon monoxide, Oxidants and Ozone, Hydro carbons and Particulate matter.

Air Pollution Control Methods and Equipment: Control methods, Source correction method, Cleaning of gaseous effluents, Particulate emission control, Control of specific gaseous pollutants SO2, NO_x, Hydro carbons, CO.

UNIT - IV

Water Pollution and Control: Origin of waste water, Types of water pollutants and their effects, Water pollution laws and standards Waste water sampling and analysis , Treatment of waste water.

Solid Waste Management: Sources and classification, Public health aspects, methods of collection, Disposal methods, Potential methods of disposal.

UNIT - V

Noise Pollution: Human acoustics, Sound and its general features, Noise and its measurement, Noise pollution hazards & Controlling methods.

REFERENCES

1. "Environmental pollution control engineering" C.S.Rao/New age International Pvt.Ltd
2. "Air pollution" M.N.Rao and M.V.N.Rao /Tata Mc Graw Hill
3. "Pollution control in process industries " S.P. Mahajan/ Tata Mc Graw Hill
4. "Energy Technology" S.Rao and B.B.Parulekar /Khanna publishers

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MME1061: SOLAR ENERGY

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT – I

Introduction: Solar energy option, specialty and potential – Sun - earth – Solar radiation , beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications.

UNIT – II

Capturing solar radiation: Physical principles of collection – types- liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis

UNIT – III

Power generation : Solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers.

UNIT – IV

Thermal energy storage: Introduction – Need - Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations.
Other solar Devices: stills, air heaters, dryers, solar ponds & solar Refrigeration.

UNIT – V

Direct energy conversion: solid – state principles – semiconductors – solar cells – performance – modular construction – applications.

Economics: Principles of Economics Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic applications.

REFERENCES

1. Principles of solar engineering – Kreith and Kerider, Taylor & Francis Inc
2. Solar energy thermal process – Duffle and Beckman, John Wiley&sons,Inc.,Hoboken,New Jersey
3. Solar energy – Sukhatme. T M H
4. Solar energy – Grag, T M H
5. Solar energy – Magal, T M H
6. Power plant technology by El Wakil

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MME1062: TURBO MACHINES

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT – I

Introduction: Types of Turbo machines, Applications of Turbo machines, Performance Characteristics, Methods of Analysis
Dimensional Analysis: Dimensions and Dimensional Homogeneity, Buckingham Pi Theorem, Other Non-dimensional Parameters for Turbo machines, Similarity Laws
Energy Transfer in Turbo machines: Review on Fluid Mechanics Related to Turbo machinery, Energy in Flowing Fluids, Euler Equations, Equations for Axial Flow Machines, Equations for Mixed and Radial Flow Machines. Degree of Reaction

UNIT-II

Centrifugal Pumps: Basic Construction and Classification, Basic Working Principles, Performance Characteristics, Cavitation, Performance Modifications, Preliminary Design Procedure, Pump Performance Tests Axial **Flow Pumps and Fans**: Introduction, Flow over Isolated Airfoils, Axial Flow Cascade, Preliminary Design Procedure, Propellers

UNIT - III

Centrifugal Fans Blowers and Compressors: Classification Performance Parameters and Characteristics, Change of Performance, Polytropic Efficiency, Preliminary Design of Centrifugal Compressors

Axial Flow Compressors: Introduction. Basic Theory, Preliminary Design of Compressor Stage, Determination of Stage Efficiency, Axial Flow Compressor Performance, Surge and Stall in Compressor and the Remedies

UNIT – IV

Gas Turbines: Introduction, Thermodynamics of Axial Flow Turbine, Degree of Reaction, Preliminary Design Procedure for Turbine Stage, Determination of Turbine Stage Efficiency, Axial Flow Turbine Performance, Compressor, Turbine Matching, Radial Inflow Gas Turbine, Thermodynamic Processes in Radial Inflow Gas Turbine.

UNIT – V

Wind Turbines: Introduction to Wind Power, Actuator Theory, Types of Wind Turbines, Wind Turbines Characteristics and Preliminary Design Analysis, Variable Speed Performance of Wind Turbines, Wind Turbine Applications.

