

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., THERMAL ENGINEERING
EFFECTIVE FROM ACADEMIC YEAR 2025- 2026 ADMITTED BATCH
R25 COURSE STRUCTURE AND SYLLABUS

I Year I Semester

Course Code	Course Title	L	T	P	Credits
Professional Core - I	Advanced Thermodynamics	3	0	0	3
Professional Core - II	Advanced Heat and Mass Transfer	3	0	0	3
Professional Elective - I	1. Advanced Fluid Mechanics 2. Fuels and Combustion 3. Electric and Hybrid Vehicles	3	0	0	3
Professional Elective - II	1. Energy conservation and Management 2. Gas turbines and Jet Propulsion 3. Nano Fluids	3	0	0	3
Core	Research Methodology and IPR	2	0	0	2
Lab - I	Advanced Heat Transfer Lab	0	0	4	2
Lab - II	Advanced Fluid Mechanics Lab	0	0	4	2
Audit - I	Audit Course - I	2	0	0	0
Total		16	0	8	18

I Year II Semester

Course Code	Course Title	L	T	P	Credits
Professional Core - III	Advanced I.C. Engines	3	0	0	3
Professional Core - IV	Computational Fluid Dynamics	3	0	0	3
Professional Elective - II	1. Finite Element Analysis 2. Optimization Techniques and Applications 3. Utilization of Solar energy	3	0	0	3
Professional Elective -IV	1. Cogeneration and Waste Heat Recovery Systems 2. Renewable Energy Sources 3. Advanced Refrigeration and Air Conditioning	3	0	0	3
	Mini Project with Seminar	0	0	4	2
Lab - III	Advanced Thermal Engineering lab	0	0	4	2
Lab - IV	Computational Methods Lab	0	0	4	2
Audit - II	Audit Course - II	2	0	0	0
Total		14	0	12	18

II Year I Semester

Course Code	Course Title	L	T	P	Credits
Professional Elective - V	1. Experimental Methods in Thermal Engineering 2. Gas Dynamics 3. Equipment Design for Thermal Systems	3	0	0	3
*Open Elective	Open Elective	3	0	0	3
Dissertation	Dissertation Work Review - II	0	0	18	6
Total		6	0	18	12

II YEAR II - SEMESTER

Course Code	Course Title	L	T	P	Credits
Dissertation	Dissertation Work Review - III	0	0	18	6
Dissertation	Dissertation Viva-Voce	0	0	42	14
Total		0	0	60	20

For Dissertation Work Review - I please refer R25 Academic Regulations

Audit Course I:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education

Audit Course II:

1. Constitution of India
2. Pedagogy Studies
3. Stress Management by Yoga
4. Personality Development through Life Enlightenment Skills

Open Electives

1. Waste to Energy Technologies
2. Thermal Management in Electronics
3. Alternate Fuels
4. Basics of Refrigeration Systems

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester****ADVANCED THERMODYNAMICS****(Professional Core – I)**

L	T	P	C
3	0	0	3

Prerequisites: Thermodynamics**Course Objectives:**

1. To deepen the understanding of the fundamental laws of thermodynamics and their applications to engineering systems.
2. To analyze thermodynamic potentials and equilibrium criteria for open and closed systems.
3. To explore advanced concepts like exergy, irreversibility, and entropy generation.
4. To understand thermodynamic behavior of real gases, multi-component systems, and phase equilibrium.
5. To apply thermodynamic principles to advanced energy systems and processes.

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

1. Analyze complex engineering systems using the first and second laws of thermodynamics.
2. Evaluate the thermodynamic efficiency of various processes using exergy and entropy balance.
3. Apply Maxwell relations and thermodynamic potentials in solving equilibrium problems.
4. Model and interpret the behavior of real gases and multi-phase systems.
5. Develop a comprehensive understanding of energy transformations in modern thermal systems.

UNIT – I: Thermodynamic laws and Corollaries

Transient Flow Analysis, Second Law of Thermodynamics, Entropy, Availability and Unavailability, Thermodynamic Potential, Maxwell Relations, Specific Heat Relations, Mayer's Relation, Evaluation of Thermodynamic Properties of Working Substance.

UNIT- II: Real Gas and PVT Analysis

Equation of State, Real Gas Behavior, Vander Waal's Equation, Generalization Compressibility Factor, Energy Properties of Real Gases, Vapour Pressure, Clausius - Clapeyron Equations, Throttling, Joule Thompson Coefficient, Non-Reactive Mixtures of Perfect Gases, Governing Laws, Evaluation of Properties, Psychometric Mixture Properties and Psychometric Chart, Air Conditioning Processes, Cooling Towers and Real Gas Mixture.

UNIT- III: Combustion

Combustion Reactions, Enthalpy of Formation, Entropy of Formation, Reference Levels of Tables. Energy of Formation, Heat Reaction, Adiabatic Flame Temperature-Generated Product, Enthalpies, Equilibrium, Chemical Equilibrium of Ideal Gases, Effect of Non-Reacting Gases Equilibrium in Multiple Reactions, The Vent Hoff's Equation, The Chemical Potential and Phase Equilibrium, The Gibbs Phase Rule.

UNIT- IV: Power Cycles

Binary Vapour Cycle, Co-Generation and Combined Cycles, Second Law Analysis of Cycles, Refrigeration Cycles, Thermodynamics of Irreversible Processes, Phenomenological Laws, Onsager Reciprocity Relation, Applicability of the Phenomenological Relations, Heat Flux and Entropy Production, Thermodynamic Phenomena, Thermo Electric Circuits.

UNIT- V: Direct Energy Conversion

Fuel Cells, Thermo Electric Energy, Thermo Ionic Power Generation, Thermodynamic Devices Magneto Hydrodynamic Generations and Photovoltaic Cells.

TEXT BOOKS:

1. Basic and Applied Thermodynamics, P. K. Nag, Tata McGraw-Hill (TMH), 3rd Edition, 2005.
2. Engineering Thermodynamics, G. F. C. Rogers, Y. R. Mayhew, Pearson Education, 4th Edition, 2010.

REFERENCE BOOKS:

1. Thermal Engineering, Mahesh M. Rathore, Tata McGraw-Hill (TMH), 1st Edition, 2010.
2. Applied Thermodynamics, R.K. Rajput, Laxmi Publications, Revised Edition, 2013.
3. Thermal Engineering, K. Soman, Prentice-Hall of India (PHI), 1st Edition, 2011.
4. Engineering Thermodynamics, P.L. Dhar, Elsevier, 1st Edition, 2008.
5. Fundamentals of Thermodynamics, Richard E. Sonntag and Claus Borgnakke (formerly Van Wylen), John Wiley and Sons, 7th Edition, 2009.
6. Thermodynamics: An Engineering Approach, J. P. Holman, McGraw-Hill Education, 10th Edition, 2010.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester****ADVANCED HEAT AND MASS TRANSFER****(Professional Core – II)**

L	T	P	C
3	0	0	3

Pre-requisite: Thermodynamics and Heat Transfer**Course Objective:**

1. To develop a strong foundation in conduction, convection, radiation, and mass transfer mechanisms.
2. To analyze transient and multidimensional heat conduction problems using analytical and numerical methods.
3. To understand forced and natural convection in internal and external flows.
4. To examine radiative heat transfer between surfaces and in participating media.
5. To apply principles of mass diffusion and convective mass transfer in practical applications.

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

1. Solve steady and unsteady state conduction problems in complex geometries.
2. Analyze convective heat transfer using boundary layer theory and dimensional analysis.
3. Evaluate radiative exchange between black and grey surfaces.
4. Apply numerical methods for solving heat and mass transfer equations.
5. Design and analyze systems involving simultaneous heat and mass transfer such as evaporators, condensers, and cooling towers.

UNIT - I: Heat Conduction Analysis

Different Modes of Heat Transfer, Governing Laws and Mathematical Models, Initial and Boundary Conditions, Heat Conduction, Development of Governing Equation for 1D, 2D and 3D, Steady and Transient Heat Conduction, Solution of 1D Steady State Heat Conduction, Composite Systems. Systems with Heat Generation: Variable Thermal Conductivity, Fins, 2D Steady State Heat Conduction, Use of Conduction Shape Factors, Use of Analytical Method for Temperature Distribution in a Slab for Simple Boundary Conditions.

UNIT - II: Transient Conduction and Forced Convection

Transient Heat Conduction: Lumped System Analysis, Infinite Bodies, Heisler Charts, Semi-Infinite Solid, 2D Transient Heat Conduction using Product Solutions.

Forced Convection: Equations of Fluid Flow, Concepts of Continuity, Momentum Equations and Derivation of Energy Equation, Methods to Determine Heat Transfer Coefficient, Analytical Methods, Dimensional Analysis and Concept of Exact Solution, Approximate Method, Integral Analysis, Von Karman Integral Momentum and Energy Equations, Determination of Laminar Heat Transfer Coefficient for Different Velocity and Temperature Profiles for Flow Over a Flat Plate.

UNIT - III: External and Internal Flow Heat Transfer

External Flows: Flow over a Flat Plate, Application of Empirical Relations to Various Geometries for Laminar and Turbulent Flows.

Internal Flows: Flow Classification based on Hydrodynamic and Thermal Entry Lengths, Fully Developed Flow, Integral Analysis For Laminar Heat Transfer Coefficient-Constant Wall Temperature And Constant Heat Flux Boundary Conditions-; Use Of Empirical Correlations For Determination Of Heat Transfer Coefficient And Friction Factor For Different Types Of Internal Flow Applications.

UNIT - IV: Free Convection and Phase Change

Free Convection: Approximate analysis on Laminar Free Convective Heat Transfer, Boussinesque Approximation, Different Geometries, Combined free and Forced Convection.

Boiling and Condensation: Boiling Curve, Correlations, Nusselt's Theory of Film Condensation on a Vertical Plate, Assumptions and Correlations of Film Condensation for Different Geometries.

UNIT- V: Heat Exchangers, Radiation and Mass Transfer

Heat Exchangers: Classification, LMTD and NTU Methods, Problems using LMTD and NTU Methods.

Radiation Heat Transfer: Radiant Heat Exchange in Gray, Non-Gray Bodies with Transmitting, Reflecting and Absorbing Media, Specular Surfaces, Gas Radiation, Radiation from Flames.

Mass Transfer: Concepts of Mass Transfer, Diffusion and Convective Mass Transfer Analogies, Significance of Non-Dimensional Numbers, Recent Advances in Heat and Mass Transfer Applications.

TEXT BOOKS:

1. Heat and Mass Transfer, Domkundwar and Arora, Dhanpat Rai Publications, 1st Edition, 2010.
2. Heat Transfer: A Basic Approach, Necati Özışık, Tata McGraw-Hill (TMH), Revised Edition, 2002.

REFERENCE BOOKS:

1. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, David P. DeWitt, John Wiley and Sons, 7th Edition, 2011.
2. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel and Afshin J. Ghajar, McGraw Hill, 5th Edition, 2014.
3. Heat Transfer, J.P. Holman, McGraw Hill Education, 10th Edition, 2010.
4. Heat Transfer, Gregory Nellis and Sanford Klein, Cambridge University Press, 1st Edition, 2009.
5. Principles of Heat Transfer, Frank Kreith, Cengage Learning, 7th Edition, 2011.
6. Introduction to Heat Transfer, S.K. Som, Prentice-Hall of India (PHI), 1st Edition, 2008.
7. Heat Transfer, Gregory Nellis and Sanford Klein, Cambridge University Press, 1st Edition, 2012.
8. Heat Transfer: A Conceptual Approach, P. K. Sharma, K. Rama Krishna, New Age International Publishers, 1st Edition, 2013.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester
ADVANCED FLUID MECHANICS**

L	T	P	C
3	0	0	3

(Professional Elective – I)**Prerequisites:** Fluid Mechanics and Hydraulic Machinery**Course Objectives:**

1. Establish an understanding of the fundamental concepts of fluid mechanics.
2. Understand and apply the potential flow equations to basic flows.
3. Understand and apply the differential equations of fluid mechanics including the ability to apply and understand the impact of assumptions made in the analysis.
4. Understand the boundary layer concepts with respect to fluid flow.
5. Understand and apply the compressible flow equations.

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

1. Understanding the concept of fluid and the models of fluids.
2. Understanding the basic physical meaning of general equations.
3. Understanding the concept of stream function and potential function.
4. Ability to derive the equation for viscous flow, including laminar flow and turbulent flow.
5. Ability to address such problems in engineering, and to solve the problems

UNIT-I: Inviscid Flow and Equations

Inviscid Flow of Incompressible Fluids: Lagrangian and Eulerian Descriptions of Fluid Motion, Path Lines, Stream Lines, Streak Lines, Stream Tubes, Velocity of a Fluid Particle, Types of Flows, Equations of Three, Dimensional Continuity Equation, Stream and Velocity Potential Functions. Basic Laws of fluid Flow: Condition for Irrotationality, Circulation and Vorticity Accelerations in Carte Systems Normal and Tangential Accelerations, Euler's, Bernoulli Equations in 3D, Continuity and Momentum Equations.

UNIT-II: Viscous Flow

Derivation of Navier-Stoke's Equations for Viscous Compressible Flow, Exact Solutions to Certain Simple Cases, Plain Poiseuille Flow, Couette Flow With and Without Pressure Gradient, Hagen Poiseuille Flow, Approximate Solutions, Creeping Motion (Stokes), Oseen's Approximation.

UNIT-III: Boundary Layer Theory

Prandtl's Contribution to Real Fluid Flows, Prandtl's Boundary Layer Theory, Boundary Layer Thickness for Flow over a Flat Plate, Von-Karman Momentum Integral Equation, Blasius Solution, Laminar Boundary Layer, Turbulent Boundary Layer, Expressions for Local and Mean Drag Coefficients for Different Velocity Profiles, Total Drag due to Laminar and Turbulent Layers and Problems.

UNIT-IV: Turbulent and Internal Flow Analysis

Turbulent Flow: Fundamental concept of Turbulence, Time Averaged Equations, Boundary Layer Equations, Prandtl Mixing Length Model, Universal Velocity Distribution Law, Van Driest Model, Approximate solutions for Drag Coefficients, More Refined Turbulence Models, K-Epsilon Model, Boundary Layer Separation and Form Drag, Karman Vortex Trail, Boundary Layer Control, Lift on Circular Cylinders.

Internal Flow: Smooth and Rough Boundaries, Equations for Velocity Distribution and Frictional Resistance in Smooth Rough Pipes, Roughness of Commercial Pipes, Moody's Diagram.

UNIT-V: Compressible Flow

Thermodynamic Basics, Equations of Continuity, Momentum and Energy, Acoustic Velocity Derivation of Equation for Mach Number, Flow Regimes, Mach Angle and Mach Cone, Stagnation State, Area Variation, Property Relationships in terms of Mach Number, Nozzles, Diffusers, Fanno and Raleigh Lines, Property Relations, Isothermal flow in Long Ducts, Normal Compressible Shock, Oblique Shock, Expansion and Compressible Shocks, Supersonic Wave Drag.

TEXT BOOKS:

1. Fluid Mechanics and Hydraulic Machines, D. S. Modi and S. M. Seth, Standard Publishers Distributors, 1st Edition, 2010.
2. Fluid Mechanics and Fluid Machines, S. K. Som, G. Biswas, Tata McGraw-Hill (TMH), 3rd Edition, 2011.

REFERENCE BOOKS:

1. Fluid Mechanics, Joseph H. Spurk, Nuri Aksel, Springer, 3rd Edition, 2008.
2. Fluid Mechanics and Hydraulic Machines, Dr. R. K. Bansal, Laxmi Publications, 9th Edition, 2019.
3. Fluid Mechanics, M.A. Jog, Cambridge University Press, 1st Edition, 2002.
4. Fluid Mechanics and Machinery, Md. Junaid Khan, Oxford University Press, 1st Edition, 2010.
5. Fluid Mechanics, Pijush K. Kundu and Ira M. Cohen, Elsevier, 5th Edition, 2012.
6. Fluid Mechanics, William S. Janna, CRC Press, 4th Edition, 2015.
7. The Dynamics and Thermodynamics of Compressible Fluid Flow, Ascher H. Shapiro, Ronald Press, Volume I and II, 1st Edition, 1953.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester
FUELS AND COMBUSTION
(Professional Elective – I)**

L	T	P	C
3	0	0	3

Prerequisites: Thermodynamics, Thermal Engineering II and I

Course Objectives:

1. Understand types and properties of various fuels.
2. Learn fundamentals of combustion and related thermodynamics.
3. Analyze air-fuel ratio, combustion efficiency, and flame characteristics.
4. Study ignition, combustion chambers, and flame propagation.
5. Explore emission formation and methods for pollution control.

