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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH. (THERMAL ENGINEERING)

EFFECTIVE FROM ACADEMIC YEAR 2019- 20 ADMITTED BATCH

R19 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 Fluid Mechanics	3	0	0	3
Professional Elective - I	1. Fuels & Combustion 2. Alternate Fuels & Pollution 3. Advanced Fuel Cell Technologies	3	0	0	3
Professional Elective - II	1. Computational Fluid Dynamics 2. Turbulence Modelling 3. Nano Fluids	3	0	0	3
MC	Research Methodology & IPR	2	0	0	2
Lab - I	Computational Methods Lab	0	0	4	2
Lab - II	Advanced Fluid Mechanics Lab	0	0	4	2
Audit - I	Audit Course-II	2	0	0	0
	Total Credits	**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	Advanced Heat and Mass Transfer	3	0	0	3
Professional Elective - III	1. Advanced Finite Element and Boundary Element Methods 2. Optimization Techniques & Applications 3. Numerical Methods for Engineers	3	0	0	3
Professional Elective - IV	1. Thermal & Nuclear Power Plants 2. Renewable Energy Sources 3. Energy Conservation & Management	3	0	0	3
	Mini Project with Seminar	0	0	4	2
Lab - III	Advanced I.C. Engines Lab	0	0	4	2
Lab - IV	Advanced Heat & Mass Transfer Lab	0	0	4	2
Audit - II	Audit Course-II	2	0	0	0
	Total Credits	**14**	**0**	**12**	**18**

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Audit Course 1 & 2:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by yoga
8. Personality Development Through Life Enlightenment Skills

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

ADVANCED THERMODYNAMICS (Professional Core - I)

Prerequisites: Thermodynamics

Course Objectives: The course is intended to

- Provide analytical methods for the determination of the direction of processes from the first and second laws of thermodynamics and to Introduce methods in using equations of potentials, availability, and excergy for thermodynamic analysis
- Gain the knowledge on non-reactive mixture properties, Psychometric Mixture properties and psychometric chart and Air conditioning processes
- Develop the ability of analyzing vapor and Gas power cycles
- Provide in depth knowledge of Direct Energy Conversion of Fuel Cells, Thermo electric energy, Thermionic power generation, Thermodynamic devices Magneto Hydrodynamic Generations and Photo voltaic cells
- Develop communication and teamwork skills in the collaborative course project

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

- Explain basic thermodynamic concepts and laws
- Describe the concepts entropy and excergy and their use in analyses of thermal energy systems
- Analyze power plants, refrigeration plants and thermal/chemical installations
- Evaluate means for minimizing excergy losses in selected processes
- Use advanced thermodynamics on a research case

UNIT - I
REVIEW OF 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
P.V.T SURFACE: Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius-Clapeyro equation. 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. 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: Review binary vapour cycle, co generation and combined cycles, Second law analysts of cycles. Refrigeration cycles, Thermodynamics of irreversible processes. Introduction, Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

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UNIT- V:

DIRECT ENERGY CONVERSION INTRODUCTION: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells.

TEXT BOOKS:

1. Basic and Applied Thermodynamics by P. K. Nag, TMH
2. Engineering Thermodynamics by Rogers & Mayhew, Pearson
3. Thermodynamics by Holman, Mc Graw Hill.

REFERENCE BOOKS:

1. Thermal Engineering by Rathore, TMH
2. Applied Thermodynamics by R.K. Rajput, Laxmi Publications
3. Thermal Engineering by Soman, PHI
4. Engineering Thermodynamics by P. L. Dhar, Elsevier
5. Thermodynamics by Sonnatag & Van Wylen, John Wiley & Sons
6. Thermodynamics for Engineers by Doolittle-Messe, John Wiley & Sons
7. Irreversible Thermodynamics by HR De Groff.
8. Thermodynamics & Heat Power by Granet & Bluestein, CRC Press
9. Engineering Thermodynamics by Chatopadyaya

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

ADVANCED FLUID MECHANICS (Professional Core - II)

Prerequisites: Fluid Mechanics & Hydraulic Machinery

Course Objectives: The course is intended to

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

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

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

UNIT-I:

Inviscid Flow of Incompressible Fluids: Lagrangian and Eulerain 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 & 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 - Coutte 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 & Turbulent Layers – Problems.