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REFERENCE BOOKS

1. Fundamentals of Turbo machinery: William W Perg, John Wiley & Sons, Inc.
2. Principles of Turbo Machinery, D. G. Shepherd, The Macmillan Company
3. Gas Turbine Theory, Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H Longman Group Ltd
4. Mechanics and thermodynamics of Propulsion- Philip Hill and Carl Peterson, Prentice Hall
5. Fluid Mechanics, Thermodynamics of Turbo machinery, Dixon, Pergamon Press
6. Gas Turbines, Ganesan, V Tata McGraw-Hill Pub.Co.Ltd., New Delhi

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MME1063: FINITE ELEMENT METHOD

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT- I

Basic Concepts: Introduction to Finite Element Method - historical back ground-engineering applications of FEM- general description- basic element shapes-finite element modeling-numbering scheme-element connectivity-co ordinates-interpolation functions-properties-Pascal triangle-Pascal pyramid-material properties considered in FEM-types of analysis.

UNIT - II

One Dimensional Fluid Flow Analysis : Steady flow of viscous incompressible fluids through circular pipes-relationship between pipe resistance, pressure and volume rate of flow-simple hydraulic pipe network problems.

Steady State Heat Transfer Analysis: One dimensional steady state heat conduction-Governing equation- boundary conditions-one dimensional element-B matrix-conductivity matrix-heat rate vector-composite wall problems.

UNIT - III

One Dimensional Heat Transfer in Thin Fins: Governing equation- boundary conditions-temperature distribution in thin fins-cylindrical pin fin.

One Dimensional Transient Heat Conduction: Element matrices for one dimensional unsteady state heat conduction-element capacitance matrix-element conductance matrix-Finite difference methods for the transient response- Forward difference method (explicit method)- Backward difference method (pure implicit method)- Determination of transient temperature distribution in the rod- Time histories of the nodal temperatures.

UNIT – IV

Two Dimensional Steady State Heat Conduction: Governing equation- boundary conditions-Triangular element-Jacobian matrix- B matrix- element conductivity matrix- heat rate vector- problems.

Three Dimensional Heat Transfer: Governing differential equation- boundary conditions-Tetrahedron element- simple problems.

UNIT – V

Numerical Integration: Gauss Quadrature formula-sampling points and weights- Gauss Quadrature for one dimension and two dimensions-sampling points for a 2X2, 3X3 and 2X3 Gauss Quadrature rule-problems.

Mesh Generation & FEM Software: Convergence requirements- mesh generation using Tesselation method, Quadtree method and Octree method- Mesh refinement- h, p, hp and r refinements- band width- pre processor- processor- post processor-Use of software such as ANSYS, CAEFEM, NASTRAN etc.

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REFERENCES

1. An Introduction to the Finite Element Method – J.N. Reddy / Tata McGraw- Hill
2. The Finite Element Method in Engineering – Singiresu S Rao – Butterworth Heinemann
3. Introduction to Finite Elements in Engineering – Tirupathi R. Chandrupatla, Ashok D. Belagundu/Prentice- Hall India.
4. Concepts and Applications of Finite Element Analysis – Robert Cook./ John Wiley & Sons

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MME151 : THERMAL ENGINEERING – I LAB.

Lecture	**: 3 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 2**	**External Examination**	**: 3 Hrs**

(Any 8 Experiments)

1) Performance test and analysis of exhaust gases of an I.C Engine.

2) Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C Engine.

3) COP estimation of vapor compression refrigeration test.

4) Performance analysis of Air conditioning unit.

5) Performance analysis of heat pipe.

6) Two phase flow heat transfer

7) Solar Flat Plate Collector.

8) Combustion analysis of computer aided CI engine test rig.

9) Performance analysis of variable compression ratio CI engine.

10) Performance analysis of variable compression

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II SEMESTER

MME201: INSTRUMENTATION, MEASUREMENTS & EXPERIMENTS IN FLUIDS

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Need and Objective of Experimental Study: Introduction, Measurement Systems, Performance Terms
Wind Tunnels: Introduction, Classification, Low-speed Wind Tunnels, Power Losses in Wind Tunnel, Instrumentation and Calibration of Wind Tunnels, Wind Tunnel Balance

UNIT - II

Flow Visualization: Introduction, Classification of Visualization Techniques, Interferometer, Schlieren and Shadowgraph
Hot-Wire Anemometry: Introduction, Operating Principle, Hot-Wire Filaments, Constant Current Hot-Wire Anemometer (CCA), Constant Temperature Hot-Wire Anemometer, Hot-Wire Probes, Limitations of Hot-Wire Anemometer