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

1. Understand the concepts of combustion phenomena in energy conversion devices
2. Apply the knowledge of adiabatic flame temperature in the design of combustion devices
3. Identify the phenomenon of flame stabilization in laminar and turbulent flames
4. Analyze the pollution formation mechanisms in combustion of solid, liquid and gaseous fuels
5. Design and evaluate combustion systems such as burners, furnaces, and fluidized bed reactors for efficient fuel utilization and reduced emissions.

UNIT – I: Classification of Fuels

Classification, Conventional and Unconventional Solid, Liquid, Gaseous Fuels and Nuclear Fuels, Origin of Coal, Analysis of Coal.

Coal: Carburization, Gasification and Liquidification, Lignite, Petroleum based Fuels, Problems Associated with very low Calorific Value Gases, Coal Gas, Blast Furnace Gas Alcohols and Biogas.

UNIT – II: Principles of Combustion

Chemical Composition, Flue Gas Analysis, Dew Point of Products, Combustion Stoichiometry, Chemical Kinetics, Rate of Reaction, Reaction Order, Molecularity, Zeroth First, Second and Third Order Reactions, Complex Reactions and Chain Reactions, Theories of Reaction Kinetics, General Oxidation behavior of HC's.

UNIT – III: Combustion Waves and Flame Propagation

Detonation and Deflagration Waves of Premixed Gasses, Rankine Hygienist Relation, Hygienist Curve, Laminar and Turbulent Flame Propagation and Structure, Burning Velocity of Fuels, Measurement of Burning Velocity, Factors affecting the Burning Velocity.

UNIT – IV: Flame Stability and Combustion Systems

Flame Stability, Combustion of Fuel, Theory of Diffusion Flames, Droplets and Sprays. Combustion Systems: Pulverized Fuel Furnaces, Fixed, Entrained and Fluidized Bed Systems.

UNIT – V: Environmental Considerations

Air Pollution, Effects on Environment, Human Health etc., Principal Pollutants, Legislative Measures, Methods of Emission Control and Emission Standards.

TEXT BOOKS:

1. Combustion Fundamentals, Roger A. Strehlow, McGraw-Hill, 1st Edition, 1984.
2. Fuels and Combustion, S. P. Sharma, Chander Mohan, Tata McGraw-Hill (TMH), 3rd Edition, 1987.

REFERENCE BOOKS:

1. Combustion Engineering and Fuel Technology, A.K. Shaha, Oxford and IBH Publishing Co., 1st Edition, 1974.
2. Principles of Combustion, Kenneth K. Kuo, John Wiley and Sons, 2nd Edition, 2005.
3. Fuels and Combustion, Samir Sarkar, McGraw Hill Education, 3rd Edition, 2009.
4. An Introduction to Combustion: Concepts and Applications, Stephen R. Turns, McGraw Hill International Edition, 2nd Edition, 2000.
5. Combustion Engineering, Gary L. Berman and Kenneth W. Ragland, McGraw Hill International Edition, 1st Edition, 1993.
6. Combustion, Irvin Glassman and Richard Yetter, Academic Press, 4th Edition, 2008.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester****ELECTRIC AND HYBRID VEHICLES****(Professional Elective – I)**

L	T	P	C
3	0	0	3

Prerequisites: Basic Electrical Engineering, Thermodynamics and Internal Combustion Engines

Course Objectives

1. Explain the history of Electric vehicles and development
2. Discuss the Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies
3. Explore to basic concept of electric traction, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives etc.
4. Analyse the Fuel Cell based energy storage and Super Capacitor based energy storage etc.
5. Explore to types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE and others) etc.

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

1. Choose the appropriate source of energy for the hybrid electric vehicle based on driving cycle.
2. Analyze the power and energy need of the various hybrid electric vehicle and Measure and Estimate the energy consumption of the Hybrid Vehicles
3. Evaluate energy efficiency of the vehicle for its drive trains
4. Elaborate the types of storage systems such as battery based, fuel cell based etc.
5. Explain the types of Driving Cycles, Fuel Cell EV, Solar Powered Vehicles

UNIT - I: Concepts of Electric Vehicles

Electric Vehicle History, Components of Electric Vehicles, Comparison with Internal Combustion Engine, Benefits and Challenges, EV Classification and their Classifications, EV Technologies.

UNIT - II: EV Evolution and Dynamics

History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today, Battery Electric Vehicle, Hybrid (ICE and Others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles, Various forces acting on the Vehicle in Static and Dynamic Conditions.

UNIT - III: EV Architecture and Power Sources

Electric Vehicle Architecture and Design, Types of Electric and Components, Classical Protection and Systems Requirement, Photo Voltaic Solar based EV Design, Battery Electric Vehicle(HEV), Plug in Hybrid Vehicle (PHEV), Fuel Cell Electric Vehicle(FCEV), Electrification Level of EV, Comparison of Fuel vs Electric and Solar Power, Solar Power Operated Electric Vehicles.

UNIT - IV: Types of Storage Systems

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Based Energy Storage and its Analysis, Fuel Cell Based Energy Storage and its Analysis, Super Capacitor Based Energy Storage and its Analysis, Flywheel Based Energy Storage and its Analysis, Hybridization of Different Energy Storage Devices. Sizing the Drive System: Matching the Electric Machine and the Internal Combustion Engine (ICE), Sizing the Propulsion Motor, Sizing the Power Electronics and Selecting the Energy Storage Technology, Calculation for the Rating.

UNIT - V: Modelling of Hybrid Electric Vehicle Range

Driving Cycles, Types of Driving Cycles, Range Modelling for Battery Electric Vehicle, Hybrid (ICE and others), Fuel Cell EV, Solar Powered Vehicles, Case study of 2 Wheeler, 3 Wheeler and 4 Wheeler vehicles.

TEXT BOOKS:

1. Electric Vehicle Technology Explained, James Larminie, John Lowry, John Wiley and Sons Ltd., 1st Edition, 2003.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, CRC Press, 1st Edition, 2004.

REFERENCE BOOKS:

1. Hybrid Electric Vehicles: Energy Management Strategies, Simona Onori, Lorenzo Serrao, and Giorgio Rizzoni, Springer, 1st Edition, 2015.
2. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 1st Edition, 2003.
3. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, CRC Press, 3rd Edition, 2018.
4. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Chris Mi, M. Abul Masrur, David Wenzhong Gao, Wiley, 1st Edition, 2011.
5. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley, 2nd Edition, 2012.
6. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, 1st Edition, 2014.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester****ENERGY CONSERVATION AND MANAGEMENT**

L	T	P	C
3	0	0	3

(Professional Elective – II)**Prerequisites:** Environment Studies, Elements of Mechanical Engineering, Thermodynamics**Course Objectives:**

1. To understand the importance of energy conservation and energy management in industrial and commercial sectors.
2. To analyze energy consumption patterns and identify opportunities for energy savings.
3. To study the principles and practices of energy auditing and monitoring.
4. To learn about energy-efficient technologies and economic analysis of energy projects.
5. To introduce government policies, standards, and regulations regarding energy conservation.

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

1. Explain the principles of energy conservation and the need for energy efficiency.
2. Conduct basic energy audits and identify key areas for improvement in energy utilization.
3. Evaluate the performance of thermal and electrical systems from an energy-saving perspective.
4. Apply techno-economic analysis for selection and implementation of energy conservation measures.
5. Interpret energy policy frameworks, legal requirements, and incentives for energy management.

UNIT-I: Energy Management Principles and Roles

Principles of Energy Management, Managerial Organization, Functional Areas for Manufacturing Industry, Process Industry, Commerce and Government, Role of Energy Manager in Each of These Organizations, 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 Constrains, 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 Method of Analysis, Replacement Analysis.

UNIT-V:

Alternative Energy Sources: Solar Energy: Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems.

TEXT BOOKS:

1. Energy Management, W.R. Murthy and G. McKay, BS Publications, 1st Edition.
2. Energy Management Principles: Applications, Benefits, Savings, Craig B. Smith, Pergamon Press, 1st Edition, 1981.

REFERENCE BOOKS:

1. Energy Management Handbook, W.C.Turner, Fairmont, Press, 5th Edition, 2001.
2. Energy Management, W.R. Murthy and G. McKay, BS Publications, 1st Edition.
3. Management, Harold Koontz and Cyril O'Donnell, McGraw Hill, Revised Edition, 1984.
4. Energy Management Handbook, Wayne C. Turner and Steve Doty, CRC Press, 8th Edition, 2013.
5. Handbook of Energy Engineering, Albert Thumann and D. Paul Mehta, Fairmont Press, 7th Edition, 2010.
6. Principles of Energy Conversion, Archie W. Culp, McGraw Hill, 2nd Edition, 1991.
7. Energy Conservation and Management, S. P. Sukhatme and J. K. Nayak, Tata McGraw Hill, 3rd Edition, 2010.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., I Year, I Semester
GAS TURBINES AND JET PROPULSION
(Professional Elective – II)

L	T	P	C
3	0	0	3

Prerequisites: Thermodynamics, Fluid Mechanics and Heat transfer

Course Objectives:

1. To present a detailed understanding of the components of a typical turbojet engine.
2. To demonstrate the physical processes involved in the operation of turbojets.
3. To teach students methods to size and design components as well as perform integration of an engine system.
4. Understand of thermodynamic cycles of jet engines.
5. Analyze jet engines; determine propulsion efficiency and design inlets and nozzles.

Course Outcomes: After the successful completion of this course, students will be able to

1. Understand construction and design features of gas turbines as used for power generation.
2. Explore to thermodynamics and fluid mechanics component for enhancing the efficiency and effectively of gas turbines
3. Develop skills in problem solving for aircraft propulsion systems, in particular gas turbine engines.
4. Analyze the performance enhancement approaches for jet propulsion engines
5. Describe the basic concepts of rocket propulsion.

UNIT-I: Cycle Performance and Evaluation

Introduction, Cycles, Actual and Ideal Cycles, Merits and Demerits, Performance Characteristics and Improvement.

UNIT-II: Compressors and Turbine Dynamics

Gas Dynamics, Centrifugal, Axial and Mixed Flow Compressor, Principles and Characteristics, Turbine Construction.

UNIT-III: Blade Design and Combustion Systems

Blade Materials, Manufacturing Techniques, Blade Fixing, Problems of High Temperature Operation, Blade Cooling, Practical Air-Cooled Blades, Combustion Systems, Various Fuels and Fuel Systems.

UNIT-IV: Jet Propulsion and Engine Performance

Theory of Jet Propulsion, Jet Propulsion Cycles and their Analysis, Thrust Equation, Parameters Affecting Performance, Thrust Power and Propulsive Efficiency, Operating Principle and Cycle Analysis of Ramjet, Turbojet, Turbofan and Turboprop Engines, Thrust Augmentation, Environmental Considerations and Applications.

UNIT-V: Rocket Propulsion Fundamentals

Types of Rocket Engines, Propellants and Feeding Systems, Ignition and Combustion, Theory of Rocket Propulsion, IOR Performance Study, Staging, Terminal and Characteristic Velocity, Space Flights.

TEXT BOOK:

1. Gas Turbines, V. Ganesan, Tata McGraw-Hill, 3rd Edition, 2003.
2. Gas Turbine Theory, H. Cohen, G. F. C. Rogers, H. I. H. Saravanamuttoo, Pearson Education, 5th Edition, 2000.

REFERENCE BOOKS:

1. Turbines, Compressors and Fans, S.M. Yahya, Tata McGraw-Hill, 2nd Edition, 1992.
2. The Theory and Design of Gas Turbine and Jet Engines, E.L. Vincent, McGraw-Hill, 1st Edition, 1950.
3. Fundamentals of Gas Turbines, W.W. Bathie, John Wiley and Sons, 1st Edition, 1996.
4. Gas Turbine Theory, H.I.H. Saravanamuttoo, G.F.C. Rogers and H. Cohen, Pearson Education, 6th Edition, 2017.
5. Mechanics and Thermodynamics of Propulsion, Philip G. Hill and Carl R. Peterson, Pearson, 2nd Edition, 1992.
6. Fundamentals of Jet Propulsion with Power Generation Applications, Ronald D. Flack, Cambridge University Press, 1st Edition, 2005.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester****NANO FLUIDS****(Professional Elective – II)**

L	T	P	C
3	0	0	3

Prerequisites: Fluid Mechanics, Thermodynamics**Course Objectives:** The course aims to:

1. Introduce the concept and significance of Nano fluids in enhancing heat and mass transfer performance.
2. Explain the synthesis, characterization, and stability of various types of Nano fluids.
3. Analyze the thermophysical properties and their influence on thermal performance.
4. Understand the governing equations and modeling approaches used in Nano fluid analysis.
5. Explore the applications of Nano fluids in engineering systems including heat exchangers, cooling devices, and biomedical applications.

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

1. Understand the types of nano fluids and the effect of volume concentration and temperature on thermo physical properties of nano fluids.
2. Estimate thermal conductivity and specific heat of Nano fluids.
3. Determine Nusselt number and friction factor of various Nano fluids using correlations.
4. Apply nano fluids in industrial heat exchanger and study their effect in obtaining higher thermal efficiency and saving energy.
5. Apply Nano fluids in heating and cooling processes.

UNIT- I: Nano fluid Properties and Measurement Techniques

Introduction to Nano Fluids, Nanostructure Materials, Base Fluids, Dispersion, Sonication and Stable Suspension, Various Types of Nano fluids, Volumetric Concentration, Thermophysical Properties. Density: Principles of Measurement and Apparatus, Theoretical Equations and New Empirical Correlations to Determine the Density of Different Nano fluids. Viscosity: Principles of Measurement and Apparatus, Andrade's and other Theoretical Equations and New Empirical Correlations to Determine the Viscosity of different Nano fluids, Effect of Volumetric Concentration and Temperature, Effect of Subzero Temperature on Nano fluid Viscosity.

UNIT- II: Thermal Conductivity and Specific Heat of Nano fluids

Principles of Measurement and Apparatus, Hamilton-Crosser and other Theoretical Equations and New Empirical Correlations to Determine the Thermal Conductivity of Different Nano fluids, Effect of Volumetric Concentration and Temperature, Effect of Brownian Motion on Enhancing the Thermal Conductivity. Specific Heat: Principles of Measurement and Apparatus, Buongiorno's Thermal Equilibrium Equation and other theoretical Equations and New Empirical Correlations to Determine the Specific Heat of Different Nano fluids, Effect of Volumetric Concentration and Temperature.

UNIT- III: Convective Heat Transfer and Flow Behavior of Nano Fluids

Combined Effects of Thermophysical Properties of Nano Fluids on the Thermal Diffusivity, The Prandtl Number, The Reynolds Number and The Nusselt Number, Basic Understanding of their Effects on Frictional Loss and Heat Transfer. Convective Heat Transfer: Single-Phase Fluid Equations, Laminar Flow, Entry Length and Fully Developed Friction Factor and Heat Transfer

Coefficient, Graetz Number Effect in the Entry Region, Correlations for Friction Factor and Nusselt Number for Nano fluids. Turbulent Flow: Single-Phase Fluid Fully Developed Flow Dittus-Boelter and Glienilski Equations, Blasius and other Turbulent Friction Factor Correlations and their Comparison with Nano fluids Data, New Correlations for Turbulent Friction Factor and Nusselt Number for Nano fluids.

UNIT- IV: Convective Heat Transfer and Applications of Nano Fluids

Principles of Measurement and Apparatus for the Nano fluid Convective Heat Transfer Coefficient, Recent Empirical Relations for Convection Coefficient of Various types of Nano fluids. Effect of Particle Peclet Number, Effect of Volumetric Concentration and Application of Nano fluids to various types of Industrial Heat Exchangers, Heating Capacity, Mass Flow, Heat Exchanger Surface Area, LMTD and Pumping Power for Nano fluids vs Conventional Heat Transfer Fluids.