UNIT-IV:

Introduction to 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:

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Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy - Acoustic Velocity Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State

Compressible Fluid Flow – II: Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Releigh 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 Fluid Machines by S K Som and G Biswas, TMH
2. Fluid Mechanics **by** Joseph H Spurk and Nuri Aksel, Springer
3. Compressible Fluid Dynamics by B K Hodge and Keith Koenig, Pearson
4. Fluid Mechanics by Potter, Cengage Learning.
5. Fluid Mechanics and Hydraulic Machines by Dr. R.K. Bansal.

Reference Books:

1. Fluid Mechanics by Jog, Cambridge
2. Fluid Mechanics and Machinery by Khan, Oxford
3. Fluid Mechanics by Cohen and Kundu, Elsevier, 5th edition
4. Fluid Mechanics by William S Janna, CRC Press
5. Dynamics & Theory and Dynamics of Compressible Fluid Flow by Shapiro.
6. Fluid Dynamics by William F. Hughes & John A. Brighton, TMH

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

FUELS AND COMBUSTION (Professional Elective - I)

Prerequisites: Thermodynamics, Thermal Engineering I & II

Course Objectives: The course is intended to make a post graduate student to understand

- The fundamental of combustion phenomena in general
- The different combustion process, its thermodynamics and kinetics
- The combustion mechanism in different types of combustion
- The burner design for efficient combustion
- Different combustion models
- The effect of quantity & quality of fuel and engine technology on exhaust emissions
- The concept of laminar and turbulent flame propagation
- Different methods to reduce air pollution

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

- Understand the concepts of combustion phenomena in energy conversion devices
- Apply the knowledge of adiabatic flame temperature in the design of combustion devices
- Identify the phenomenon of flame stabilization in laminar and turbulent flames
- Analyze the pollution formation mechanisms in combustion of solid, liquid and gaseous fuels

UNIT–I:
Fuels: Detailed classification – Conventional and Unconventional Solid, Liquid, gaseous fuels and nuclear fuels – Origin of Coal – Analysis of coal.
Coal – Carborisation, Gasification and liquification – 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 – chain reactions. Theories of reaction Kinetics – General oxidation behavior of HC's.

UNIT–III:
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, Combustion of fuel, Theory of diffusion flames, droplets and sprays – Combustion systems – Pulverized fuel furnaces – fixed, Entrained and Fluidised Bed Systems.

UNIT–V:
Environmental Considerations: Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.

TEXT BOOKS:

1. Combustion Fundamentals by Roger A Strehlow, Mc Graw Hill
2. Fuels and combustion by Sharma and Chander Mohan, Tata Mc Graw Hill

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REFERENCE BOOKS:

1. Combustion Engineering and Fuel Technology by Shaha A.K., Oxford and IBH.
2. Principles of Combustion by Kanneth K. Kuo, Wiley and Sons.
3. Fuels & Combustion by Sameer Circar, Mc. Graw Hill.
4. An Introduction to Combustion by Stephen R. Turns, Mc. Graw Hill International Edition.
5. Combustion Engineering by Gary L. Berman & Kenneth W. Ragland, Mc. Graw Hill International Edition.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

ALTERNATE FUELS AND POLLUTIONS (Professional Elective - I)

Prerequisites: Hydrogen and Fuel Cells, Biodiesel - Production and Properties

Course Objectives:

- Gain knowledge of various alternative fuels
- Know about Natural gas, LPG, hydrogen and bio gas.

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

- Identify the need of alternate fuels and list out some prospective alternate fuels.
- Categorize, interpret and understand the essential properties of fuels for petrol and diesel engines.
- Infer the storage and dispensing facilities requirements.
- Analyze the implement limitations with regard to performance, emission and materials compatibility.
- Identify and understand possible harmful emissions and the legislation standards

UNIT- I:
Need for alternate fuel: Availability and properties of alternate fuels, general use of alcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternate energy sources. Like EV, hybrid, fuel cell and solar cars.

UNIT- II:
Alcohols: Properties as engine fuel, alcohols and gasoline blends, performance in SI engine, methanol and gasoline blends, combustion characteristics in CI engines, emission characteristics, DME, DEE properties performance analysis, performance in SI & CI Engines.

UNIT- III:
Natural Gas, LPG, Hydrogen and Biogas: Availability of CNG, properties, modification required to use in engines, performance and emission characteristics of wiring CNG & LPG in SI & CI engines. Hydrogen; storage and handling, performance and safety aspects.