UNIT - III

Analog Methods: Introduction, Hale-Shaw Apparatus, Electrolytic Tank, Hydraulic Analogy, Hydraulic Jumps
Pressure Measurement Techniques: Introduction, Barometers, Manometers, Dial type pressure gauge, Pressure Transducers, Pitot, Static, and Pitot-Static Tube and Its characteristics, Flow direction measurement probes and Low Pressure Measurement Gauges

UNIT - IV

Velocity Measurement: Introduction, Velocity & Mach number from pressure measurements, Laser droplet anemometer- LDA Principle, Doppler shift equation, Reference beam system, Fringe system. Measurement of velocity by Hot-Wire Anemometer, Measurement of velocity using vortex shedding Technique, Fluid Jet Anemometer, Mass & volume flow measurement

UNIT - V

Temperature measurement: Introduction, Types of thermometers, Thermocouples, RTD, Thermisters, Pyrometers, Temperature measurement in fluid flows
Uncertainty Analysis: Introduction, Estimation of measurement errors, External estimation of errors, Internal estimate of the error, Uncertainty Analysis- Uses of uncertainty analysis, Uncertainty estimation, General procedure- Uncertainty in flow Mach number, Uncertainty calculation

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REFERENCES

1. Instrumentation, Measurements and Experiments in Fluids, E. Rathakrishnan, CRC press, 2007.
2. Experimental methods for Engineers, Jack Philip Holman, Walter J. Gajda, Edition: 4, McGraw-Hill, 1984.
3. Measurement Systems, Ernest Doebelin, McGraw Hill Professional, 2003.
4. Mechanical Measurements, Thomas G. Beckwith, Nelson Lewis Buck, Edition: 5, Addison- Wesley Pub. Co., 1961.

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MME202: NON-CONVENTIONAL SOURCES OF ENERGY

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Introduction : Energy Scenario – Survey of Energy Resources – Classification – Need for Non-Conventional Energy Resources.
Solar Energy: The Sun - Sun-Earth Relationship –Solar radiation – Attention –Radiation measuring Instruments.
Solar Energy Applications: Solar water Heating, Space Heating – Active and Passive heating – Energy storage – selective surface – solar stills and ponds – solar refrigeration – photovoltaic generation.

UNIT - II

Wind Energy: Wind – characteristics – wind energy conversion systems – types – Betz model – Interference Factor – Power Coefficient – Torque Coefficient and thrust coefficient – Lift machines and drag machines – matching – electricity generation..
Geothermal Energy: Structure of Earth – Geothermal Regions – Hot springs – Hot Rocks – Hot Aquifers – Analytical Methods to estimate Thermal Potential – Harnessing Techniques – Electricity Generation Systems.

UNIT - III

Energy From Oceans: Tidal Energy; Tides – Diurnal and Semi – Diurnal Nature – Power from Tides.
Wave Energy : Waves – Theoretical Energy Available – Calculation of period and phase velocity of waves – wave power systems – submerged devices.
Ocean Thermal Energy: Principles – Heat Exchangers – Pumping requirements – Practical Considerations.

UNIT - IV

Bio – Energy: Biomass Energy Sources – Plant Productivity, Biomass Wastes – Aerobic and Anaerobic bio-conversion processes – Raw Materials and properties of Bio-gas-
Bio-gas plant Technology and Status – The Energetic and Economics of Biomass systems – Biomass gasification

UNIT - V

Direct Energy Conversion Systems:
Fuel Cells and Solar Cells–Thermionic and Thermoelectric Generation – MHD Generator-Open and Closed Systems

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REFERENCES

1. Renewable Energy Resources -John Twidell &Tony Weir,Routledge Publishers
2. Biological Energy Resources - Malcolm Flesher & Chrris Lawis
3. Renewable Energy Resources – Basic Principles and Applications – G.N.Tiwari and M.K.Ghosal, Narosa Publication Ltd.,
4. Non-Conventional Energy Sources, G.D Rai, (4th ed.),, Khanna Publishers, New Delhi, India (2000).
5. Non-Conventional Energy-Ashok V Desai-Wiley Eastern

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MME203: REFRIGERATION AND AIR CONDITIONING

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 5**	**External Examination**	**: 3 Hrs**

UNIT - I

Refrigeration: Introduction-Necessity and applications, unit of refrigeration, Heat Engine, Refrigerator and Heat Pump-C.O.P and Types of Refrigeration.