UNIT- V: Nano Fluids in Thermal Systems and Arctic Applications

Application to Building Heating and Cooling Comparison of Nano fluids Performance with Glycol Solution in Hydronic Coils, Application to Automobile Radiators, Comparison of the Performance of Nano fluids under Arctic and Sub-Arctic Temperatures with Glycol Solutions, Introduction To Electronic Cooling in Microchannel with Nano fluids.

TEXT BOOKS:

1. Microscale and Nanoscale Heat Transfer, C. B. Sobhan, G. P. Peterson, , CRC Press, 1st Edition, 2008.
2. Nanofluids: Fundamentals and Applications, S. Kakaç, A. Pramuanjaroenkij and L. Vasiliev, Springer, 1st Edition, 2008.

REFERENCE BOOKS:

1. Handbook of Nanostructured Materials and Nanotechnology, Vol. I and II, H. S. Nalwa, American Scientific Publishers, 1st Edition, 1999.
2. Springer Handbook of Nanotechnology, Bharat Bhushan, Springer-Verlag, 1st Edition, 2004.
3. Heat Transfer and Fluid Flow in Minichannels and Microchannels, Satish Kandlikar, Springer, 2nd Edition, 2014.
4. Nanoparticle Heat Transfer and Fluid Flow, W. J. Minkowycz, E. M. Sparrow and J. P. Abraham, CRC Press, 1st Edition, 2012.
5. Convective Heat Transfer in Nanofluids, W. Daungthongsuk, Springer, 1st Edition, 2020.
6. Nanofluids for Heat and Mass Transfer, M. M. Sarafraz, Springer, 1st Edition, 2021.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech. I Year, I Semester****RESEARCH METHODOLOGY AND IPR**

L	T	P	C
2	0	0	2

Prerequisite: Fundamentals of Statistics, Technical Writing Skills

Course Objectives:

1. To understand research fundamentals, methodologies, and the significance of research ethics.
2. To enable students to formulate research problems and conduct literature surveys effectively.
3. To introduce the principles of data collection, analysis, and interpretation in research.
4. To explain intellectual property rights, patents, copyrights, and trademarks.
5. To highlight the importance of IPR in protecting innovative ideas and research outcomes.

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

1. Understand the research process, methodologies, and ethics involved in scholarly work.
2. Formulate and define research problems with appropriate objectives.
3. Apply suitable data collection and analysis techniques for research projects.
4. Understand the various forms of intellectual property rights and legal aspects related to patents and copyrights.
5. Apply the knowledge of IPR to safeguard their innovations and research findings.

UNIT-I: Research Problem and Investigation Approaches

Meaning of Research Problem, Sources of Research Problem and Criteria Characteristics of a Good Research Problem, Errors in Selecting a Research Problem, Scope and Objectives of Research Problem. Approaches of Investigation of Solutions for Research Problem, Data Collection, Analysis, Interpretation, Necessary Instrumentations.

UNIT-II: Literature Review and Ethics

Effective Literature Studies Approaches, Analysis, Plagiarism, Research Ethics.

UNIT-III: Technical Writing and Proposals.

Effective Technical Writing, How to Write Report, Paper Developing a Research Proposal, Format of Research Proposal, a Presentation and Assessment by A Review Committee.

UNIT-IV: Intellectual Property and Patenting

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process Of Patenting and Development: Technological Research, Innovation, Patenting, Development. International Scenario: International Cooperation on Intellectual Property. Procedure for Grants of Patents, Patenting Under PCT.

UNIT-V: Patent Rights and Emerging IPR

Patent Rights: Scope of Patent Rights, Licensing and Transfer of Technology, Patent Information and Databases, Geographical Indications. New Developments in IPR: Administration of Patent System. IPR of Biological Systems, Computer Software Etc., Traditional Knowledge Case Studies, IPR and IITs.

TEXTBOOKS:

1. Research methodology: an introduction for science and engineering students, Stuart Melville and Wayne Goddard, Juta and Co. Ltd, 1ST Edition, 1996.
2. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, SAGE, 2nd Edition, 2010.

REFERENCE BOOKS:

1. Resisting Intellectual Property, Debora J. Halbert, Routledge, Taylor and Francis, 1st Edition, 2005.
2. Industrial Design, W. H. (William Henry) Mayall, Iliffe Books (London), also McGraw-Hill editions, 1st Edition, 1974.
3. Intellectual Property in the New Technological Age, Robert P. Merges, Peter S. Menell and Mark A. Lemley, Aspen Casebook Series, Latest Edition, 2016.
4. Intellectual Property Rights under WTO, T. Ramappa, Wheeler Publishing, 1st Edition, 2000.
5. Research Methodology and IPR, P. N. Ganesan, Scitech Publications, 1st Edition, 2019.
6. Intellectual Property Rights: Unleashing the Knowledge Economy, Prabuddha Ganguli, Tata McGraw-Hill, 1st Edition, 2001.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester****ADVANCED HEAT TRANSFER LAB**

L	T	P	C
0	0	4	2

Prerequisites: Heat and Mass Transfer**Course Objective:**

1. Provide hands-on experience in conducting experiments related to conduction, convection, and radiation heat transfer.
2. Reinforce theoretical knowledge through practical validation of advanced heat transfer concepts.
3. Develop skills to design and execute experiments involving measurement and analysis of thermal parameters.
4. Introduce the use of modern instrumentation and data acquisition systems in thermal experiments.
5. Cultivate analytical thinking and report-writing abilities for interpreting and presenting experimental results.

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

1. Determine the thermal property of the solids using energy balance and also using unsteady state analysis
2. Determine the heat transfer coefficient of air in free and force convective conditions
3. Determine the performance of Recuperative Type heat exchangers
4. Determine the drag acting on different surfaces and its effects on pumping power
5. Determine the performance of Heat Pipes

List of Experiments:

1. Determination of Thermal Conductivity of a Metal Rod using Searle's Apparatus
2. Determination of thermal Conductivity of a thin disc using Lee's Disc Apparatus
3. Determination of Free Convective Heat Transfer Coefficient of air Using Vertical Rod
4. Determination of Forced Convective Heat Transfer Coefficient of air using Forced Convection Apparatus
5. Determination of Performance of a Heat Pipe
6. Determination of the effectiveness of Parallel and Counter Flow Heat Exchanger
7. Determination of Condensation Heat Transfer Coefficient under Film and Drop wise Condensation Conditions
8. Heat exchanger service module with axillaries Tubular heat exchanger, shell and tube heat exchanger, plate heat exchanger, jacketed vessel with coil and stirrer.
9. Determination of Stefan Boltzmann Constant.
10. Determination of overall heat transfer coefficient using shell and tube heat exchanger.
11. Transient Heat Conduction Experiment.

TEXT BOOKS:

1. Experimental Methods for Engineers, Holman J.P., McGraw-Hill Education, 8th Edition, 2012.
2. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel, Afshin J. Ghajar, McGraw-Hill Education, 6th Edition, 2020.

LAB MANUALS:

1. Advanced Heat Transfer Lab Manual, S.P. Sukhatme, Universities Press, 4th Edition, 2017.
2. Heat Transfer Laboratory Manual, R.C. Sachdeva, New Age International, 3rd Edition, 2015.
3. Experimental Heat Transfer Lab Manual, Frank P. Incropera, Wiley India, 2nd Edition, 2014.
4. Heat and Mass Transfer Lab Manual, P.K. Nag, McGraw Hill Education, 3rd Edition, 2018.
5. Thermal Engineering Lab Manual, D.S. Kumar, S.K. Kataria and Sons, 10th Edition, 2016.
6. Practical Heat Transfer Experiments, J.P. Holman, Tata McGraw Hill, 9th Edition, 2011.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, I Semester****ADVANCED FLUID MECHANICS LAB**

L	T	P	C
0	0	4	2

Pre-Requisites: Advanced Fluid Mechanics**Course Objectives:**

1. To identify the behavior of analytical models introduced in lecture to the actual behavior of real fluid flows.
2. To explain the standard measurement techniques of fluid mechanics and their applications.
3. To illustrate the students with the components and working principles of the Hydraulic machines- different types of Turbines, Pumps, and other miscellaneous hydraulics machines.
4. To analyze the laboratory measurements and to document the results in an appropriate format.

Course Outcomes: After the successful completion of course

1. Describe the measurement techniques of fluid mechanics and its appropriate application.
2. Interpret the results obtained in the laboratory for various experiments.
3. Compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows and draw correct and sustainable conclusions.
4. Write a technical laboratory
5. Operate and troubleshoot hydraulic machines and flow measurement setups, demonstrating hands-on competence in handling experimental fluid mechanics equipment.

List of Experiments:

1. Jet impact on flat and curved surfaces
2. Measurement of drag on a circular cylinder in high Reynolds number flow
3. Energy loss measurements in subcritical and supercritical open channel flow
4. Measurement of fluid viscosity
5. Determination of friction factor as a function of Reynolds number in pipe flow
6. Studying laminar-turbulent transition for flow in a tube
7. Boundary layer flow over a flat plate
8. Pressure distribution around a circular cylinder in high Reynolds number flow
9. Measurements using Forced Vortex Apparatus and Free Vortex Apparatus
10. Measure the losses in piping System
11. Measure Friction loss along a pipe
12. Pulsating flow setup
13. Flow Measuring Apparatus
14. Flow through an Orifice
15. Water Flow Channel

Note: Perform any 12 exercises out of 15

LAB MANUALS:

1. Advanced Fluid Mechanics Lab Manual, R.K. Bansal, Laxmi Publications, 2nd Edition, 2016.
2. Fluid Mechanics Laboratory Manual, K. Subramanya, Tata McGraw Hill, 3rd Edition, 2015.
3. Experimental Fluid Mechanics Lab Manual, Cengel and Cimbala, McGraw Hill Education, 2nd Edition, 2017.
4. Fluid Mechanics and Machinery Lab Manual, D.S. Kumar, S.K. Kataria and Sons, 10th Edition, 2014.
5. Fluid Flow Laboratory Manual, R.S. Khurmi, S. Chand and Company, Revised Edition, 2013.
6. Practical Fluid Mechanics Experiments, P.N. Modi and S.M. Seth, Standard Book House, 2nd Edition, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, II Semester
ADVANCED I.C. ENGINES
(Professional Core – III)**

L	T	P	C
3	0	0	3

Prerequisites: Thermodynamics, Thermal Engineering II and I

Course objectives: The course is intended to:

1. Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle.
2. Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance.
3. Understand the delay period and fuel injection system.
4. Become aware of the relevance of environmental and social issues on the design process of internal combustion engines

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

1. Apply thermodynamic analysis to IC engines and describe combustion phenomena in spark ignition and compression ignition engines.
2. Describe the working of major systems used in conventional and modern engines.
3. Summarize the methods used to improve engine performance and estimate performance parameters.
4. Describe engine emission control techniques and implement viable alternate fuels.
5. Analyze modern IC engine technologies like HCCI, GDI, lean burn, and bio-fuels for improved efficiency and reduced emissions.

UNIT – I: Types of Engines and Cycle Analysis

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, Differences and Factors Responsible for Computer Modeling.

UNIT – II: Gas Exchange and Charge Motion

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 IC Engines

Engine Combustion in SI Engines: Combustion and Speed, Cyclic Variations, Ignition, Abnormal Combustion Fuel Factors, MPFI, SI Engine Testing.

Combustion in CI Engines: Essential Features, Types of Cycle. Pr. Data, Fuel Spray Behavior, Ignition Delay, Mixing Formation and Control, Common Rail Fuel Injection System.

UNIT – IV: Pollutant Formation and Control

Nature and Extent of Problems, Nitrogen Oxides, Carbon Monoxide, Unburnt Hydrocarbon and Particulate, Emissions, Measurement, Exhaust Gas Treatment, Catalytic Converter, SCR, Particulate Traps, Lean, Nox, Catalysts.

UNIT – V: Heat Transfer and Fuel Systems

Engine Heat Transfer: Importance of Heat Transfer, Heat Transfer and Engine Energy Balance, Convective Heat Transfer, Radiation Heat Transfer, Engine Operating Characteristics.
Fuel Supply Systems for S.I. and C.I Engines to use Gaseous Fuels like LPG, CNG and Hydrogen.
Modern Trends in IC Engines: Lean Burning and Adiabatic Concepts, Rotary Engines and Modification in I.C Engines to Suit Bio Fuels, HCCI and GDI Concepts.

TEXT BOOKS:

1. Internal Combustion Engines, V. Ganesan, Tata McGraw-Hill (TMH), 4th Edition, 2012.
2. Internal Combustion Engine Fundamentals, John B. Heywood, Tata McGraw-Hill (TMH), 1st Edition, 1988.

REFERENCE BOOKS:

1. I.C. Engines, R.K. Rajput, Laxmi Publications, Revised Edition, 2005.
2. Dual-Fuel Diesel Engines, Ghazi A. Karim, CRC Press, 1st Edition, 2015.
3. I.C. Engines, G.K. Pathak and D.K. Chevan, Standard Publishers Distributors, 1st Edition, 2004.
4. Internal Combustion Engines, S.S. Thipse, Jaico Publishing House, 1st Edition, 2010.
5. Internal Combustion Engine Fundamentals, John B. Heywood, McGraw Hill, 2nd Edition, 2018.
6. Advanced Engine Technology, Heinz Heisler, SAE International, 1st Edition, 1995.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, II Semester****COMPUTATIONAL FLUID DYNAMICS**

L	T	P	C
3	0	0	3

(Professional Core – IV)**Pre-requisite:** Heat Transfer, Fluid Mechanics**Course Objective:** The course aims to:

1. Introduce the fundamentals of computational techniques for solving fluid flow and heat transfer problems.
2. Develop an understanding of governing equations (Navier–Stokes, continuity, and energy equations) and their discretization.
3. Explore finite difference and finite volume methods for numerical simulation.
4. Equip students with the skills to implement boundary conditions and analyze stability and convergence.
5. Enable practical experience with CFD software for solving real-world engineering problems.

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

1. Differentiate between different types of Partial Differential Equations and to be able to apply appropriate numerical techniques
2. Solve the simple heat transfer and fluid flow problems using different numerical techniques
3. Understand and to appreciate the need for validation of numerical solution
4. Apply Finite Volume and Finite Difference Methods to steady and unsteady heat conduction and fluid flow problems.
5. Implement and analyze pressure-velocity coupling algorithms like SIMPLE and SIMPLER for solving incompressible and compressible flow problems.

UNIT - I: Governing Equations and Numerical Methods

Review of Governing Equations in Heat Transfer and Fluid Flow: Conservation Laws, Differential form of Equations, Characteristics of Governing Equations. Solution Methods: Analytical, Experimental and Numerical Methods, Review of Boundary Conditions.

Introduction to Numerical Methods: Brief about Finite Difference, Finite Element and Finite Volume Methods, Solution of Linear Algebraic Equations, Direct and Iterative Approaches.

Mathematical Behavior of Partial Differential Equations: Classification of Partial Differential Equations, Illustrations.

Finite Difference Method: Taylor's Series, Derivation of Finite Difference Formulae for Partial Derivative Terms, FD Formulation of 1D Elliptic PDEs, 1D Steady State Heat Transfer Problems, Cartesian, Cylindrical and Spherical Co-Ordinate Systems and Boundary Conditions.

UNIT - II: Finite Difference Method

2D Elliptic PDEs, 2D Steady State Heat Conduction Problems, Parabolic PDEs, Transient Heat Conduction, Errors and Stability, Explicit Method, Stability Analysis, Implicit and Crank Nicholson Method, 2D Parabolic Pdes, Finite Difference Formulation, ADI Method and Explicit Method, Finite Difference Formulation of 1D Hyperbolic PDEs, Wave Equation.

UNIT - III: Finite Volume Method

Formation of Basic Rules for Finite Volume Approach, General Nodal Equation, Interface Thermal Conductivity, Treatment of Source Term and Treatment of Nonlinearity, Solution of 1D and 2D Elliptic PDEs, Heat Conduction Problems, Solution of 1D Parabolic PDEs, Explicit Method and Implicit Methods, Transient Heat Conduction Problems.