UNIT- IV:
Technical Background of Diesel/Bio-diesel fuels-Oil feed stocks- Transesterification-Bio-diesel production from Vegetable oils and waste cooking oil-High blend levels of bio-diesel-Testing, Bio diesel-Oxidation stability-Performance in Engines, Properties of bio-fuels and their importance in the context of IC Engines. Vegetable Oils: Various vegetable oils for engines, esterification, performance in engines, performance and emission characteristics, bio diesel and its characteristics

UNIT- V:
Electric, Hybrid, Fuel Cell and Solar Cars: Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, fuel cell vehicles, solar powered vehicles.

TEXT BOOKS:

1. Alternate Fuels by Dr. S. S. Thipse, Jaico Publications
2. Alternative Fuels Guide Book by Richard. L & Bechfold, SAE International Warrendale - 1997.

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REFERENCE BOOKS:

1. Energy Today & tomorrow by Maheswar Dayal, 1 & B Horishr India-1982.
2. Power Plant Engineering by Nagpal, Khanna Publishers, 1991.
3. Alcohols as motor fuels progress in technology, Series No. 19 - SAE Publication USE - 1980.
4. SAE paper nos. 840367, 841333, 841334, 841156, Transactions, SAE, USA
5. Alternative Fuels Guidebook by Bechtold R.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

ADVANCED FUEL CELL TECHNOLOGIES (Professional Elective - I)

UNIT- I:
Introduction: Relevance, Principle, various configurations (Alkaline, Acid, Proton Exchange Membrane, direct methanol, molten carbonate and solid oxide fuel cells) fuel cell applications. Basic theory of electrochemistry, electrochemical energy conversion, electrochemical techniques. Thermodynamics of fuel cells. Heat and mass transfer in fuel cells. Single cell characteristics.

UNIT- II:
Modelling: Electrochemical model. Heat and mass transfer model. System thermodynamic model.

UNIT- III:
Low and High Temperature Fuel Cells: Proton exchange membrane fuel cell (PEMFC) and direct methanol fuel cell (DMFC): their special features and characteristics. Molten carbonate fuel cell (MCFC) and solid oxide fuel cell (SOFC) for power generation, their special features and characteristics.

UNIT –IV:
Fuels and Fuel Processing: Availability, production and characteristics of Hydrogen, fossil fuel – diverted fuels and biomass- diverted fuels. Principles of design of PEMFC, DMFC and SOFC.

UNIT- V:
Fuel Cell System: Materials, component, stack, interconnects, internal and external reforming, system layout, operation and performance.

TEXT BOOKS:
1. Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y. (2007).
2. O' Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).

REFERENCES:
1. J., Dick A., Fuel Cell Systems Explained, 2nd Ed. Wiley, 2003.
2. Liu, H., Principles of fuel cells, Taylor & Francis, N.Y. (2006).
3. Bard, A. J., L. R., Faulkner, Electrochemical Methods, Wiley, N.Y. (2004) Ref Book.
4. M.T.M. Koper (ed.), Fuel Cell Catalysis, Wiley, Larminie 2009.
5. J. O'M. Bockris, A.K.N. Reddy, Modern Electrochemistry, Springer 1998.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

COMPUTATIONAL FLUID DYNAMICS (Professional Elective - I)

Pre-requisite: Heat Transfer, Fluid Mechanics

Course Objective: To apply the principles of Heat Transfer and Fluid Mechanics to solve simple heat transfer and fluid flow problems using different numerical techniques

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

- Differentiate between different types of Partial Differential Equations and to be able to apply appropriate numerical techniques
- Solve the simple heat transfer and fluid flow problems using different numerical techniques
- Understand and to appreciate the need for validation of numerical solution

UNIT-I:
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 –- 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 Nickolson method – 2-D 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 & Stream Function Method – Advantages and Disadvantages – Treatment of Boundary Conditions - Staggered Grid as Remedy for representation of Flow Field - Pressure Velocity Coupling - SIMPLE & 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 Pub. House)

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2. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekhara (PHI)
3. Computational Fluid Flow and Heat Transfer by Muralidharan & Sundarajan (Narosa Pub)
4. Computational Fluid Dynamics and Heat Transfer by P. S. Ghoshdastidar, Centage Pub