Aircraft Refrigeration System: Necessity of Aircraft Refrigeration – Advantages of Air cycle for Aircraft Refrigeration – Classification of Aircraft Refrigeration Systems –Simple air craft Bootstrap– Regenerative air refrigeration systems

Refrigerants*:* A survey of Refrigerants-Nomenclature, Desirable properties- Classification of Refrigerants – Alternate refrigerants – Ozone depletion potential and Global Warming Potential.

UNIT - II

Vapour Compression Refrigeration: Performance of Vapour Compression System-Subcooling and Superheating-Actual VCR cycle

Multistage Vapour Compression Systems: Introduction-Multi stage or Compound Compression-Multi Evaporator system-Cascade Systems.

UNIT - III

Vapour Absorption Refrigeration System: Description and working of simple and actual Aqua-Ammonia system-Maximum COP-Li-Br Water system-Three fluid absorption system-Applications

Steam Jet Refrigeration System: Working and Analysis, Applications, merits and demerits

Non-Conventional Refrigeration Methods: Principle and operation of (i) Thermoelectric refrigerator (ii) Vortex tube or Hilsch tube (iii) Pulse Tube (iv) Adiabatic demagnetization.

UNIT - IV

Introduction to Air Conditioning: Psychometric properties and processes, Construction of psychometric chart -Requirements of Comfort Air conditioning – Thermodynamics of human body, Summer, Winter and Year round air conditioning systems-Cooling load estimation.

UNIT-V

Design of Air conditioning systems: All fresh air, Re-circulated air with and without bypass- factor -ADP, RSHF, GSHF& ESHF for different systems

Heat Pump: Different Heat Pump circuits-Analysis of Heat pump cycle- Applications.

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REFERENCES

1. "Refrigeration and air conditioning" – C.P.Arora, Tata McGraw-Hill, 2001.
2. " Refrigeration & Air Conditioning" - Arora & Domkundwar – Dhanpat Rai & Co
3. "Refrigeration and Air Conditioning"- Manohar Prasad, New Age International, 2003.
4. "Principles of refrigeration"- Roy J. Dossat . Prentice Hall, 1996.
5. "Refrigeration and air conditioning"-Wilbert F. Stoecker, Jerold W. Jones, MGH, 1986.
6. "Refrigeration & Air Conditioning" : Anantha Narayana (TMH)

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MME204: DESIGN OF HEAT TRANSFER EQUIPMENT

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 5**	**External Examination**	**: 3 Hrs**

UNIT - I

Classification of Heat Exchangers: Introduction- Recuperation & Regeneration-Tubular heat exchangers-Double pipe, Shell and Tube heat exchangers, Plate heat exchanger Exchangers-Plate fin and Tubular fin heat exchangers
Basic Design Methods of Heat Exchangers: Basic equations in Design, Overall heat transfer coefficient-LMTD method for heat exchanger analysis-Parallel flow, Counter flow, Multi pass,
Cross flow heat exchanger design calculations – Effectiveness method (NTU))-Keys and London charts-Compact Heat exchangers – Heat Transfer optimization

UNIT - II

Design of Condensers: Types of Condensers-Air cooled condenser –Water cooled condensers-Evaporative condensers-Heat Transfer in condensers-Desuperheating-Condensing heat transfer coefficient-Condensation outside horizontal tubes-Condensation inside horizontal tubes-Water side coefficient-Fouling factor-Air side coefficient-Augmentation of condensing heat transfer coefficient-Influence of air inside condensers

UNIT - III

Design of Evaporators: Types of Evaporators-Heat transfer in Evaporators-Pool boiling – Heat transfer coefficient for Nucleate pool boiling-Flow or forced convection boiling-Forced convection boiling correlations-Horizontal Vs. Vertical tube-Effect of oil in refrigerant on heat transfer-Extended surface evaporators-Cooling and dehumidifying coils-Augmentation of boiling heat transfer-Pressure drop in evaporators

UNIT - IV

Design of Cooling Towers and Spray Ponds: Classification-performance of cooling towers – analysis of counter flow cooling towers- enthalpy-temperature diagram of air and water-cooling ponds- types of cooling ponds –cross flow cooling towers- procedure for calculation of outlet conditions.