UNIT - IV: FVM to Convection and Diffusion

General form of Governing Equations for Fluid Flow and Heat Transfer, Burger's Equation, Steady 1D Convection Diffusion, Discretization Schemes and their Assessment, Treatment of Boundary Conditions.

UNIT - V: Calculation of Flow Field

Vorticity and Stream Function Method, Advantages and Disadvantages, Treatment of Boundary Conditions, Staggered Grid as remedy for Representation of Flow Field, Pressure Velocity Coupling, SIMPLE and SIMPLER (Revised Algorithm) Algorithms.

Compressible Flows: Introduction, Pressure, Velocity and Density Coupling.

TEXT BOOKS:

1. Numerical Heat Transfer and Fluid Flow, S. V. Patankar, Hemisphere Publishing Corporation, 1st Edition, 1980.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H. K. Versteeg, W. Malalasekera, Prentice Hall / PHI Learning, 2nd Edition, 2007.

REFERENCE BOOKS:

1. Computational Fluid Dynamics, Klaus A. Hoffmann and Steve T. Chiang, Engineering Education System, 4th Edition, 2000.
2. Computational Fluid Dynamics: The Basics with Applications, John D. Anderson, Tata McGraw-Hill, 1st Edition, 1995.
3. Computational Methods for Fluid Dynamics, Joel H. Ferziger and Milovan Perić, Springer, 3rd Edition, 2002.
4. Computational Fluid Dynamics, T.J. Chung, Cambridge University Press, 2nd Edition, 2010.
5. Computational Fluid Flow and Heat Transfer, S. Muralidhar, T. Sundararajan, Narosa Publishing House, 2nd Edition, 2014.
6. Computational Fluid Dynamics and Heat Transfer, P. S. Ghoshdastidar, Cengage Learning, 1st Edition, 2010.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, II Semester
FINITE ELEMENT ANALYSIS
(Professional Elective – III)**

L	T	P	C
3	0	0	3

Prerequisites: Finite Element Methods, Heat Transfer, Mechanical Vibrations

Course Objectives:

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

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

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

UNIT-I: Introduction to Finite Element Method

Fundamentals, scope, advantages, limitations, and applications of FEM; general formulation procedure including discretization, interpolation functions, element equations, assembly, boundary conditions, and solution, with comparison to other numerical methods. Variational formulation using the Principle of Minimum Potential Energy, Galerkin and Ritz methods; coordinate systems, element shapes, and interpolation functions. Principle of virtual work, stiffness matrix properties, treatment of boundary conditions, and solution techniques. 1-D axial bar element formulation under mechanical and thermal loads, load vectors, temperature effects, elasticity equations, stress–strain and strain–displacement relations, constitutive models, and introduction to higher-order elements with quadratic shape functions.

UNIT-II: Analysis of Trusses and Beams

Formulation and analysis of plane truss and space truss elements, including derivation of stiffness matrices, load vectors and solution of practical engineering problems under various loading and support conditions. Introduction to beam element theory with Hermite shape functions for flexural deformation, derivation of element stiffness matrices and equivalent nodal load vectors, and application to the analysis of beams with different boundary and loading conditions. Emphasis on numerical examples to illustrate finite element modeling, computation, and interpretation of structural response.

UNIT-III: 2-D, 3-D and Axisymmetric FEM Analysis

Analysis of 2-D problems using Constant Strain Triangle (CST) elements, including derivation of force terms, stiffness matrices, and load vectors, with treatment of various boundary conditions. Development and application of iso-parametric elements, focusing on quadrilateral elements, shape function formulation, and numerical integration techniques. Finite element modeling of axisymmetric solids subjected to axisymmetric loading using triangular elements, with formulation of governing equations and solution procedures. Extension to 3-D problems with tetrahedral elements, including derivation of the Jacobian matrix, computation of stiffness matrices.

UNIT-IV: Scalar Field Problems

Formulation of one-dimensional heat conduction problems in steady and transient states, including analytical and numerical solutions for slabs and extended surfaces (fins) with various boundary conditions. Introduction to two-dimensional heat conduction problems in Cartesian and polar coordinates, governing differential equations, and boundary condition types. Application of finite element methods to discretize and solve scalar field equations, with emphasis on temperature distribution analysis.

UNIT-V: Dynamic Analysis of Structures

Introduction to dynamic considerations in structural analysis, including sources of dynamic loading such as wind, seismic forces, and impact, and the importance of representing mass, stiffness, and damping accurately. Formulation of dynamic equations of motion for single- and multi-degree-of-freedom systems in matrix form, with emphasis on the derivation of consistent mass matrices for bar and triangular finite elements and comparison with lumped mass formulations. Computation of eigenvalues and eigenvectors, interpretation of their physical meaning, and determination of natural frequencies and mode shapes.

TEXT BOOKS:

1. The Finite Element Method in Engineering, S. S. Rao, Pergamon Press, 4th Edition, 2005.
2. Introduction to Finite Elements in Engineering, Ashok Kumar Chandrupatla and Ashok D. Belegundu, Prentice Hall, 3rd Edition, 2011.

REFERENCE BOOKS:

1. Finite Element Methods: Basic Concepts and Applications, T. K. Chandrupatla and A. D. Belegundu, PHI Learning, 1st Edition, 2002.
2. Applied Finite Element Analysis, Larry J. Segerlind, Wiley India, 1st Edition, 2006.
3. Finite Element Modeling and Simulation with ANSYS Workbench, Xiaolin Chen and Yijun Lui, CRC Press, 1st Edition, 2017.
4. Finite Element Method, R. Zincowitz, McGraw Hill, 1st Edition, 2004.
5. Introduction to Finite Element Analysis, S. Md. Jalaludeen, Anuradha Publications, 1st Edition, 2012.
6. A First Course in the Finite Element Method, Daryl L. Logan, Cengage Learning, 5th Edition, 2011.
7. Finite Element Analysis – Theory and Programming, P. Seshu, McGraw Hill, 1st Edition, 2000.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, II Semester****OPTIMIZATION TECHNIQUES and APPLICATIONS****(Professional Elective – III)**

L	T	P	C
3	0	0	3

Pre-requisites: Operations Research**Course Objectives:**

1. To introduce the fundamentals of optimization and its role in engineering and decision-making.
2. To develop the ability to formulate optimization problems for real-world applications.
3. To familiarize students with classical, numerical, and modern optimization techniques.
4. To enable analysis and comparison of various optimization algorithms for efficiency and accuracy.
5. To apply optimization methods to solve practical problems in manufacturing, design, and management.

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

1. Apply suitable optimization techniques to solve single-variable and multivariable problems.
2. Perform sensitivity analysis for parameter changes in Linear Programming Problems.
3. Solve integer and stochastic programming problems using appropriate algorithms.
4. Formulate and solve Goal Programming models for multi-objective optimization.
5. Apply metaheuristic methods such as Genetic Algorithm, Simulated Annealing, and Particle Swarm Optimization to real-world problems.

UNIT-I: Linear Programming

Formulation, Simplex Method and Artificial Variable Optimization Techniques: Big M and Two-Phase Methods. Sensitivity Analysis: Changes in the Objective Coefficients, Constants and Coefficients of the Constraints. Addition of Variables, Constraints. Simulation, Introduction, Types, Steps, Applications. Inventory and Queuing, Advantages and Disadvantages.

UNIT-II: Integer and Stochastic Programming Techniques

Integer Programming: Introduction, Formulation, Geometry Cutting Plane Algorithm, Zero or One Algorithm, Branch and Bound Method.

Stochastic Programming: Basic Concepts of Probability Theory, Random Variables, Distributions - Mean, Variance, Correlation, Co Variance, Joint Probability Distribution. Stochastic Linear Programming: Chance Constrained Algorithm.

UNIT-III: Single Variable Non-Linear Unconstrained Optimization

Elimination Methods: Uni-Model Function, Its Importance. Fibonacci Method and Golden Section Method. Interpolation Methods: Quadratic and Cubic Interpolation Methods.

UNIT-IV: Multi variable non-linear unconstrained optimization

Direct Search Methods, Univariant Method, Pattern Search Methods, Powell's, Hook Jeeves, Rosenbrock Search Methods. Gradient Methods: Gradient Of Function and its Importance, Steepest Descent Method, Conjugate Direction Methods: Fletcher- Reeves Method Variable Metric Method.

UNIT-V: Geometric Programming and Modern Optimization Methods

Geometric Programming: Posynomials, Arithmetic, Geometric Inequality, Unconstrained G.P, Constrained G.P (\leq Type Only).

Non-Traditional Optimization Algorithms: Genetics Algorithm, Working Principles, Similarities and Differences Between Genetic Algorithm and Traditional Methods. Simulated Annealing, Working Principle, Simple Problems. Introduction to Particle Swarm Optimization. (PSO).

TEXTBOOKS:

1. Engineering Optimization: Theory and Practice, S. S. Rao, New Age International Pvt. Ltd Publishers, 3rd Edition, 2013.
2. Optimization for Engineering Design: Algorithms and Examples, Kalyanmoy Deb, PHI, 2nd Edition, 2012.

REFERENCE BOOKS:

1. Operations Research: Theory and Applications, S. D. Sharma, Kedar Nath Ram Nath Publisher, 4th Edition, 2022.
2. Operations Research: An Introduction, H. A. Taha, Pearson Publisher, 10th Edition, 2019.
3. Optimization in operations research, R. L Rardin, Pearson Imprint, 3rd Edition, 2016.
4. Optimization Techniques, Chakraverty and P.R. Chandraputla, Pearson Asia, 1st Edition, 2011.
5. Optimization: Theory and Practice, Mohan C. Joshi and Kannan M. Moudgalya, Narosa Publishing House, 1st Edition, 2004.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, II Semester
UTILIZATION OF SOLAR ENERGY
(Professional Elective – III)**

L	T	P	C
3	0	0	3

Prerequisites: Non-Conventional Energy Resources and Fundamentals of Solar Engineering
Course Objectives

1. Understand basic terminology applicable to solar energy study
2. Create Awareness on solar cells and PV technology
3. Explore to solar instruments /devices for utilization of solar energy
4. Discuss the utilization of solar energy in building and industry applications.
5. To introduce solar passive architecture and energy storage systems.

Course Outcomes: After successful completion of this course, students shall be able to;

1. Understand and learn the basic knowledge of tracking the Sun for Solar Energy Utilization
2. Explore to different techniques for Solar Energy Conversion into useful Energy i.e. Electrical Energy Thermal Energy etc.
3. Explain the working of different Instruments/Devices used for Convert/Measuring Solar Energy
4. Elaborate Designing concept of different Solar Thermal Devices for building applications i.e. Different Thermal Collectors, Their Orientations etc.
5. Analyze the solar heating / cooling and storage concepts with regard to industrial Applications

UNIT- I: Solar Radiation and Sun Geometry

Irradiation and Peak Sun Hours, Solar Radiation Data, Sun Path Diagram, Defining the Position of the Sun, Sun Tracking, Solar Altitude, Geometric Effects, Tilting Solar Modules.

UNIT- II: Solar Cell Characteristics

PV / Solar Cell and Solar Lighting: Introduction, Characteristics of a Solar Cell, Power Characteristics of a Solar Cell, Fill Factor and Equivalent Solar Cell Circuit, STC and NOCT, Factors Which Affect the Performance of Solar Cells, Types of Solar Cells, Different PV Technology, Solar Lanterns, Home Lighting Systems, Solar Lanterns, Solar PV Pumps.

UNIT- III: Solar Thermal Collectors

Solar Thermal Applications: Solar Collectors and its Types, Flat Plate, Concentrating Solar Collectors, Evacuated Tube Collector, Advanced Collectors and Solar Concentrators, Collector Efficiency, Solar Water Heating System, Solar Cooking, Solar Drying, , Solar Thermal Power Generation.

UNIT- IV: Solar Heating and Cooling

Solar Heating, Cooling and It's Types, Active and Passive Heating and Cooling of Buildings.

UNIT- V: Solar Storage and Industrial Applications

Solar Energy Storage, Industrial Process Heat Systems, Low Temperature Application

TEXT BOOKS:

1. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme, Tata McGraw-Hill, New Delhi, 2nd Edition, 1996.
2. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman, John Wiley and Sons, New York, 2nd Edition, 1991

REFERENCE BOOKS:

1. Principles of Solar Engineering, D.Y. Goswami, Frank Kreith and Jan F. Kreider, Taylor and Francis, Philadelphia, 2nd Edition, 2000.
2. Solar Passive Building: Science and Design, M.S. Sodha, N.K. Bansal, P.K. Bansal, A. Kumar and M.A.S. Malik, Pergamon Press, New York, 1st Edition, 1986.
3. Solar Engineering of Thermal Processes, John A. Duffie and William A. Beckman, Wiley, 4th Edition, 2013.
4. Solar Energy: Fundamentals, Design, Modelling and Applications, G.N. Tiwari, Narosa Publishing House, Revised Edition, 2010.
5. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki, PHI Learning, 3rd Edition, 2015.
6. Renewable Energy Resources, John Twidell and Tony Weir, Routledge, 3rd Edition, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., I Year, II Semester
CO-GENERATION AND WASTE HEAT RECOVERY SYSTEMS
(Professional Elective – IV)

L	T	P	C
3	0	0	3

Prerequisites: Power Plant Engineering, Thermodynamics

Course Objectives:

1. To introduce the concept and types of co-generation systems and their benefits.
2. To explain various waste heat recovery techniques and equipment.
3. To analyze the thermodynamic cycles used in co-generation.
4. To study economic and environmental aspects of waste heat utilization.
5. To expose students to design methodologies and performance evaluation of co-generation systems.

Course outcomes: The student can

1. Explain the basics of cogeneration and Waste heat recovery
2. Apply the concepts of Cogeneration technologies and functions of its components
3. Analyse the issues and applications of Co-generation technologies
4. Choose the appropriate criteria for waste heat recovery systems and its components
5. Understand the Economic aspects of cogeneration and Waste heat recovery

UNIT - I: Cogeneration Cycles and Waste Heat Recovery Systems

Principles of Thermodynamics and Cycles, Topping and Bottoming, Combined Cycle, Organic Rankine Cycles, Performance Indices of Cogeneration Systems, Waste Heat Recovery, HRSG, Sources and Types, Concept of Tri Generation.

UNIT - II: Co-Generation Technologies

Configuration and Thermodynamic Performance, Steam Turbine Co- Generation Systems, Gas Turbine Cogeneration Systems, Reciprocating IC Engines Cogeneration Systems, Combined Cycles Cogeneration Systems. Advanced Cogeneration Systems: Fuel Cell, Stirling Engines Etc...

UNIT - III: Issues and Applications of Cogeneration Technologies

Cogeneration Plants Electrical Interconnection Issues, Utility and Cogeneration Plant Interconnection Issues, Applications of Cogeneration in Utility Sector, Industrial Sector, Building Sector, Rural Sector, Impacts of Cogeneration Plants, Fuel, Electricity and Environment.

UNIT - IV: Waste Heat Recovery Systems

Selection Criteria for Waste Heat Recovery Technologies, Recuperators and Regenerators, Economizers, Plate Heat Exchangers, Thermic Fluid Heaters, Waste Heat Boilers, Classification, Location, Service Conditions, Design Considerations, Fluidized Bed Heat Exchangers, Heat Pipe Exchangers, Heat Pumps, Sorption Systems.

UNIT - V: Economic Analysis

Investment Cost, Economic Concepts, Measures of Economic Performance, Procedure for Economic Analysis and Examples. Procedure for Optimized System Selection and Design, Load Curves, Sensitivity Analysis, Regulatory and Financial Frame Work for Cogeneration and Waste Heat Recovery Systems.

TEXT BOOKS:

1. Cogeneration, Charles H. Butler, McGraw-Hill Book Company, 1st Edition, 1984.
2. Power Generation Handbook: Selection, Applications, Operation, and Maintenance, Philip Kiameh, McGraw Hill, 2nd Edition, 2011.