REFERENCE BOOKS:

1. Computational Fluid Dynamics by Hoffman and Chiang, Engg Education System
2. Computational Fluid Dynamics by Anderson, TMH
3. Computational Methods for Fluid Dynamics by Ferziger, Peric, Springer
4. Computational Fluid Dynamics by T.J. Chung, Cambridge University
5. Computational Fluid Dynamics by A Practical Approach – Tu, Yeoh, Liu, Elsevier
6. Text Book of Fluid Dynamics by Frank Chorlton, CBS Publishers

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

TURBULENCE MODELLING (Professional Elective - II)

Prerequisites: Thermodynamics 1 & 2

Course Objectives: The course is intended to

- Understand the fundamental concepts of turbo machines
- Apply concepts of fluid mechanics in turbo machines.
- Understand the thermodynamic analysis of steam nozzles and turbines.
- Understand the different types of compressors and evaluating their performances in the form of velocity triangles.
- Familiarize the basic concepts of gas dynamics and analyze the performance of axial flow gas turbines

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

- To design and analyze the performance of Turbo machines for engineering applications
- To understand the energy transfer process in Turbo machines and governing equations of various forms.
- To understand the structural and functional aspects of major components of Turbo machines.
- To design various Turbo machines for power plant and aircraft applications
- Understand the design principles of the turbo machines
- Analyze the turbo machines to improve and optimize their performance

UNIT-I:
Introduction and Origin Of Turbulence: Properties of laminar flow, Properties of turbulent flow. Boundary Layer: Boundary Layer, Growth rate of Boundary layer for Laminar and Turbulent Flows. Characteristics of Turbulent Flow: The Origin of Turbulence, Nature of Turbulence, Swirling Structure, Mean Motion and Fluctuations, Consequences of Turbulence, Homogeneous Isotropic Turbulence.
Correlation Functions, Kolmogorov Hypothesis and Probability Density Function: Correlation Functions, Ideas about eddy size, Intensity of Turbulence or Degree of Turbulence. Kolmogorov Hypothesis and Energy Cascade: Kolmogorov Universal Law for the Fine Structure, Energy Cascade, Kolmogorov Length Scale, Kolmogorov's First Hypothesis, Kolmogorov's Second Hypothesis. Probability Density Functions and Averaging: Introduction, Probability density function, averaging used in the analysis of turbulent flows.

UNIT -II:
Reynolds Averaged Navier-Stokes Equations and Classical Idealization Of Turbulent Flows: Reynolds' Decomposition, Examples of Turbulent Fluctuations, some Measurements on Fluctuating Components. Measurements on Fluctuating Components: Shear Stress due to the Fluctuations, The boundary layer measurements of Klebanoff. Turbulent Boundary Layer Equations: Turbulent Boundary Layer Equations for a two-dimensional flow. Classical Idealization of Turbulent Stresses: Introduction, The boussines or eddy viscosity model, Eddy viscosity.

UNIT-III:
Vorticity Dynamics: Introduction, Vorticity and the equations of motion, Reynolds stress and vorticity. Vortex Stretching. The Vorticity Equation, Vorticity in Turbulent Flows.
Dynamics of Turbulent Kinetic Energy and Important Scaling Relations: Kinetic Energy of the Mean Flow. Kinetic Energy of Fluctuations. Scaling Relations.

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UNIT-IV:

Wall Bounded Flows and Free Shear Flows: The Law of the Wall for Wall Bounded Flows, The Universal Velocity Profile. Free Shear Flows, Turbulent Jets, Uniform Eddy Viscosity model.

Spectral Dynamics: Correlation Functions and Spectra. Correlation Functions and Spectra.

Large - Eddy Simulation of Turbulent Flows: RANS Equations and Eddy Viscosity: Introduction Reynolds Averaged Navier-Stokes (RANS) Equations, Eddy Viscosity Models, Zero-Equation Models. One-Equation Model: One-Equation Model, Two-Equation Model. Two Equation Models: k - ω Model, SST (Shear Stress Transport) Turbulence Model. Discussion on Applicability

UNIT-V:

Large - Eddy Simulation of Turbulent Flows: Low Reynolds number k - ε model: Special Features of Near Wall Flow, Near Wall Treatment in Transport Equation based Models, Wall Function Approach, Low Reynolds number version of k - ε model: Asymptotic Consistency, Damping Functions. RNG k - ε Model and Kato-Launder Model. The Realizable k - ε Model, Reynolds Stress Models (RSM), Large Eddy Simulation (LES). Mathematical Modeling of Turbulent Flows: The Filtered Navier-Stokes Equations, Subgrid Scale Closure, Standard Subgrid-Scale Model. Dynamic Model of LES. Direct Numerical Simulation.