UNIT - V

Cooling of Electronic Equipment: Introduction-The chip carrier-Printed circuit boards-Cooling load of Electronic equipment
Conduction Cooling: Conduction in chip carriers-conduction in printed circuit boards-heat frames.
Air Cooling: Natural convection and radiation- Forced convection- Fan selection-cooling personal computers
Heat Pipes

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REFERENCES

1. Heat Transfer – Necati Ozisik, TMG
2. Refrigeration & Air-Conditioning by C.P.Arora. TMH
3. Cooling Towers –J.D. Gurney, : Maclaren(London)
4. Heat Exchanger Design- A.P. Frass and M.N. Ozisik, John Wieley & Sons, New York
5. Heat and mass transfer by Arora & Domkundwar.,Dhanpat rai
6. Refrigeration & Air-Conditioning by Stoecker.MGH
7. Refrigeration & Air Conditioning by Dossat, Preentice Hall of India

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MME2051: THERMAL AND NUCLEAR POWER PLANTS

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Introduction-Sources of Energy, Types of Power Plants, Direct Energy Conversion System, Recent developments in Power Generation, Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue Gas Analysis

Fuels and combustion : Coal, fuel oil, natural and petroleum gas, emulsion firing, coal – oil and coal – water mixtures, synthetic fuels, bio-mass, combustion reactions, heat of combustion and enthalpy of combustion, theoretical flame temperature, free energy of formation, equilibrium constant, effect of dissociation

UNIT - II

Steam Power Plants: Introduction-General Layout of Steam Power Plant, Modern Coal fired Steam Power Plants, Power Plant Cycles, Fuel Handling, Combustion Equipment, Ash handling, Dust Collectors- ESP, fabric filters, bag houses

Steam Generators: Basic types of steam generators, Economisers, Superheaters, Reheaters, Steam generator control, air preheater, fluidized bed boilers, feed water treatment, deaeration, evaporation, internal treatment, boiler blow down, steam purity

UNIT - III

Gas Turbine Power Plant: Types-Working-Cogeneration, Combined Cycle with Gas Producton from coal (IGCC Power Plants), combined cycles using PFBC-system, Combined cycle with organic fluids, advantages of combined cycles, Peformance of Combined cycle, Future of Combined Cycle

Waste Heat Recovery Systems- Introduction, Sources of Waste Heat and Their Grading, Thermodynamic Cycles for Waste Heat Recovery, Recovery forms and Methods, Other uses of Waste Heat

UNIT - IV

Principles of Nuclear Energy: Introductin-Atomic structure – Chemical and Nuclear equations – Energy from Nuclear reactions – Nuclear Fission and Fusion – Energy from fission and fuel burn up – Radioactivity – Decay rates and Half lifes –Fission reactor types

Nuclear Power Plants: Nuclear Reactors-Classification-Types of Reactors, Site selection, Methods of Enriching Uranium- Applications of Nuclear Power Plants.

Nuclear Power Plant Safety: Bi-Products of Nuclear Power Generation-Nuclear Waste Disposal-Future of Nuclear power.

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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.
Power Plant Instrumentation: Classification-Pressure measuring Instruments-Temperature measurement and Flow measurement-Analysis of combustion gases-Pollution-Types-Methods to control.

REFERENCES

1. Power Plant Engineering – M.M. El. Wakil – McGraw Hill
2. Power Plant Engineering – P.K. Nag-TMH
3. Power Plant Engineering – Arora & Domkundwar – Dhanpat Rai & Co
4. Introduction to Nuclear Engineering-John R.Lamarsh,Anthony j.Baratta,Printice Hall

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MME2052: COMPUTATIONAL FLUID DYNAMICS

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Introduction: Computational Fluid Dynamics as a Research and Design Tool, Applications of Computational Fluid Dynamics

Governing Equations of Fluid Dynamics: Introduction, Control Volume, Substantial Derivative, Divergence of Velocity, Continuity Equation, Momentum Equation and Energy Equation

UNIT - II

Mathematical Behavior of Partial Differential Equations:
Introduction, Classification of Quasi-Linear Partial Differential Equations, Eigen Value Method, Hyperbolic Equations, Parabolic Equations, Elliptic Equations

UNIT - III

Basics Aspects of Discretization: Introduction, Introduction of Finite Differences, Difference Equations, Explicit and Implicit Approaches, Errors and Stability Analysis, Grid Generation

UNIT - IV

Incompressible Fluid Flow: Introduction, Implicit Crank-Nicholson Technique, Pressure Correction Method, Computation of Boundary Layer Flow

UNIT - V

Heat Transfer: Finite Difference Applications in Heat conduction and Convention – Heat conduction, steady heat conduction, in a rectangular geometry, transient heat conduction, Finite difference application in convective heat transfer.