REFERENCE BOOKS:

1. Waste Heat Utilization and Management, Subrata Sengupta and S.S. Lee (Eds.), Hemisphere Publishing Corporation, Washington, 1st Edition, 1983.
2. Air Pollution Control Engineering, Noel De Nevers, McGraw Hill, New York, 2nd Edition, 1995.
3. Cogeneration and Combined Heat and Power (CHP): Principles and Applications, Paul Breeze, Academic Press, 1st Edition, 2019.
4. Combined Heating, Cooling and Power Handbook: Technologies and Applications, Neil Petchers, Fairmont Press, 1st Edition, 2003.
5. Energy Efficiency and Waste Heat Recovery Technologies, V. V. N. Kishore, The Energy and Resources Institute (TERI), 1st Edition, 2010.
6. Waste Heat Recovery: Principles and Industrial Applications, Edward A. Beardsley, Industrial Press, 1st Edition, 2004.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, II Semester
RENEWABLE ENERGY SOURCES
(Professional Elective – IV)**

L	T	P	C
3	0	0	3

Prerequisites: Basics concepts of solar, wind, hydro, biomass, fuel cells and geothermal systems.

Course Objectives:

1. To provide an overview of various renewable energy sources and technologies.
2. To understand the principles, components, and performance of solar, wind, biomass, geothermal, and small hydro systems.
3. To assess the technical and economic feasibility of renewable energy projects.
4. To promote sustainable energy planning and integration with existing grids.
5. To familiarize with policy frameworks and environmental impacts related to renewable energy.

Course Outcomes: At the successful completion of course, the student is expected to,

1. Identify and classify different types of renewable energy systems.
2. Analyze the performance and limitations of solar, wind, and other renewable energy technologies.
3. Design basic renewable energy systems based on availability and load requirements.
4. Evaluate techno-economic viability of renewable energy projects.
5. Understand the role of renewable energy in sustainable development and national energy planning.

UNIT - I: Solar Fundamentals and Radiation

Introduction: Overview of the Course. Classification of Energy Resources, Energy Scenario in the World and India.

Basic Sun-Earth Relationships: Definitions, Celestial Sphere, Altitude-Azimuth, Declination, Hour Angle and Declination, Right Ascension Coordinate Systems for Finding the Position of the Sun, Celestial Triangle and Coordinates of the Sun, Greenwich Mean Time, Indian Standard Time, Local Solar Time, Sun Rise and Sun Set Times and Day Length, Numerical Problems.

Solar Radiation: Nature of Solar Radiation, Solar Radiation Spectrum, Solar Constant, Extra-Terrestrial Radiation on a Horizontal Surface, Attenuation of Solar Radiation, Beam, Diffuse and Global Radiation, Measurement of Global, Diffuse and Beam Radiation. Prediction of Solar Radiation; Angstrom Model, Page Model, Hottel's Model, Liu and Jordan Model Etc., Insolation on an Inclined Surface, Angle of Incidence, Illustrative Problems.

UNIT - II: Solar Thermal and PV Systems

Solar Thermal Systems: Principle of working of Solar Water Heating Systems, Solar Cookers, Solar Desalination Systems, Solar Ponds, Solar Chimney Power Plant.

Solar Concentrating Collectors: Classification of Solar Concentrators, Basic definitions such as Concentration Ratio, Angle of Acceptance Etc., Tracking of the Sun, Description of different Tracking Modes of a Solar Collectors and the determination of Angle of Incidence of Insolation in Different Tracking Modes, Illustrative Problems. **Photovoltaic Energy Conversion:** Introduction, Single Crystal Silicon Solar Cell, I-V Characteristics, Effect of Insolation and Temperature on the Performance of Silicon Cells, Different Types of Solar Cells, Modern Technological Methods of Producing these Cells, Indian and World Photovoltaic Energy Scenario.

UNIT - III: Energy Storage and Wind Power

Energy Storage: Necessity for Energy Storage, Classification of Methods of Energy Storage. Thermal Energy Storage: Sensible Heat Storage, Latent Heat Storage, Reversible Chemical Reaction Storage.

Electromagnetic Energy Storage, Hydrogen Energy Storage, Chemical Battery Storage, Pumped Hydel Energy Storage.

Wind Energy: Origin of Winds, Nature of Winds, Wind Data Measurement, Wind Turbine types and their Construction, Wind-Diesel Hybrid System, Environmental Aspects, Wind Energy Programme in India and the World.

UNIT - IV: Ocean Energy and Fuel Cells

Ocean Energy: Ocean Thermal Energy, Open Cycle and Closed Cycle OTEC Plants, Environmental Impacts, Challenges, Present Status of OTEC Systems. Ocean Tidal Energy: Single Basin and Double Basin Plants, Their Relative Merits. Ocean Wave Energy: Basics of Ocean Waves, Different Wave Energy Conversion Devices, Relative Merits.

Fuel Cells: Introduction, Applications, Classification, Different Types of Fuel Cells such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell, Development and Performance Fuel Cells.

UNIT - V: Biomass, Biogas and Geothermal Energy

Biomass: Introduction, Photosynthesis, Biofuels, Biomass Resources, Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass to Ethanol Conversion, Biomass Energy Scenario in India.

Biogas: Biogas Production, Constant Pressure and Constant Volume Biogas Plants, Operational Parameters of the Biogas Plant.

Geothermal Energy: Origin, Applications, Types of Geothermal Resources, Relative Merits.

TEXT BOOKS:

1. Non-Conventional Energy Resources, B. H. Khan, Tata McGraw-Hill, New Delhi, 2nd Edition, 2012.
2. Energy Technology: Non-Conventional, Renewable and Conventional, S. Rao, B. B. Parulekar, Khanna Publishers, 3rd Edition, 2010.

REFERENCE BOOKS:

1. Solar Energy: Principles of Thermal Collection and Storage, S.P. Sukhatme and J.K. Nayak, Tata McGraw-Hill (TMH), 3rd Edition, 2008.
2. Solar Engineering of Thermal Processes, J.A. Duffie and W.A. Beckman, John Wiley and Sons, 4th Edition, 2010.
3. Fundamentals of Renewable Energy Sources, D. Mukherjee and S. Chakrabarti, New Age International, 2nd Edition, 2011.
4. Renewable Energy Resources, John Twidell and Tony Weir, Routledge, 3rd Edition, 2015.
5. Energy from Biomass: A Review of Combustion and Gasification Technologies, Paul Breeze, Academic Press, 1st Edition, 2018.
6. Introduction to Renewable Energy, Vaughn C. Nelson, CRC Press, 2nd Edition, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., I Year, II Semester
ADVANCED REFRIGERATION AND AIR CONDITIONING
(Professional Elective – IV)

L	T	P	C
3	0	0	3

Prerequisites: Thermodynamics, Fundamentals of Heat Transfer

Course Objectives:

1. To impart advanced knowledge on vapor compression, absorption, and gas cycle refrigeration systems.
2. To analyze psychrometric processes and air conditioning system design.
3. To explore refrigerants, system components, and their selection criteria.
4. To study refrigeration load estimation and heat pump technologies.
5. To evaluate energy efficiency and environmental impact of refrigeration systems.

Course Outcomes: After the successful completion of this course, students will be able to

1. Apply thermodynamic principles to advanced refrigeration cycles.
2. Evaluate and select refrigerants and components for specific applications.
3. Design and analyze air conditioning systems using psychrometric methods.
4. Perform cooling load calculations for various applications.
5. Assess energy performance and propose eco-friendly refrigeration solutions.

UNIT– I: VCR and Compound Compression

Vapour Compression Refrigeration (VCR): Performance of Complete Vapor Compression System, Actual vs Ideal Cycle, Effect of Operating Parameters on COP.

Components of Vapor Compression System: The Condensing Unit, Evaporators, Expansion Valve, Refrigerants and Properties, ODP and GWP, Load Balancing of Vapor Compression Unit.

Compound Compression: Flash Inter-Cooling, Flash Chamber, Multi Evaporators and Multistage Systems.

UNIT– II: Cryogenics and Absorption Systems

Production of Low Temperature: Liquefaction System, Liquefaction of Gases, Hydrogen and Helium, Cascade System, Applications and Dry Ice System.

Vapor Absorption System: Simple and Modified Aqua, Ammonia System, Representation on Enthalpy, Concentration Diagram, Lithium and Bromide System three Fluid System and HCOP.

UNIT– III: Air and Jet Refrigeration

Air Refrigeration: Applications, Air Craft Refrigeration, Simple, Bootstrap, Regenerative and Reduced Ambient Systems, Problems based on different Systems.

Steam Jet Refrigeration System: Representation on T-S and H-S Diagrams, Limitations and Applications.

Unconventional Refrigeration System: Thermo-Electric, Vortex Tube and Pulse Tube, Working Principles.

UNIT– IV: AC Basics and Load Analysis

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 Calculations: Summer/Winter Heating Load Calculation, Heat Losses through Structure and Heat Losses due to Infiltration, Effects of Solar Radiation and Internal Heat Sources on Heating Loads.

Air Heating System: Classification, Gravity Warm Heating System, Forced Warm Air Heating System, Balancing a Warm Air Heating System, Warm Air Furnaces, Air Cleaners, Humidifiers and De-Humidifiers.

UNIT– V: Air Conditioning Systems and Ventilation Equipment

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.

Ventilation: Ventilation and Infiltration, Requirement of Ventilation Air, Various Sources of Infiltration Air, Ventilation and Infiltration as a part of Cooling Load. Fans and Blowers: Types, Performance Characteristics, Series and Parallel Arrangement, Selection Procedure.

Equipment and Controls: Chillers, Condensing Units, Cooling Coils, Bypass Factors, Humidifiers, Dehumidifiers, Heat Pumps.

TEXT BOOKS:

1. Refrigeration and Air Conditioning, C. P. Arora, Tata McGraw-Hill (TMH), 3rd Edition, 2010.
2. Refrigeration and Air Conditioning, R. S. Arora and S. Domkundwar, Dhanpat Rai and Co., Latest Revised Edition, 2013

REFERENCE BOOKS:

1. Basic Refrigeration and Air Conditioning, P.N. Ananthanarayanan, McGraw Hill Education, Revised Edition, 2013.
2. Refrigeration and Air Conditioning, Wilbert F. Stoecker and Jerold W. Jones, McGraw Hill, 2nd Edition, 1982
3. Refrigeration and Air Conditioning, Carl H. Jordan and William H. Priester, Prentice Hall, 1st Edition, 1965.
4. Principles of Refrigeration, Roy J. Dossat, McGraw Hill, 4th Edition, 2001.
5. Refrigeration and Air Conditioning, Manohar Prasad, New Age International Publishers, 2nd Edition, 2011.
6. Refrigeration and Air Conditioning, R.S. Khurmi and J.K. Gupta, S. Chand Publications, Revised Edition, 2014.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., I Year, II Semester
ADVANCED THERMAL ENGINEERING LAB

L	T	P	C
0	0	4	2

Prerequisites: Thermodynamics, Thermal Engineering

Course Objective: The course aims to:

1. Provide experimental exposure to advanced thermal systems involving energy conversion and transport.
2. Enable students to understand the performance characteristics of IC engines, compressors, turbines, and other thermal systems.
3. Develop competency in measuring thermodynamic and transport properties using instrumentation.
4. Reinforce theoretical concepts through experiments on heat exchangers, combustion analysis, and refrigeration cycles.
5. Improve technical reporting skills through systematic data collection, analysis, and interpretation.

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

1. Conduct performance tests on IC engines, compressors, and turbines, and interpret experimental data.
2. Analyze heat transfer processes using various types of heat exchangers and evaluate their efficiency.
3. Investigate refrigeration and air conditioning systems to determine their COP and performance characteristics
4. Use thermocouples, manometers, gas analyzers, and flow meters for precise measurement in thermal systems
5. Prepare structured lab reports with clear presentation of experimental results, error analysis, and engineering interpretations.

List of 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. Evaluation of Performance Parameters for Axial Fan and Centrifugal Blower
4. Evaluation of Performance of a Nozzle and Determination of Nozzle Pressure Distribution
5. Determination of Performance Evaluation of Impulse and Reaction Turbines
6. Simulation of Flow Network for Basic Pipe Flow and Interconnection of Pipes
7. Simulation of Flow Network and Performance Evaluation of Rankine Cycle with Reheat and Regeneration
8. Simulation of Flow Network and Performance Evaluation of Brayton Cycle with Intercooling and Reheat
9. Simulation of Flow and Thermal Networks and Performance Evaluation of a Boiler along with Boiler, Economizer, Super heater and Reheater
10. Steady and Transient Simulation of Compressible Flow Network.

LAB MANUALS:

1. Advanced Thermal Engineering Lab Manual, R.K. Rajput, Laxmi Publications, 2nd Edition, 2016.
2. Thermal Engineering Laboratory Manual, D.S. Kumar, S.K. Kataria and Sons, 10th Edition, 2015.
3. Applied Thermal Engineering Lab Manual, P.L. Ballaney, Khanna Publishers, 3rd Edition, 2014.
4. Experiments in Thermal Engineering, R.S. Khurmi and J.K. Gupta, S. Chand and Company, Revised Edition, 2013.
5. Thermal and Heat Power Lab Manual, S.C. Arora and S. Domkundwar, Dhanpat Rai and Co., 8th Edition, 2012.
6. Thermal Science Laboratory Manual, P.K. Nag, McGraw Hill Education, 3rd Edition, 2017.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., I Year, II Semester****COMPUTATIONAL METHODS LAB**

L	T	P	C
0	0	4	2

Pre-requisite: Heat Transfer and Fluid Mechanics**Course Objective:** The course aims to:

1. Develop programming skills for implementing numerical methods to solve engineering problems.
2. Introduce numerical techniques for solving linear and nonlinear algebraic equations, differential equations, and interpolation problems.
3. Provide practical experience in using tools like MATLAB, Python, or C/C++ to implement computational algorithms.
4. Reinforce the understanding of numerical stability, accuracy, and convergence of solutions.
5. Equip students to apply computational methods in thermal, fluid, and structural analysis applications.

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

1. Implement numerical methods for solving equations and performing interpolation and curve fitting.
2. Solve ordinary and partial differential equations using numerical schemes and validate results.
3. Analyze the accuracy and stability of computational algorithms.
4. Develop MATLAB/Python/C-based programs to solve engineering problems
5. Apply computational techniques to practical problems in heat transfer, fluid flow, and mechanical systems, and interpret the results effectively.

List of Experiments:

1. Simulation of Couette flow when the upper plate is moving with a velocity of 40 m/s. Take the distance between the plates as 4 cm. Properties of fluid are; $\nu = 0.000217 \text{ m}^2/\text{s}$, $\rho = 800 \text{ kg/m}^3$. Make simulations for a pressure gradient of 0-30000 N/m²/m and 20000 N/m²/m and report the variation of velocity contours for each case.
2. Simulation of a channel flow (Tube flow) for a tube of diameter, 5 cm and take the fluid as water at 30°C at the entry of the tube of length 0.7 m. A heat flux of 30000 W/m² is imposed along the wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centerline temperature and velocity of fluid.
3. Simulation of a channel flow (Tube flow) for a tube of diameter, 5 cm and take the fluid as water at 30°C at the entry of the tube of length 0.7 m. A constant wall temperature of 300°C 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.
4. Unsteady simulation of compressible flow of air through 2D a convergent – divergent nozzle, with inlet and outlet of 0.2 m 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 atm and leaves at 0.73 atm. Obtain the contours of velocity, pressure and Mach number.
5. 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.

6. Simulation of temperature contours for a square plate of size 0.2 m and subjected to different types of boundary conditions
7. Simulation of temperature contours for a pin fin subjected to natural and forced convective conditions
8. Simulation of Natural convection with and without radiation inside an enclosure
9. Simulation of Lid driven cavity problem
10. Structural analysis for beams and trusses
11. The experiments are to be conducted using ANSYS – CFX or equivalent software

Note: Each student will take different problem cases to solve each of the problem, based on the equipment given in the list as example.