TEXT BOOKS:

1. A First Course in Turbulence by H. Tennekes and J.L. Lumley, 1987, The MIT Press, Cambridge, Massachusetts, and London, England.
2. Fluid Mechanics by P.K. Kundu and I.M. Cohen, 2002, Academic Press (An Imprint of Elsevier Science, USA.

REFERENCE BOOKS:

1. Turbulent Flows by S.B. Pope, 2000, Cambridge University Press, UK.
2. Turbulent Flows: Fundamentals, Experiments and Modeling by G. Biswas and V. Eswaran, 2002, Narosa Publishing House, New Delhi, India.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

NANO FLUIDS (Professional Elective - II)

Prerequisites: Fluid Mechanics, Thermodynamics

Course Objectives: The course is intended to

- Understanding of superior thermo physical properties of nanofluids**.**
- Understanding of synthesis of nanofluids**.**
- Comparison of heat transfer using nanofluids with conventional fluids**.**
- Understanding of convection and boiling heat transfer**.**
- Research on this new topic to design modern mini and micro channel heat exchangers with nanofluids exhibiting much higher thermal efficiency and saving energy

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

- To introduce the application of nanotechnology in the area of fluids and thermal engineering

UNIT- I:
Introduction to nanofluids, nanostructure materials, base fluids, dispersion, sonication and stable suspension. Various types of nanofluids-volumetric concentration. Thermophysical properties: Density; principles of measurement and apparatus. Theoretical equations and new empirical correlations to determine the density of different nanofluids. Viscosity: principles of measurement and apparatus. Andrade's and other theoretical equations and new empirical correlations to determine the viscosity of different nanofluids. Effect of volumetric concentration and temperature. Effect of subzero temperature on nanofluid viscosity.

UNIT- II:
Thermal conductivity: principles of measurement and apparatus. Hamilton-Crosser and other theoretical equations and new empirical correlations to determine the thermal conductivity of different nanofluids. Effect of volumetric concentration and temperature. Effect of Brownian motion on enhancing the thermal conductivity. Specific heat: principles of measurement and apparatus. Buongeorno's thermal equilibrium equation and other theoretical equations and new empirical correlations to determine the specific heat of different nanofluids. Effect of volumetric concentration and temperature.

UNIT- III:
Combined effects of thermophysical properties of nanofluids 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 nanofluids. Turbulent flow: Single phase fluid fully developed flow Dittus-Boelter and Glienilski equations. Blasius and other turbulent friction factor correlations. Their comparison with nanofluids data. New correlations for turbulent friction factor and Nusselt number for nanofluids.

UNIT- IV:
Principles of measurement and apparatus for the nanofluid convective heat transfer coefficient. Recent empirical relations for convection coefficient of various types of nanofluids. Effect of particle Peclet number. Effect of volumetric concentration. Application of nanofluids to various types of industrial heat exchangers. Heating capacity, mass flow, heat exchanger surface area, LMTD and pumping power for nanofluids versus conventional heat transfer fluids.

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UNIT- V:

Application to building heating and cooling Comparison of nanofluids performance with glycol solution in hydronic coils. Application to automobile radiators. Comparison of the performance of nanofluids under arctic and sub-arctic temperatures with glycol solutions. Introduction to electronic cooling in microchannels with nanofluids.