REFERENCES

1. Computational fluid dynamics - Basics with applications - John. D. Anderson / Mc Graw Hill.
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H.,Taylor and Francis
3. Numerical heat transfer and fluid flow / Suhas V. Patankar- Butter-worth Publishers
4. Fundamentals of Computational Fluid Dynamics, T. K Sengupta, University Press

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MME2053: CONVECTIVE HEAT & MASS TRANSFER

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Introduction: Convection, review of conservation equations - Forced convection in laminar flow -Exact and approximate solutions of Boundary layer energy equation for plane isothermal plate in longitudinal flow - problems.
Forced convection: heat transfer in laminar tube flow - forced convection in turbulent flow – Internal Flows-Correlations-Problems.

UNIT - II

Free convective: Approximate analysis of laminar free convective heat transfer on a vertical plate-external flows-correlations-problems.

UNIT - III

Boiling and condensation: Analysis of film condensation on a vertical surface – pool boiling - forced convection boiling inside tubes - problems.

UNIT - IV

Mass Transfer: Definitions of concentration and velocities relevant to mass transfer, Fick's law, species conservation equation in different forms.

Steady state diffusion in dilute solutions in stationary media, transient diffusion in dilute solutions in stationary media, one dimensional non dilute diffusion in gases with one component stationary.

UNIT - V

Convective mass transfer : governing equations-forced diffusion from flat plate- Dimension less correlation's for mass transfer.
Simultaneous heat and mass transfer - analogy between heat, mass and momentum transfer.

REFERENCES

1. Heat transfer - J. P. Holman, TMH.
2. Heat Transfer – Necati Ozisik ,TMH
3. Heat and Mass transfer- R.C. Sachdeva, New Age
4. Convective Heat and Mass Transfer- W.M. Kays & M.E. Crawford (TMH)
5. Heat and Mass transfer - V.Gupta and I.Srinivasan - Tata Mc.Graw Hill

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MME2061: JET PROPULSION AND ROCKETRY

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Principles of Jet Propulsion: Introduction, Fundamentals of jet propulsion
Air-Breathing Engines: Introduction, Thermodynamics of Aircraft Jet Engines- Turbo jet, Turbo fan, Turbo prop, and Ramjet engines, Typical Engine Performance

UNIT - II

Aero Thermodynamics of Inlet, Combustors and Nozzles: Introduction, Subsonic Inlets, Supersonic Inlets, Gas Turbine Combustors, After burners and Ram jet Combustors, Supersonic Combustion, Exhaust Nozzles

UNIT - III

Performance of Rocket Vehicles: Introduction, Static Performance, Vehicle Acceleration, Gravity-Free Drag-Free Space Flight, Forces Acting on a Vehicle in the Atmosphere, Basic Relations of Motion, Space Flight, Flight Maneuvers, Effect of Propulsion System on Vehicle Performance, Flight Vehicles, Military Missiles, Flight Stability, Chemical Rockets

UNIT - IV

Liquid Propellant Rocket Engine Fundamentals: Types of Propellants, Propellant Tanks, Propellant Feed Systems, Gas Pressure Feed Systems, Tank Pressurization, Turbopump Feed Systems and Engine Cycles
Solid Propellant Rocket Fundamentals: Basic Relations and Propellant Burning Rate, Other Performance Issues. Propellant Grain and Grain Configuration, Propellant Grain Stress and Strain, Attitude Control and Side Maneuvers with Solid Propellant Rocket

UNIT - V

Liquid Propellants: Propellant Properties, Liquid Oxidizers, Liquid Fuels, Liquid Monopropellants, Gelled Propellants, Gaseous Propellants, Safety and Environmental Concerns
Solid Propellants: Classification, Propellant Characteristics, Hazards, Propellant Ingredients, Other Propellant Categories, Liners, Insulators, and Inhibitors, Propellant Processing and Manufacture

REFERENCES

1. Mechanics and Dynamics of Propulsion –Philip Hill and Carl Peterson.- Addison-Wesley
2. Rocket Propulsion Elements – P.Sutton & Oscar Billarz-John Wiley& sons
3. Gas Turbine Theory- Henry Cohen, G. F. C. Rogers, H. I. H. Saravanamuttoo, Longman Group Ltd
4. Rocket and Spacecraft Propulsion, Martin J.L. Turner, Springer

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MME2062: CRYOGENIC ENGINEERING

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT - I

Introduction to Cryogenic System: Introduction- Historical development-Mechanical Properties –Thermal properties-Electric and Magnetic properties – Properties of cryogenic fluids.