LAB MANUALS:

1. Computational Methods Lab Manual, S.S. Sastry, PHI Learning, 4th Edition, 2012.
2. Numerical Methods and Computation Lab, M.K. Jain, New Age International, 3rd Edition, 2016.
3. Applied Numerical Methods Lab Manual, Steven C. Chapra, McGraw Hill Education, 3rd Edition, 2017.
4. Numerical Methods Laboratory Manual, B.S. Grewal, Khanna Publishers, 2nd Edition, 2015.
5. MATLAB Based Computational Lab Manual, Rudra Pratap, Oxford University Press, 2nd Edition, 2014.
6. Finite Difference Methods Lab Manual, R.D. Hirschweiler, Pearson Education, 1st Edition, 2011.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., II Year, I Semester
EXPERIMENTAL METHODS IN THERMAL ENGINEERING
(Professional Elective – V)

L	T	P	C
3	0	0	3

Prerequisites: Heat Transfer, Thermodynamics and Fluid Mechanics

Course Outcomes: The course aims to:

1. Introduce fundamental principles and techniques used in experimental thermal analysis.
2. Develop knowledge of instrumentation used to measure temperature, pressure, flow, and heat flux.
3. Explain data acquisition systems, sensor calibration, and error analysis methods.
4. Teach experimental design and interpretation of thermal system behaviors.
5. Prepare students for research and industrial experimentation with real-time thermal systems.

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

1. Understand the concepts of errors in measurements, statistical analysis of data, regression analysis, correlation and estimation of uncertainty.
2. Understand conceptual development of zero, first and second order systems.
3. Describe the working principles in the measurement of field and derived quantities.
4. Analyze sensing requirements for measurement of thermo-physical properties, radiation properties of surfaces, and vibration.
5. Select and apply appropriate experimental techniques to measure thermal and transport properties for engineering applications.

UNIT - I: Measurement Systems and Experimental Error Analysis

Introduction, Generalized Measurement System, Standards and Calibration, Dynamic Measurements, System Response, Distortion, Impedance Matching, Fourier Analysis, Experiment Planning, Causes and Types of Errors, Error Analysis, Uncertainty Analysis, Evaluation, Statistical Analysis of Experimental Data and Probability Distribution.

UNIT - II: Data Acquisition and Transducer Technologies

Data Acquisition, Data Transmission, Data Storage and Display, Variable Resistance Transducers, Capacitive Transducers, Piezoelectric Transducers, Photoconductive Transducers, Photovoltaic Cells, Ionization Transducers, Hall Effect Transducers.

UNIT - III: Pressure Measurement and Dynamic Response Instruments

Dynamic Response Considerations, Bridgman Gauge, McLeod Gauge, Pirani Thermal Conductivity Gauge, Knudsen Gauge, Alpha Tron.

UNIT - IV: Flow and Temperature Measurement Techniques

Flow Measurement by Drag Effects, Hot Wire Anemometers, Magnetic Flow Meters, Flow Visualization Methods, Interferometer and Laser Doppler Anemometer, Temperature Measurement by Mechanical Effect, Temperature Measurement by Radiation, Transient Response of Thermal Systems, Thermocouple Compensation, Temperature Measurements in High-Speed Flow.

UNIT - V: Thermal Property Measurements and Radiation Detection

Thermal Conductivity Measurement of Solids, Liquids and Gases, Measurement of Gas Diffusion, Convection Heat Transfer Measurements, Humidity Measurements, Heat-Flux Meters, Detection of Thermal Radiation, Measurement of Emissivity, Reflectivity and Transmissivity, Solar Radiation Measurement.

TEXT BOOKS:

1. Experimental Methods for Engineers, J. P. Holman, Tata McGraw-Hill, 7th Edition, 2001.
2. Mechanical Measurements, Thomas G. Beckwith, John H. Lienhard V, Roy D. Marangoni, Pearson Education, 5th Edition, 2010.

REFERENCE BOOKS:

1. Fundamentals of Heat and Mass Transfer, D. P. DeWitt, T. F. Bergman, F. P. Incropera, A. S. Lavine, Wiley, 7th Edition, 2011.
2. Mechanical Measurements, Beckwith, Marangoni, and Lienhard, Pearson, 6th Edition, 2006.
3. Measurement Systems: Application and Design, Ernest O. Doebelin, Tata McGraw-Hill, 5th Edition, 2008.
4. Principles of Measurement Systems, John P. Bentley, Pearson Education, 4th Edition, 2005.
5. Instrumentation for Engineering Measurements, James W. Dally, William F. Riley and Kenneth G. McConnell, Wiley, 2nd Edition, 1993.
6. Engineering Experimentation, E.O. Doebelin, McGraw Hill, 1st Edition, 1980.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., II Year, I Semester****GAS DYNAMICS****(Professional Elective – V)**

L	T	P	C
3	0	0	3

Prerequisites: Thermodynamics, Fluid Mechanics**Course Objectives:**

1. To introduce the fundamental concepts of compressible fluid flow and gas dynamics.
2. To study the behavior of gases under varying pressure and velocity conditions.
3. To analyze one-dimensional isentropic, shock, and Fanno and Rayleigh flow models.
4. To understand the physics and mathematics of shock waves, expansion waves, and high-speed flows.
5. To apply gas dynamic principles in nozzles, diffusers, and propulsion systems.

Course Outcomes: After completing this course, students will be able to:

1. Explain the characteristics and equations governing compressible flows.
2. Analyze one-dimensional isentropic flow and flow with area change in ducts.
3. Evaluate normal and oblique shock waves and their effect on flow properties.
4. Solve problems involving Fanno and Rayleigh flows in ducts with friction and heat addition.
5. Apply gas dynamic principles to the design of high-speed aerodynamic and propulsion systems.

UNIT- I: Compressible Flow

Introduction to Compressible Flow, Brief Review of Thermodynamics And Fluid Mechanics, Integral Forms Of Conservation Equations, Differential Conservation Equations, Continuum Postulates, Acoustic Speed And Mach Number, Governing Equation For Compressible Flows.

UNIT – II: One-Dimensional Compressible Flow

One Dimensional Flow Concepts, Isentropic Flows, Stagnation / Total Conditions, Characteristics Speeds of Gas Dynamics, Dynamic Pressure and Pressure Coefficients, Normal Shock Waves, Rankine Hugoniot Equations, Rayleigh Flow, Fanno Flow, Crocco Theorem.

UNIT – III: Quasi-One-Dimensional Flows and Nozzles

Governing Equations, Area Velocity Relations, Isentropic Flow through Variable Area Ducts, Convergent Divergent (or De Laval) Nozzles, Over Expanded and Under Expanded Nozzle and Diffusers.

UNIT- IV: Two-Dimensional Supersonic Flow and Shock Waves

Oblique Shock Wave and its Governing Equations, E-B-M Relations, The Hodograph and Shock Polar, Supersonic Flow Over Wedges and Cones, Mach Line, Attached and Detached Shock, Reflection and Interaction of Oblique Shock Waves, Supersonic Flow Over Convex and Concave Corners, Approximation of Continuous Expansion Waves by Discrete Waves.

UNIT- V: Unsteady Wave Motion and Shock Tube Theory

Moving Normal Shock Waves, Reflected Shock Waves, Physical Features of Wave Propagation, Elements of Acoustic Thermal Engineering Theory, Incident and Reflected Expansion Waves, Finite Compression Waves, Shock Tube Relations.

TEXT BOOKS:

1. Gas Dynamics, S.M. Yahya, New Age International Publishers, 5th Edition, 2016.
2. Gas Dynamics, V. Radhakrishnan, PHI Learning Pvt. Ltd., 2nd Edition, 2012.

REFERENCE BOOKS:

1. Gas Dynamics, Robert D. Zucker and Oscar Biblarz, Wiley, 2nd Edition, 2002.
2. Dynamics and Thermodynamics of Compressible Fluid Flow (Vol. I and II), Ascher H. Shapiro, Ronald Press Company, 1st Edition, 1953.
3. Elements of Gas Dynamics, H.W. Liepmann and A. Roshko, Dover Publications, Revised Edition, 2001.
4. Fundamentals of Gas Dynamics, V. Babu, Ane Books Pvt. Ltd., 1st Edition, 2008.
5. Modern Compressible Flow: With Historical Perspective, John D. Anderson Jr., McGraw Hill Education, 3rd Edition, 2002.
6. Compressible Fluid Dynamics, B.K. Hodge and Keith Koenig, Pearson Education, 1st Edition, 2004.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., II Year, I Semester****EQUIPMENT DESIGN FOR THERMAL SYSTEMS****(Professional Elective – V)**

L	T	P	C
3	0	0	3

Prerequisites: Advanced Heat and Mass Transfer**Course Objective:** The course is intended to,

1. To introduce the principles of thermal system design and component integration.
2. To study design methodologies for heat exchangers, boilers, condensers, and evaporators.
3. To apply thermal analysis, pressure drop, and material selection criteria in equipment design.
4. To understand mechanical and thermal stress considerations in thermal systems.
5. To develop skills in using design codes, standards, and software for thermal equipment design.

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

1. Understand the physics and the mathematical treatment of typical heat exchangers.
2. Apply LMTD and Effectiveness methods in the design of heat exchangers and analyze the importance of LMTD approach over AMTD approach.
3. Analyze the performance of double-pipe counter flow (hair-pin) heat exchangers.
4. Design and analyze the shell and tube heat exchanger.
5. Understand the fundamental, physical and mathematical aspects of boiling and condensation.

UNIT -I: Classification and Basic Design of Heat Exchangers

Classification of Heat Exchangers: Introduction, Recuperation and Regeneration, Tabular Heat Exchangers, Double Pipe, Shell and Tube Heat Exchanger, Plate Heat Exchangers, Extended Surface Heat Exchanger, Plate Fin and Tubular Fin.

Basic Design Methods Of Heat Exchanger: Introduction, Basic Equations in Design, Overall Heat Transfer Coefficient, LMTD Method for Heat Exchanger Analysis, Parallel Flow, Counter Flow, Multipass and Cross Flow Heat Exchanger Design Calculations.

UNIT-II: Design and Analysis of Heat Exchangers

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 of Shell and Tube Heat Exchangers.

UNIT-III: Condensation of Vapors in Heat Exchangers

Calculation of Horizontal Condenser, Vertical Condenser, De Super Heater Condenser, Vertical Condenser and Sub Cooler, Horizontal Condenser and Sub Cooler.

UNIT-IV: Extended Surface and Vaporizing Heat Exchanger Design

Vaporizing Processes, Forced Circulation Vaporizing Exchanger, Natural Circulation Vaporizing Exchangers, Calculations of a Reboiler. Extended Surfaces: Longitudinal Fins, Weighted Fin Efficiency Curve, Calculations 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 Exchangers and Heat Pipe Technologies

Cooling Towers, Relation between Wet Bulb and Dry Bulb Temperatures, Calculation of Cooling Tower Performance.

Heat Pipe: Gravity Assisted Thermo Syphons, Micro Heat Pipes, Pulsating Heat Pipes, Loop Heat Pipe Operation and Working Principles.

TEXT BOOKS:

1. Process Heat Transfer, D. Q. Kern, Tata McGraw-Hill (TMH), 1st Edition, 1950.
2. Heat Exchanger Design, Arthur P. Fraas, Mehmet N. Ozisik, John Wiley and Sons, New York, 1st Edition, 1985.

REFERENCE BOOKS:

1. Cooling Towers, J.D. Gurney and I.A. Cotter, Maclaren and Sons Ltd., 1st Edition, 1962.
2. Heat Pipe Science and Technology, Amir Faghri, Taylor and Francis, 1st Edition, 1995.
3. Heat Pipe Technology and Applications, J.P. Peterson, John Wiley and Sons, 1st Edition, 1994.
4. Process Equipment Design, M.V. Joshi and V.V. Mahajani, Macmillan India, 3rd Edition, 2009.
5. Mechanical Design of Heat Exchangers, Krishna P. Singh, Hemisphere Publishing, 1st Edition, 1990.
6. Compact Heat Exchangers, Kuppan Thulukkanam, CRC Press, 2nd Edition, 2013.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech., I Year, I Semester
ENGLISH FOR RESEARCH PAPER WRITING
(Audit Course - I)

L	T	P	C
2	0	0	0

Prerequisite: Basic English Grammar and Composition, Fundamentals of Technical Writing

Course objectives: Students will be able to:

1. To improve the quality and clarity of academic writing specifically for research papers.
2. To provide students with the structure, style, and conventions of scholarly communication.
3. To help students understand how to write titles, abstracts, introductions, literature reviews, methods, results, and conclusions effectively.
4. To guide students in avoiding common grammatical, structural, and ethical mistakes in writing.
5. To build competence in reviewing and editing research manuscripts for publication.

Course Outcomes: After the successful completion of this course, students will be able to:

1. Write grammatically correct, well-structured, and coherent research papers.
2. Use appropriate academic language and tone for different parts of a research article.
3. Construct effective titles, abstracts, and concise conclusions.
4. Apply standard referencing styles and avoid plagiarism.
5. Critically revise and refine research drafts for clarity and publication readiness.

UNIT-I: Effective Writing and Sentence Structuring

Planning And Preparation, Word Order, Breaking up Long Sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT-II: Academic Writing and Research Ethics

Clarifying Who Did What, Highlighting your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts and Introduction

UNIT-III: Research Paper Structure and Finalization

Review of the Literature, Methods, Results, Discussion, Conclusions and Final Check.

UNIT-IV: Essential Academic Writing Skills for Research Papers

Key Skills are needed when Writing a Title, Key Skills are needed when Writing an Abstract, Key Skills are needed when Writing an Introduction, Skills needed when writing a Review of the Literature.

UNIT-V: Advanced Research Writing Skills

Skills are needed when Writing the Methods, Skills needed when writing the Results, Skills are needed when writing the Discussion, and Skills are needed when writing the Conclusions.

UNIT-VI: Perfecting Your Research Paper

Useful Phrases, How to ensure Paper is as Good as it could possibly be the First Time Submission.

TEXT BOOKS:

1. Writing for Science, Robert Goldbort, Yale University Press, 1st Edition, 2006.
2. How to Write and Publish a Scientific Paper, Robert A. Day and Barbara Gastel, 6th Edition (Cambridge University Press), 2006.

REFERENCE BOOKS

1. Handbook of Writing for the Mathematical Sciences, Nicholas J. Higham, SIAM, 2nd Edition, 1998.
2. English for Writing Research Papers, Adrian Wallwork, Springer, 1st Edition, 2011.
3. How to Write and Publish a Scientific Paper, Barbara Gastel, Robert A. Day, Cambridge University Press, 8th Edition, 2016
4. The Elements of Style, William Strunk Jr., E.B. White, Pearson Education, 4th Edition, 2000
5. Scientific Writing and Communication: Papers, Proposals, and Presentations, Angelika H. Hofmann, Oxford University Press, 3rd Edition, 2016
6. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded, Joshua Schimel, Oxford University Press, 1st Edition, 2012

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech., I Year, I Semester
DISASTER MANAGEMENT
(Audit Course - I)

L	T	P	C
2	0	0	0

Prerequisite: Environmental Science, Basic Geography or Earth Science

Course Objectives: Students will be able to

1. To introduce the concepts, phases, and classifications of disasters and disaster management.
2. To develop an understanding of disaster risk reduction and mitigation strategies.
3. To impart knowledge on institutional frameworks, legal aspects, and community-based approaches.
4. To build the ability to assess risks and prepare emergency management plans.
5. To create awareness about post-disaster recovery, rehabilitation, and resilience planning.

Course Outcomes: After the successful completion of this course, students will be able to

1. Identify different types of natural and man-made disasters and their causes.
2. Analyze risk factors and develop suitable mitigation and preparedness strategies.
3. Understand the role of government agencies, NGOs, and international bodies in disaster management.
4. Apply principles of emergency response planning and coordination.
5. Contribute to post-disaster rehabilitation and sustainable development planning.

UNIT-I: Disaster

Definition, Factors and Significance, Difference between Hazard and Disaster, Natural and Manmade Disasters, Difference between Nature Types and Magnitude.

UNIT-II: Repercussions of Disasters and Hazards

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches. Man made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III: Disaster Prone Areas in India

Study of Seismic Zones, Areas Prone to Floods and Droughts, Landslides and Avalanches, Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami, Post Disaster Diseases and Epidemics

UNIT-IV: Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard, Evaluation of Risk, Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V: Risk Assessment Disaster Risk

Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation, Techniques of Risk Assessment, Global Co- Operation in Risk Assessment and Warning, People's Participation in Risk Assessment, Strategies for Survival.