TEXT BOOKS:

1. Microscale and Nanoscale Heat Transfer by C. Sobhan and G. Peterson, First edition, CRC Press.
2. Handbook of Nanostructured Materials and Nanotechnology by H.S. Nalwa, I edition, Vol. I and II, American Scientific Publishers.
3. Springer Handbook of Nanotechnology by Bharat Bhushan, 1st edition, Springer-Verlag Publication

REFERENCE BOOKS:

1. Text book of Nano Science and Nano Technology by BS Murthy, P. Shankar, Universities Press.
2. Fluid Mechanics by F. M. White, 5th Edition, McGraw-Hill
3. Heat Transfer by A. Bejan 2nd Edition, John Wiley

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

COMPUTATIONAL METHODS LAB (Lab - I)

Pre-requisite: Heat Transfer and Fluid Mechanics

Course Objective: To apply the principles of Heat Transfer and Fluid Mechanics to solve simple heat transfer and fluid flow problems using commercial CFD software

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

- Solve the simple heat transfer and fluid flow problems
- Understand and to appreciate the need for validation of numerical solution

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; v = 0.000217 m^2/s, ρ= 800 kg/m^3. Make simulations for a pressure gradient of 0-30000 $N/m^2/m$ and 20000 $N/m^2/m$ and report the variation of velocity contours for each case.
2. Simulation of a channel flow (Tube flow) for a tube of diameter, 5 cm and take the fluid as water at 30^0C at the entry of the tube of length 0.7 m. A heat flux of 30000 W/m^2 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.
3. Simulation of a channel flow (Tube flow) for a tube of diameter, 5 cm and take the fluid as water at 30^0C at the entry of the tube of length 0.7 m. A constant wall temperature of 300^0C is imposed along the wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.
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
    The experiments are to be conducted using ANSYS – CFX or equivalent software

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

ADVANCED FLUID MECHANICS LAB (Lab - II)

Pre-Requisites: Advanced Fluid Mechanics

Course Objectives:

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

Course Outcomes: Students who successfully complete this course will have demonstrated ability to:

- Describe the measurement techniques of fluid mechanics and its appropriate application.
- Interpret the results obtained in the laboratory for various experiments.
- Compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows and draw correct and sustainable conclusions.
- Write a technical laboratory

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, (H10 Setup)
14. Flow through an Orifice (H4 Setup)
15. Water Flow Channel (H17 Setup)

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. I Year I Sem. (THERMAL ENGINEERING)

RESEARCH METHODOLOGY AND IPR

Prerequisite: None

Course Objectives:

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

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

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I:
Meaning of research problem, Sources of research problem, 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:
Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT-III:
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:
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: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

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TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".

REFERENCES:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

ENGLISH FOR RESEARCH PAPER WRITING (Audit Course - I & II)

Prerequisite: None

Course objectives: Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

UNIT-I:
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT-II:
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT-III:
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT-IV:
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:
skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

TEXT BOOKS/ REFERENCES:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

DISASTER MANAGEMENT (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches,
- planning and programming in different countries, particularly their home country or the countries they work in

UNIT-I:
Introduction:
Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.
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-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 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-IV:
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-V:
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.

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TEXT BOOKS/ REFERENCES:

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “’New Royal book Company.
2. Sahni, Pardeep Et. Al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies”, Deep &Deep Publication Pvt. Ltd., New Delhi.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes: Students will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

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/ REFERENCES:

1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

VALUE EDUCATION (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course outcomes: Students will be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

UNIT-I:
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:
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 and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness.

UNIT-IV:
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 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/ REFERENCES:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

CONSTITUTION OF INDIA (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I:
History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working), **Philosophy of the Indian Constitution:** Preamble**,** Salient Features.

UNIT-II:
Contours of Constitutional Rights & 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-III:
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-IV:
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-V:
Election Commission: 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.

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TEXT BOOKS/ REFERENCES:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

PEDAGOGY STUDIES (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes: Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-I:
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:
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT-III:
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 scho 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:
Research gaps and future directions: Research design**,** Contexts**,** Pedagogy**,** Teacher education**,** Curriculum and assessment**,** Dissemination and research impact.

TEXT BOOKS/ REFERENCES:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

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4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

STRESS MANAGEMENT BY YOGA (Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To achieve overall health of body and mind
- To overcome stress

Course Outcomes: Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

UNIT-I:
Definitions of Eight parts of yog. (Ashtanga)

UNIT-II:
Yam and Niyam.

UNIT-III:
Do`s and Don't's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT-IV:
Asan and Pranayam

UNIT-V:
i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

TEXT BOOKS/ REFERENCES:

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Thermal Engineering)

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS
(Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes: Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

UNIT-I:

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

UNIT-II:

Neetisatakam-Holistic development of personality

- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

UNIT-III:

Approach to day to day work and duties.

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

UNIT-IV:

Statements of basic knowledge.

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

UNIT-V:

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

TEXT BOOKS/ REFERENCES:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

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