UNIT - II

Gas Liquefaction : Minimum work for liquefaction – Methods to produce low temperature – Liquefaction systems for gases other than Neon, Hydrogen and Helium. Liquefaction systems for Neon, Hydrogen and Helium.

UNIT - III

Components of Liquefaction Systems: Heat Exchangers – Compressors and Expanders – Expansion valve – Losses for real machines.

UNIT - IV

Gas Separation and Purification System: Properties of mixtures – Principles of mixtures – Principles of gas separation – Air separation systems.

Cryogenic Refrigeration system – Working media – Solids, Liquids and gases.

UNIT - V

Cryogenic fluid Storage & Transfer – Cryogenic storage systems – Insulation Fluid transfer mechanics – Cryostat – Cryo Coolers.

Applications: Space technology – in- flight air separation and collection of LOX – Gas Industry – Biology - Medicine - Electronics.

REFERENCES

1. Cryogenic Systems- R..Barron. Mc Graw Hill company.
2. Cryogenic Research and Applications-Marshal Sitting, Von Nostrand Inc, New Jersey
3. Cryogenics Engineering –R.B. Scott, Von Nostrand Inc, New Jersey
4. Cryogenic Engineering -Huston: McGraw Hill
5. Refrigeration and Air-conditioning - Arora & Domkundwar, Dhanpat Rai & Co
6. Hand book of cryogenic engineering-J.G.Weisend-II, Taylor and Francis,1998.

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MME2063: ADVANCED OPTIMIZATION TECHNIQUES

Lecture	**: 4 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 4**	**External Examination**	**: 3 Hrs**

UNIT- I

Linear Programming: Introduction to Linear Programming, Two phase Simplex method, Big-M method ,duality, interpretation, applications.

UNIT- II

Assignment problems: Hungarian's algorithm, Degeneracy, applications, unbalanced problems, travelling salesman problem.

Classical optimization techniques: Single variable optimization with and without constraints, multi-variable optimization without constraints, multi-variable optimization with constraints-method of Lagrange multipliers, Kuhn- Tucker conditions.

UNIT- III

Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, steepest descent method, Newton's method, types of penalty methods for handling constraints.

UNIT- IV

Genetic Algorithm (GA): Introduction, Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

UNIT- V

Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

REFERENCES

1. Optimal design- Jasbir Arora, Mc Graw Hill Publishers
2. Optimization for Engineering Design- Kalyanmoy Deb, PHI publishers
3. Engineering Optimization- S.S.Rao, New Age Publishers
4. Genetic algorithms in search, Optimization, and Machine learning- D.E. Goldberg, Addison Wesley Publishers
5. Genetic Programming, J.R.Koza,M.A.keane,J.Yu,F.H.Bennett,2000-Springer

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MME251: THERMAL ENGINEERING – II LAB.

Lecture	**: 3 Periods/week**	**Internal Marks**	**: 40**
		External Marks	**: 60**
Credits	**: 2**	**External Examination**	**: 3 Hrs**

(Any 8 Experiments)

1. Wind Tunnel Calibration
2. Pressure distribution of Circular Cylinder in Low speed Wind Tunnel
3. Generation of potential flow pattern over circular cylinder using Hele-Shaw Apparatus
4. Generation of Potential flow pattern over non-circular objects using Hele-Shaw Apparatus
5. Flow Visualization study of Circular Cylinder in water channel
6. Flow Visualization study of Non-circular objects in water channel
7. Flow over a Flat Plate using Computational Fluid Dynamics package (CFD)
8. Flow over a Symmetric Aerofoil Computational Fluid Dynamics package (CFD)
9. Flow over a Circular Cylinder Computational Fluid Dynamics package (CFD)
10. Estimation of Bio-Gas Characteristics
11. Calibration of Convergent-Divergent Nozzle
12. Estimation of Mach Number of Nozzle by Various Methods
13. Subsonic Jet Characteristics
14. Water Jet Characteristics

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