UNIT-VI: Disaster Mitigation

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

TEXT BOOKS:

1. Disaster Management in India: Perspectives, Issues and Strategies, R. Nishith and A. K. Singh, New Royal Book Company, 1st Edition, 2007
2. Disaster Mitigation: Experiences and Reflections, Pardeep Sahni et al. (Eds.), Prentice Hall India, 1st Edition, 2001

REFERENCE BOOKS:

1. Disaster Administration and Management: Text and Case Studies, S. L. Goel, Deep and Deep Publications, 1st Edition, 2007.
2. Introduction to International Disaster Management, Damon P. Coppola, Butterworth-Heinemann, 3rd Edition, 2015.
3. Disaster Management and Preparedness, Thomas D. Schneid, Larry Collins, CRC Press, 1st Edition, 2001.
4. Disaster Science and Management, Tushar Bhattacharya, McGraw Hill Education, 1st Edition, 2013.
5. Natural Disasters, Patrick L. Abbott, McGraw Hill Education, 9th Edition, 2016.
6. Environmental Hazards: Assessing Risk and Reducing Disaster, Keith Smith, Routledge, 6th Edition, 2013.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M. Tech., I Year, I Semester****SANSKRIT FOR TECHNICAL KNOWLEDGE****(Audit Course - I)**

L	T	P	C
2	0	0	0

Prerequisite: Basic understanding of Indian heritage and classical languages**Course Objectives:**

1. To expose students to Sanskrit as a classical language of knowledge and science.
2. To introduce technical terms and concepts embedded in ancient Sanskrit texts.
3. To enable understanding of foundational texts related to mathematics, engineering, and philosophy.
4. To build linguistic skills for reading and interpreting original Sanskrit sources.
5. To appreciate the relevance of Sanskrit in the context of modern scientific discourse.

Course Outcomes: Students will be able to

1. Understand the structure and grammar of Sanskrit relevant to technical usage.
2. Recognize and interpret key technical terms and concepts from ancient Sanskrit literature.
3. Translate and explain Sanskrit verses that relate to scientific and engineering disciplines.
4. Develop an interdisciplinary perspective connecting ancient wisdom with contemporary science.
5. Appreciate the contribution of Sanskrit to Indian scientific, philosophical, and cultural heritage.

UNIT-I:

Alphabets in Sanskrit,

UNIT-II:

Past / Present / Future Tense, Simple Sentences

UNIT-III:

Order, Introduction of Roots,

UNIT-IV:

Technical Information about Sanskrit Literature

UNIT-V:

Technical Concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TEXT BOOKS:

1. Abhyaspustakam, Dr. H. R. Vishwasa, Samskrita Bharati Publication, New Delhi, 1st Edition, 2012.
2. Teach Yourself Sanskrit: Prathama Diksha, edited by Vempati Kutumbashastri, Rashtriya Sanskrit Sansthanam, New Delhi, 1st Edition, 2002.

REFERENCE BOOKS:

1. Technical Literature in Sanskrit, S. Balachandra Rao, Rashtriya Sanskrit Vidyapeetha, 1st Edition, 2005.
2. Sanskrit and Science, Prabhakar Apte, Central Institute of Indian Languages, 1st Edition, 2003.
3. Scientific Heritage of India in Sanskrit, R. Ganapathi, Bharatiya Vidya Bhavan, 1st Edition, 1990.
4. Sanskrit and Artificial Intelligence, Rick Briggs, AI Magazine (Journal Paper), 1st Edition, 1985.
5. Essentials of Sanskrit Language for Engineering Students, M. Sampath Kumar, Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya, 1st Edition, 2010.
6. Vyavaharika Samskritam (Functional Sanskrit), R.S. Vadhyar, R.S. Vadhyar and Sons, 3rd Edition, 2008.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M. Tech., I Year, I Semester****VALUE EDUCATION**

L	T	P	C
2	0	0	0

(Audit Course - I)**Prerequisite:** Basic Understanding of Ethics and Social Responsibility**Course Objectives:** Students will be able to

1. To help students understand the importance of values in personal and professional life.
2. To promote ethical behavior and decision-making based on human values.
3. To develop a sense of responsibility, empathy, and integrity.
4. To cultivate respect for diversity, equality, and sustainable living.
5. To encourage self-reflection and a commitment to lifelong value-based learning.

Course Outcomes: Students will be able to

1. Recognize and apply core human values such as honesty, compassion, and respect.
2. Analyze ethical dilemmas and make morally sound decisions.
3. Demonstrate socially responsible behavior in both personal and professional contexts.
4. Promote harmony in relationships, society, and the environment.
5. Engage in continuous personal development guided by ethical principles.

UNIT-I: Values and Ethics

Values and Self-Development, Social Values and Individual Attitudes, Work Ethics, Indian Vision of Humanism, Moral and Non- Moral Valuation, Standards and Principles, Value Judgements.

UNIT-II: Core Personal Values

Importance of Cultivation of Values, Sense of Duty, Devotion, Self-Reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of Faith, National Unity, Patriotism, Love for Nature, Discipline.

UNIT-III: Personality Traits

Personality and Behavior Development, Soul and Scientific Attitude, Positive Thinking, Integrity and Discipline, Punctuality, Love and Kindness.

UNIT-IV: Virtuous Living

Avoid Fault Thinking, Free from Anger, Dignity of Labour, Universal Brotherhood and Religious Tolerance, True Friendship, Happiness vs Suffering, Love for Truth, Aware of Self-Destructive Habits, Association and Cooperation, Doing Best for Saving Nature.

UNIT-V: Character and Wisdom

Character and Competence, Holy Books vs Blind Faith, Self-Management and Good Health, Science of Reincarnation, Equality, Nonviolence, Humility, Role of Women, All Religions and Same Message, Mind Your Mind, Self-Control, Honesty, Studying Effectively.

TEXT BOOKS:

1. Values and Ethics for Organizations: Theory and Practice, S. K. Chakraborty, Oxford University Press, 1st Edition, 1998 (paperback reprint 1999).
2. Value Education and Professional Ethics, R.R. Gaur, R. Sangal, G.P. Bagaria, Excel Books, 1st Edition, 2010.

REFERENCE BOOKS:

1. Education in Values: A Source Book, UNESCO, NCERT Publication, 1st Edition, 2002.
2. Value Education: Principles and Practice, S. Ignacimuthu, Don Bosco Publications, 1st Edition, 2009.
3. Value Education: Theory and Practice, G. Rajagopalan, Bharatiya Vidya Bhavan, 1st Edition, 2011.
4. Education for Values in Schools – A Framework, NCERT, NCERT Publication, 1st Edition, 2012.
5. Education in Human Values, A.C. Bhaktivedanta Swami Prabhupada, Bhaktivedanta Book Trust, 1st Edition, 2001.
6. Teaching of Values: Some Reflections, M. M. Goel, Shipra Publications, 1st Edition, 2005.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech., I Year, II Semester
CONSTITUTION OF INDIA
(Audit Course - II)

L	T	P	C
2	0	0	0

Prerequisite: Basic knowledge of Indian history and Governance

Course Objectives:

1. To provide a comprehensive understanding of the Indian Constitution, its structure, and significance.
2. To familiarize students with the fundamental rights, duties, and directive principles.
3. To introduce the key organs of government and their roles in a democratic system.
4. To promote awareness of constitutional values, governance mechanisms, and public responsibility.
5. To understand the relationship between the Constitution and the legal-administrative framework of India.

Course Outcomes: Students will be able to:

1. Describe the history, evolution, and philosophy behind the Constitution of India.
2. Explain the fundamental rights and duties of citizens and the structure of the Indian government.
3. Analyze the functioning of constitutional bodies and judicial systems.
4. Understand the significance of constitutional amendments and landmark legal cases.
5. Demonstrate responsible citizenship and awareness of constitutional governance

UNIT-I: Constitution Drafting History

History of Making of the Indian Constitution, History Drafting Committee, (Composition and Working)

UNIT-II: Constitutional Philosophy

Philosophy of the Indian Constitution, Preamble, Salient Features

UNIT-III: Rights and Duties Framework

Contours of Constitutional Rights and Duties, Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-IV: Organs of Governance

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions

UNIT-V: Local Administration

District's Administration Head, Role and Importance. Municipalities: Introduction, Mayor and Role of Elected Representative, CEO of Municipal Corporation. Panchayat Raj: Introduction, PRI: Zila Panchayat, Elected Officials and their Roles, CEO Zila Panchayat, Position and Role, Block Level, Organizational Hierarchy (Different Departments), Village Level, Role of Elected and Appointed Officials, Importance of Grass Root Democracy.

UNIT-VI: Election Commission

Role and Functioning, Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and Women.

TEXT BOOKS:

1. The Constitution of India (Bare Act), Government Publication, 1st Edition, 1950.
2. Dr. B. R. Ambedkar: Framing of Indian Constitution, Dr. S. N. Busi, Ava Publications, 1st Edition, 2016.

REFERENCE BOOKS:

1. Introduction to the Constitution of India, M. P. Jain, LexisNexis, 7th Edition, 2014.
2. Introduction to the Constitution of India, D. D. Basu, LexisNexis, 22nd Edition, 2015.
3. Indian Polity, M. Laxmikanth, McGraw Hill Education, 6th Edition, 2021.
4. Our Constitution, Subhash Kashyap, National Book Trust, 1st Edition, 2011.
5. The Constitution of India: A Contextual Analysis, Arun K. Thiruvengadam, Bloomsbury Publishing, 1st Edition, 2017.
6. The Constitution of India, P.M. Bakshi, Universal Law Publishing, 17th Edition, 2020.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech., I Year, II Semester
PEDAGOGY STUDIES
(Audit Course - II)

L	T	P	C
2	0	0	0

Prerequisite: Basic understanding of Teaching-Learning processes

Course Objectives:

1. To understand the concepts, principles, and theories of pedagogy and their application.
2. To evaluate the effectiveness of different teaching approaches in varied educational contexts.
3. To analyze the impact of teacher behavior, classroom environment, and instructional strategies on learning.
4. To assess the challenges in implementing pedagogical innovations in diverse settings.
5. To enable the design of learner-centered, inclusive, and effective educational practices.

Course Outcomes: Students will be able to understand

1. Explain key pedagogical theories and their relevance to classroom teaching.
2. Compare traditional and modern teaching strategies based on evidence from research.
3. Identify factors affecting student engagement, motivation, and learning outcomes.
4. Design instructional plans that incorporate effective pedagogical principles.
5. Critically evaluate and adapt teaching practices to meet diverse learner needs.

UNIT-I: Pedagogical Foundations

Introduction and Methodology, Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

UNIT-II: Global Pedagogical Practices

Thematic Overview, Pedagogical Practices are being used by Teachers in Formal and Informal Classrooms in Developing Countries, Curriculum, Teacher Education.

UNIT-III: Effective Pedagogy Evidence

Evidence on the Effectiveness of Pedagogical Practices, Methodology for the Indepth Stage, Quality Assessment of Included Studies, How Can Teacher Education (Curriculum and Practicum) and the School Curriculum and Guidance Materials best Support Effective Pedagogy, Theory of Change, Strength and Nature of the body of Evidence for Effective Pedagogical Practices, Pedagogic Theory and Pedagogical Approaches, Teachers' Attitudes and Beliefs and Pedagogic Strategies.

UNIT-IV: Professional development

Alignment with Classroom Practices and Follow-Up Support, Peer Support, Support from the Head Teacher and the Community, Curriculum and Assessment, Barriers to Learning, Limited Resources and Large Class Sizes.

UNIT-V: Future Pedagogical Research

Research Gaps and Future Directions, Research Design, Contexts, Pedagogy, Teacher Education, Curriculum and Assessment, Dissemination and Research Impact.

TEXT BOOKS:

1. Classroom interaction in Kenyan primary schools Ackers, J., and Hardman, F., Compare a Journal of Comparative and International Education, Volume 31, 2001.
2. Curricular reform in schools: The importance of evaluation, Agrawal, M, Journal of Curriculum Studies, Volume 36, 2003.

REFERENCE BOOKS:

1. Teacher training in Ghana - does it count? , Akyeampong, K, Multi-site teacher education research project (MUSTER) country report 1. Department for International Development (DFID), London, 1st Edition, 2003.
2. How Learning Works: Seven Research-Based Principles for Smart Teaching, Susan A. Ambrose, Jossey-Bass, 1st Edition, 2010.
3. Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement, John Hattie, Routledge, 1st Edition, 2009.
4. Teaching for Quality Learning at University, John Biggs, Catherine Tang, McGraw-Hill Education, 4th Edition, 2011.
5. The Skillful Teacher: On Technique, Trust, and Responsiveness in the Classroom, Stephen D. Brookfield, Jossey-Bass, 3rd Edition, 2015.
6. Learning Theories: An Educational Perspective, Dale H. Schunk, Pearson Education, 7th Edition, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M. Tech., I Year, II Semester
STRESS MANAGEMENT BY YOGA**

L	T	P	C
2	0	0	0

(Audit Course - II)

Prerequisite: Basic awareness of mental and physical health

Course Objectives:

1. To introduce the concept of stress and its impact on physical and mental well-being.
2. To provide an understanding of yoga as a tool for stress relief and emotional balance.
3. To teach various yogic practices including asanas, pranayama, and meditation for managing stress.
4. To cultivate self-awareness, relaxation, and resilience through regular yogic practice.
5. To promote a healthy lifestyle by integrating yogic discipline in daily life.

Course Outcomes: Students will be able to:

1. Understand the causes and physiological effects of stress.
2. Apply basic yogic techniques to reduce stress and enhance focus.
3. Practice breathing techniques and meditation to maintain emotional stability.
4. Demonstrate improved physical flexibility, mental clarity, and stress tolerance.
5. Incorporate yoga as a sustainable approach to managing academic, professional, and personal pressures.

UNIT-I:

Definitions of Eight parts of yoga. (Ashtanga)

UNIT-II:

Yam and Niyam.

UNIT-III: Do`s and Dont`s in Life

Ahinsa, Satya, Astheya, Bramhacharya and Aparigraha. Shaucha, Santosh, Tapa, Swadhyay, Ishwarpranidhan

UNIT-IV:

Aasan and Pranayam

UNIT-V:

Various Yoga Poses and their Benefits for Mind and Body. Regularization of Breathing Techniques and its Effects, Types of Pranayam

TEXT BOOKS:

1. Yogic Asanas for Group Training – Part I, Janardan Swami Yogabhyasi Mandal, Janardan Swami Yogabhyasi Mandal, Nagpur, Standard Edition, 1990.
2. Rajayoga or conquering the Internal Nature, Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata, 2010.

REFERENCE BOOKS:

1. The Heart of Yoga: Developing a Personal Practice, T.K.V. Desikachar, Inner Traditions, 1st Edition, 1999.
2. Yoga for Stress Relief, Swami Shivapremananda, Jaico Publishing House, 1st Edition, 2002.
3. Light on Yoga, B.K.S. Iyengar, HarperCollins, Revised Edition, 2015.
4. The Relaxation Response, Herbert Benson, HarperTorch, Updated Edition, 2000.
5. Yoga for Wellness, Shri Yogendra, The Yoga Institute, 1st Edition, 2001.
6. Yoga as Medicine, Timothy McCall, Bantam Books, 1st Edition, 2007.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech., I Year, II Semester
PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS
(Audit Course - II)

L	T	P	C
2	0	0	0

Prerequisite: Basic Communication and Interpersonal skills

Course Objectives:

1. To understand the concept of personality and its development through ethical and moral grounding.
2. To enhance self-awareness, confidence, and emotional intelligence.
3. To inculcate life-enlightening values drawn from Indian wisdom and philosophy.
4. To improve communication, leadership, and decision-making abilities.
5. To promote a positive attitude and holistic approach toward life and career.

Course Outcomes: Students will be able to

1. Explain the key elements of personality and factors influencing its growth.
2. Demonstrate improved self-confidence, empathy, and interpersonal relationships.
3. Apply principles from enlightened texts (e.g., Bhagavad Gita, Upanishads) to everyday decision-making.
4. Exhibit qualities of ethical leadership and responsible citizenship.
5. Lead a balanced, purposeful, and value-driven personal and professional life.

UNIT-I:

Neetisatakam-Holistic development of personality

1. Verses- 19,20,21,22 (wisdom)
2. Verses- 29,31,32 (pride and heroism)
3. Verses- 26,28,63,65 (virtue)

UNIT-II:

Neetisatakam-Holistic development of personality

1. Verses- 52,53,59 (don't's)
2. Verses- 71,73,75,78 (do's)

UNIT-III:

Approach to day-to-day work and duties.

1. Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
2. Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
3. Chapter 18-Verses 45, 46, 48.

UNIT-IV:

Statements of basic knowledge.

1. Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
2. Chapter 12 -Verses 13, 14, 15, 16,17, 18
3. Personality of Role model. Shrimad Bhagwad Geeta:

UNIT-V:

1. Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
2. Chapter 4-Verses 18, 38,39
3. Chapter18 – Verses 37,38,63

TEXT BOOKS:

1. Srimad Bhagavad Gita, Swami Swarupananda, Advaita Ashram (Publication Department), Kolkata, 2018.
2. Bhartrihari's Three Satakas, (Niti-sringar-vairagya), P. Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi, 1st Edition, 2002.

REFERENCE BOOKS:

1. Awakening the Giant Within, Anthony Robbins, Free Press, 1st Edition, 1992
2. The 7 Habits of Highly Effective People, Stephen R. Covey, Simon and Schuster, 30th Anniversary Edition, 2020
3. Wings of Fire: An Autobiography, A.P.J. Abdul Kalam, Universities Press, 30th Impression, 2014
4. Living with the Himalayan Masters, Swami Rama, Himalayan Institute Press, Revised Edition, 2002
5. The Monk Who Sold His Ferrari, Robin Sharma, Jaico Publishing House, 1st Edition, 1997
6. The Power of Now, Eckhart Tolle, New World Library, 1st Edition, 1999.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., II Year, I Semester****WASTE TO ENERGY TECHNOLOGIES****(Open Elective)**

L	T	P	C
3	0	0	3

Prerequisites: Renewable Energy Engineering and Technology**Course Objectives:**

1. Understand classifications and characteristics of different waste materials as fuels for energy production.
2. Learn various thermo-chemical conversion technologies including pyrolysis, gasification, and combustion of biomass and waste.
3. Study design, operation, and applications of biogas plants and anaerobic digestion processes.
4. Explore biochemical conversion techniques and production of biofuels like bioethanol and biodiesel.
5. Analyze urban waste-to-energy conversion methods and national biomass energy programs.

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

1. Classify waste materials and select appropriate conversion devices for energy recovery.
2. Explain pyrolysis and gasification processes, their types, and applications in waste-to-energy systems.
3. Describe biomass combustion technologies and improved stove designs for efficient energy use.
4. Understand biogas generation, plant design, and biomass resource management.
5. Evaluate biochemical conversion, biofuel production, and urban waste energy applications.

UNIT – I: Waste as Energy Resource and Conversion Technologies

Classification of Waste as Fuel: Agro-Based, Forest Residue, Industrial Waste, Municipal Solid Waste (MSW). Overview of Waste-to-Energy Technologies: Incinerators, Gasifiers, Digesters, and Other Conversion Devices.

UNIT – II: Thermochemical Conversion – Pyrolysis and Gasification

Pyrolysis: Types (Slow and Fast), Manufacture of Charcoal, Pyrolytic Oils and Gases – Yields and Applications. Biomass Gasification: Types of Gasifiers (Fixed Bed, Downdraft, Updraft, Fluidized Bed), Design and Operation. Gasifier Burner and Engine Arrangements, Equilibrium and Kinetic Aspects of Gasification.

UNIT – III: Biomass Combustion and Improved Devices

Biomass Stoves and Improved Chullahs: Types and Designs. Fixed Bed Combustors, Inclined Grate Combustors, Fluidized Bed Combustors: Design Principles, Construction and Operation. Operational Aspects and Efficiency Considerations of Biomass Combustors.

UNIT – IV: Biogas Production and Technologies

Biogas Properties: Calorific Value and Composition. Biogas Plant Technology: Design, Construction, and Current Status. Biomass Resources: Types and Classification. Biomass Conversion Processes: Anaerobic Digestion Mechanisms and Biochemical Pathways.

UNIT – V: Biochemical Conversion and Urban Waste to Energy

Thermochemical Conversion Processes: Combustion, Gasification, Pyrolysis, Liquefaction. Biochemical Conversion: Anaerobic Digestion and Biogas Plants. Bioethanol and Biodiesel Production from Biomass. Technologies and Strategies for Urban Waste to Energy Conversion. Overview of Biomass Energy Programs in India.

TEXT BOOKS:

1. Non-Conventional Energy, Ashok V. Desai, Wiley Eastern Ltd., 1st Edition, 1990.
2. Biogas Technology – A Practical Handbook, Vol. I and II, K.C. Khandelwal and S.S. Mahdi, Tata McGraw-Hill Publishing Co. Ltd., 1st Edition, 1983.

REFERENCE BOOKS:

1. Food, Feed and Fuel from Biomass, D.S. Challal, IBH Publishing Co. Pvt. Ltd., 1st Edition, 1991.
2. Biomass Conversion and Technology, C.Y. WereKo-Brobby and E.B. Hagan, John Wiley and Sons, 1st Edition, 1996.
3. Renewable Energy Engineering and Technology: Principles and Practice, V.V.N. Kishore, TERI Press, 1st Edition, 2009.
4. Biomass to Renewable Energy Processes, Jay Cheng, CRC Press, 2nd Edition, 2017.
5. Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, Gary C. Young, Wiley, 1st Edition, 2010.
6. Anaerobic Digestion – Making Biogas – Making Energy: The Earthscan Expert Guide, Tim Pullen, Routledge, 1st Edition, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., II Year, I Semester
THERMAL MANAGEMENT IN ELECTRONICS
(Open Elective)

L	T	P	C
3	0	0	3

Prerequisites: Heat Transfer and Thermodynamics

Course objectives:

1. Explain the need and significance of thermal management in electronic systems.
2. Introduce heat generation mechanisms in electronic devices and systems
3. Analyze various cooling techniques including conduction, convection, and radiation-based methods.
4. Explore advanced cooling solutions such as heat pipes, phase change materials, liquid cooling, and Nano fluids.
5. Provide the ability to model, simulate, and design thermal management systems for electronic.

Course Outcomes: Upon successful completion of this course, the student will be able to

1. Introduction to Working principles, modelling, and design of thermal management systems for electronics
2. Understand the purpose of Heat sinks, heat pipes, microchannel heat exchangers, thermoelectric devices.
3. Understand the importance of thermal management of electronics for various applications, including Space applications.
4. Evaluate and design advanced phase-change thermal management systems such as heat pipes and immersion cooling for high-performance electronics.
5. Analyze and apply thermoelectric and radiation cooling techniques for specialized applications, including space and remote electronic systems.

UNIT -I: Packaging and Cooling Technologies

Packaging and Cooling Technologies, Trends and Challenges, Cooling Load of Electronic Equipment in a Thermal Environment, Thermal Consideration in Chip Carrier, Passive and Active Methods of Cooling, Properties of Materials used in Electronics and Equipment, Fabrication Techniques, Equipment Level, Cabinet Level, Board Level and Chip or Component Level.

UNIT-II: Conduction Cooling and Thermal Resistance

Conduction Cooling, Thermal Resistance and Resistance Networks, Conduction in Chip Carriers, Conduction in PCB, Heat Frames and Synthetic Jets.

UNIT- III: Convection Cooling and Heat Sink Design

Design Application of Natural and Forced Convection Cooling in Thermal Management, Optimization of Heat Sinks and Metal Foams, Fan Selection, Liquid Cooled Heat Sinks, Mini and Micro Channel Heat Exchangers, Fluid Selection, Jet Impingement Technique.

UNIT -IV: Phase Change Cooling and Heat Pipes

Phase Change Methods, Heat Pipes and their Principles and Types, Limits of Heat Pipe, Thermal Resistance, Design Procedure, Applications Case Studies and Advancements, Space Applications, Thermal Management of Satellites, Immersion Cooling.

UNIT- V: Thermoelectric and Radiation Cooling

Design Procedure of Peltier and Seebeck Elements for Thermal Management, Figure of Merits, Current, Voltage and Power Matching of Thermoelectric Modules, Radiation Cooling in Space Electronics.

TEXT BOOKS:

1. Heat Transfer: Thermal Management of Electronics, Younes Shabany, CRC Press, 1st Edition, 2009.
2. Thermal Measurements in Electronics Cooling, Kaveh Azar, CRC Press, 1st Edition, 1997.

REFERENCE BOOKS:

1. Heat Pipes: Theory, Design and Applications, D. Reay, P. Kew, R. McGlen, Butterworth-Heinemann, 6th Edition, 2014.
2. Electronics Cooling, S. M. Sohel Murshed and Carlos R. de S. Pereira, CRC Press, 1st Edition, 2016.
3. Thermal Management of Electronics: Conductive, Radiative and Convective Air Cooling, Younes Shabany, CRC Press, 1st Edition, 2010.
4. Thermal Design and Thermal Behaviour of Radio and Electronic Components, Anatoliï K. Katsman, Springer, 1st Edition, 2005.
5. Thermal Management Handbook for Electronic Assemblies, Jerry E. Sergent and Al Krum, McGraw Hill, 1st Edition, 1998.
6. Thermal Computations for Electronics: Conductive, Radiative, and Convective Air Cooling, Gordon Ellison, CRC Press, 2nd Edition, 2011.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech., II Year, I Semester
ALTERNATE FUELS
(Open Elective)

L	T	P	C
3	0	0	3

Prerequisites: Internal Combustion Engines and Thermodynamics

Course Objectives:

1. To introduce the need and significance of alternate fuels in reducing dependency on fossil fuels.
2. To study the properties, production methods, and utilization of various alternate fuels.
3. To analyze engine performance and emissions when using alternate fuels.
4. To explore blending techniques, retrofitting, and material compatibility.
5. To assess techno-economic and environmental feasibility of alternate fuel applications.

Course Outcomes:

1. Identify various alternate fuels such as biofuels, alcohols, hydrogen, CNG, LPG, and synthetic fuels.
2. Evaluate combustion characteristics and suitability of alternate fuels in IC engines.
3. Analyse engine modifications and fuel systems required for alternate fuel usage.
4. Assess emission characteristics and environmental impacts of alternate fuels.
5. Recommend suitable alternate fuels for specific applications based on performance, availability, and cost.

UNIT-I: Introduction to Alternate Fuels

Need For Alternate Fuels In Internal Combustion Engines, Desirable Characteristics Of Good Alternate Fuel, Environmental and Economic Considerations, Overview of Global and Indian Energy Scenario, Fuel Characteristics and Comparison with Conventional Fuels.

Alcohols as Fuels: Methanol, Ethanol, Properties, Production from Biomass, Engine Modifications for Alcohol Fuels, Performance, Combustion and Emissions Characteristics.

UNIT-II: Gaseous Fuels and Biodiesel

Hydrogen, Natural Gas, Biogas, Producer Gas, LPG, Properties, Production Methods, Storage, Handling and Safety Aspects and their use in SI And CI Engines, Performance and Emission Characteristics.

Biodiesel and Vegetable Oils: Soya Been Oil, Jatropha, Pongamia, Rice Bran, Mahua etc., as Alternate Fuel and their Properties, Esterification of Oils, Natural Gas, LPG, Availability of CNG, Properties, Modification Required to use in Engines.

UNIT-III: Hydrogen as an IC Engine Fuel

Production Methods: Electrolysis, Thermochemical, Photochemical, Storage and Safety Issues, use in Spark Ignition and Compression Ignition Engines, Performance, Combustion and Emissions.

Other Alternative Fuels: Algae-Based Fuels, Synthetic Fuels and E-Fuels.

UNIT-IV: Emission Control and after treatment

Emissions from Alternative Fuels, NOX, Particulate Matter, CO, HC Control Strategies, Catalytic Converters and Particulate Filters.

UNIT-V: Alternative Fuel Standards and Regulations

Fuel Quality Standards (ASTM, BIS, Etc.), Emission Norms (BS-VI, Euro Norms), Policy and Regulatory Framework in India and Globally.

TEXT BOOKS:

1. Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance, Richard Folkson, Woodhead Publishing, 1st Edition, 2014.
2. Alternative Fuels and Advanced Vehicle Technologies, K. Venkateswarlu, B. S. R. Murthy, PHI Learning, 1st Edition, 2013.

REFERENCE BOOKS:

1. Fuels and Combustion, Samir Sarkar, Orient Longman (now Universities Press), 3rd Edition, 2009.
2. Internal Combustion Engines, V. Ganesan, Tata McGraw-Hill, 4th Edition, 2012.
3. SAE Technical Papers on Alternate Fuels, Society of Automotive Engineers (SAE International), Various Editions.
4. Alternative Fuels: The Future of Hydrogen, Michael Frank Horddeski, CRC Press, 2nd Edition, 2008.
5. Fuels and Combustion, Samir Sarkar, Universities Press, 3rd Edition, 2009.
6. Alternative Fuels and Emissions, Michael F. Horddeski, The Fairmont Press, 2nd Edition, 2008.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**M.Tech., II Year, I Semester****BASICS OF REFRIGERATION SYSTEMS****(Open Elective)**

L	T	P	C
3	0	0	3

Prerequisites: Heat Transfer and Basic Knowledge of Refrigerants**Course Objectives:**

1. To understand the principles of refrigeration.
2. To understand different vapor Absorption systems.
3. To know Aircraft Air refrigeration systems.
4. To gain knowledge about refrigerants.
5. Ozone depletion potential and global warming potential.

Course Outcomes: On successful completion of the course, the student will be able to:

1. Illustrate the basic concepts of refrigeration system.
2. Analyze the vapour compression cycle and interpret the usage of refrigerants.
3. Explain the components of vapour absorption system.
4. Demonstrate the use of refrigerants.
5. Discuss the theory Ozone depletion potential and global warming potential.

UNIT- I: Refrigerants and Properties

Desirable Properties, Thermo Dynamic, Chemical and Transport Properties, Designation of Refrigerants, Inorganic, Halo Carbon Refrigerants, Secondary Refrigerants, Properties of Mixtures of Refrigerants.

UNIT- II: Vapor Compression Cycle Analysis

Analysis of Vapor Compression Refrigeration Cycle, Reversed Carnot Cycle for Vapour, Effect of Suction Temperature and Condensing Temperature on Cycle Performance Practical Refrigeration Cycle, Sub-Cooled Liquid and Super-Heated Vapor Refrigeration Cycles their Effect on Performance.

UNIT- III: Vapor Absorption Refrigeration Systems

Simple Vapor Absorption Systems, Actual Vapor Absorption Cycle, Representation of the Cycle on T-S Diagram, Common Refrigerant Systems, Practical Single Effect Water, Lithium Bromide Absorption System, Double Effect System Electrolux Refrigerator, Newer Mixtures for Absorption Systems.

UNIT- IV: Alternative Refrigeration Systems

Aircraft Air Refrigeration and their Functions, Working Conditions, Types, Steam Jet Water Vapor Systems, Thermoelectric Refrigeration Systems, Vortex Refrigeration System and Pulse Tube Refrigeration.

UNIT- V: Refrigerants Impact and Alternatives

Ozone Depletion Potential and Global Warming Potential, Effect of Refrigerants, Alternative Refrigerants and Newer Refrigerants.

TEXT BOOKS:

1. Refrigeration and Air Conditioning, F. Stoecker, Jerold W. Jones, McGraw-Hill International, 1st Edition, 1982.
2. Refrigeration and Air Conditioning, C. P. Arora, Tata McGraw-Hill, 3rd Edition, 2000.

REFERENCE BOOKS:

1. Refrigeration and Air Conditioning, Manohar Prasad, New Age International Publishers, Revised Edition, 2011.
2. Principles of Refrigeration, Roy J. Dossat, Pearson Education, 4th Edition, 1997.
3. Refrigeration and Air Conditioning, A. Gosney, Oxford University Press, 1st Edition, 1980.
4. Principles of Refrigeration, Roy J. Dossat and Thomas H. Stoecker, Pearson Education, 5th Edition, 2002.
5. Basic Refrigeration and Air Conditioning, P.N. Ananthanarayanan, McGraw Hill, 3rd Edition, 2013.
6. Refrigeration and Air Conditioning Technology, William C. Whitman, William M. Johnson and John A. Tomczyk, Cengage Learning, 8th Edition, 2017.