JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

Master of Technology

Batch: 2014-2016

Department of Mechanical Engineering – Thermal Engineering

I to IV Semesters

Course Matrix & Syllabus

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

SEMESTER – I

Course Matrix

M.Tech in Thermal Engineering

Sl. No.	Subject Code	Name of the Subject	Teaching/ Practical Hours Per Week	Credit	Duration of the Exam (Hrs)	I A Marks	Exam Marks	Total
1	14TE11	Applied Mathematics	4	4	3	50	50	100
2	14TE12	Advanced Fluid Mechanics	4	4	3	50	50	100
3	14TE13	Advanced Heat Transfer	4	4	3	50	50	100
4	14TEELXX	Elective - I	4	4	3	50	50	100
5	14TEELXX	Elective - II	4	4	3	50	50	100
6	14TE16	Seminar-I	---	2	---	50	---	50
TOTAL				**22**		**300**	**250**	**550**

Elective - I		Elective - II	
Subject Code	**Subject Name**	**Subject Code**	**Subject Name**
14TEEL11	Cryogenic Engineering	14TEEL21	Energy Resources
14TEEL12	Advanced Refrigeration & Air Conditioning	14TEEL22	Finite Elements Methods
14TEEL13	Thermal Power Stations - I	14TEEL23	Nuclear Energy Conversion
14TEEL14	Compressible Fluid Flow	14TEEL24	Fluid Power Engineering

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

SEMESTER – II

Course Matrix

M.Tech in Thermal Engineering

Sl. No.	Subject Code	Name of the Subject	Teaching/ Practical Hours Per Week	Credit	Duration of the Exam (Hrs)	I A Marks	Exam Marks	Total
1	14TE21	Energy Conversion Devices	4	4	3	50	50	100
2	14TE22	Hydro Power Conversion	4	4	3	50	50	100
3	14TE23	Combustion Engineering	4	4	3	50	50	100
4	14TEELXX	Elective - III	4	4	3	50	50	100
5	14TEELXX	Elective - IV	4	4	3	50	50	100
6	14TE26	Seminar - II	---	2	---	50	---	50
TOTAL				**22**		**300**	**250**	**550**

Elective - III		**Elective - IV**	
Subject Code	**Subject Name**	**Subject Code**	**Subject Name**
14TEEL31	Thermal Power Stations - II	14TEEL41	Theory of IC Engines
14TEEL32	Power plant design/ systems	14TEEL42	Thermal Storage Technologies
14TEEL33	Dynamics of Energy Conversion	14TEEL43	Experimental Techniques in Energy /Thermal Systems
14TEEL34	Jet and Rocket Propulsion	14TEEL44	Computational Fluid Dynamics

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

SEMESTER – III

Course Matrix

M.Tech in Thermal Engineering

Sl. No.	Subject Code	Name of the Subject	Credits	Total Marks
1	14TEPW31	Industrial Training / Internship	**16**	**500**

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

SEMESTER – IV

Course Matrix

M.Tech in Thermal Engineering

Sl. No.	Subject Code	Name of the Subject	Credit	Theory	Practical	Duration	I A Marks	Dissertation & Viva Voce		Total
1	14TEPW41	Project work and Dissertation	20	-	-	3	100	300	100(Viva)	**500**

Total Credits of all Semesters	Total Marks of all Semesters
80	**2100**

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

Master of Technology

CET - Thermal Engineering

I

Semester

Syllabus

Applied Mathematics

Subject Code: 14TE11 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Computer Arithmetic and Errors: Truncation error, Round off error, Error in original data, Propagated error, Floating point arithmetic, Arithmetic accuracy in computers, Errors in converting values, Absolute Vs relative error, Significant digits.

06 Hrs

Unit II

Solution of Algebraic and Transcendental Equations: Bisection method, iteration method, Method of false position, Newton–Raphson method, Graeffe's root squaring method, Order of convergence of the above methods.

08 Hrs

Unit III

Solution of linear system of equations: Direct methods – Gauss elimination, Method of factorization Iterative methods – Jacobi, Gauss Seidel Method, LU Decomposition Method.

08 Hrs

Unit IV

Interpolation: Finite difference – Forward, Backward, Central difference, Differences of a polynominal, Newton's formulae for interpolation. Gauss central difference interpolation formula, interpolation with unevenly spaced points – Lagrange's interpolation formula, Hermite interpolation formula.

08 Hrs

PART - B

Unit V

Numerical differentiation: Numerical differentiation – High accuracy differentiation formulae, Richardson extrapolation.

06 Hrs

Unit VI

Numerical Integration: Newton-Cote's integration formulae, Trapezoidal rule–a composite formula, Romberg integration, Simpson's Rules – 1/3 rule and 3/8 rule, Gaussian quadrature.

06 Hrs

Unit VII

Numerical solution of Ordinary Differential Equations: Taylor's series method, Euler and Modified Euler method, Runge–Kutta methods, Milne's method & Adam's Moulten method.

10 Hrs

Unit VIII

Numerical Solutions of Partial Differential Equations General 2^{nd} order linear partial differential equations: Elliptic, Parabolic and Hyperbolic. Finite difference approximation to derivatives.

08 Hrs

TEXTS / REFERENCE BOOKS:

1. S S Sastry: "Introductory Methods of Numerical Analysis", 3rd Edition, PHI New Delhi – 1998.
2. Numerical methods for scientific and engineering computation **-**M.K. Jain, S.R.K. Iyengar and R.K. Jain New age international publication 5th ed., 2007

Advanced Fluid Mechanics

Subject Code: 14TE12 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Introduction and Kinematics of Fluids: Methods of describing fluid motion - Lagrangian method, Eulerian method; translation, rotation and rate of deformation; stream lines, path lines and streak line; material derivative and acceleration; vorticity.

10 Hrs

Unit II

Governing Equations for Fluid Flow: Conservation equations for mass, momentum and energy - differential and integral forms; Euler's equations of motion, integration along the stream line; integration of steady irrotational motion; integration for two dimensional unsteady flow.

08 Hrs

Unit III

Incompressible and in viscid flow in two dimensions: Stream function for uniform stream, sources and sink, flow field due to source and sink, doublet, two dimensional flow past solid bodies, and vortex potential, Velocity functions.

12 Hrs

PART – B

Unit IV

Viscous fluid flow: Laminar and turbulent flows; viscous flow at different Reynolds number laminar plane Poiseuille flow; stokes flow; flow through a circular pipe, Hagen Poiseuilee's equation, Darcy and Chezy;s Equations. Limiting cases of small viscosity, exact solution, theory of hydrodynamic lubrication.

10 Hrs

Unit V

Boundary Layer Flow: Two dimensional laminar boundary layer, flow separation, effect of pressure gradient, boundary layer thickness, Displacement thickness, Momentum Thickness and Energy Thickness, skin friction, approximate methods of solution, momentum integral equation, two-dimensional flow with zero pressure gradient, flow with pressure gradient, boundary layer circulation, stresses stability of laminar boundary layer.

12 Hrs

Unit VI

Turbulent flow: Additional turbulent stresses. Boussiwesq's hypothesis, Prandtl's mixing length hypothesis, universal velocity distribution, turbulent flow in pipes, turbulent boundary layer with zero pressure gradient.

08 Hrs

TEXTS / REFERENCE BOOKS:

1. **Foundations of Fluid Mechanics -** S.W. Yuan, Prentice Hall of India, 1976.
2. **Engineering Fluid Mechanics -** P.A. Aswatha Narayana & K.N. Seetharamu, , Narosa publications, 2005.
3. **Fluid Mechanics -** F.M. White, McGraw-Hill publications, 1994.
4. **Advanced Engineering Fluid Mechanics -** K. Muralidhar and G. Biswas, Narosa publications, 2005.

Advanced Heat Transfer

Subject Code: 14TE13 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Introduction and One-Dimensional Heat Transfer: The modes of heat transfer, the laws of heat transfer, General three dimensional heat conduction equation in rectangular, cylindrical and spherical co-ordinates, Boundary Conditions, Problems on Mathematical formulation of boundary conditions, One dimensional steady state problems with heat generation in heat conduction, concept of thermal resistance, the critical thickness of insulation, extended surfaces- fins, Variable Thermal Conductivity.

10 Hrs

Unit II

Numerical Methods in Heat Transfer: Finite Difference formulation of steady and transient heat conduction problems, Discretization schemes – Explicit, Crank Nicholson and fully implicit schemes, Consistency, stability and convergence of numerical schemes, Stability criterion of explicit and implicit schemes, Control volume formulation, Steady one and two dimensional heat transfer problems.

08 Hrs

Unit III

Thermal Radiation: Basic concepts, emission characteristics and laws of black body radiation, radiation incident on a surface, solid angle and radiation intensity, heat exchange by radiation between two black surface elements, heat exchange by radiation between two finite black surfaces, the shape factor, radiant heat exchange in an enclosure having black surfaces, heat exchange by radiation between two finite parallel diffuse-gray surfaces, heat exchange by radiation in an annular space between two infinitely long concentric cylinders , radiant heat exchange in an enclosure having diffuse gray surfaces, problems.

10 Hrs

Unit IV

Principles of Fluid flow: The law of conservation of mass –the differential equation of continuity, differential equations of motion in fluid flow –Navier-stokes equations, laminar flow in a circular pipe, turbulent flow in a pipe, velocity boundary layer, thermal boundary layer, laminar flow over a flat plate, the momentum integral equation, Approximate solution of boundary layer equations using momentum integral equation**.**

06 Hrs

PART - B

Unit V

Heat transfer by Forced Convection: Differential equation of heat convection, laminar flow heat transfer in circular pipe and ducts, turbulent flow heat transfer in a pipe and duct, heat transfer in laminar flow over a flat plate, heat transfer in turbulent flow over a flat plate, flow across a cylinder, sphere, flow across a bank of tubes.

08 Hrs

Unit VI

Heat transfer by Free Convection: Natural convection heat transfer from a vertical plate and cylinder, correlations for a horizontal cylinder and a horizontal plate, correlations for enclosed spaces, Combined Free & Forced convection problems.

06 Hrs

Unit VII

Heat Exchangers: types of heat exchangers, direct transfer type of heat exchangers, classification according to flow arrangement, fouling factor, logarithmic mean temperature difference, LMTD correction factor, the effectiveness-NTU method, other design consideration, Compact heat exchangers.

06 Hrs

Unit VIII

Condensation and Boiling: film and drop wise condensation, film condensation on a vertical plate, condensation on horizontal tubes, bank of tubes, effect of superheated vapor and of non-condensable gases, types of boiling: correlations in pool boiling heat transfer, forced convection boiling, problems.

06 Hrs

REFERENCE / TEXT BOOKS:

1. Frank P Incropera: "**Fundamentals of Heat and Mass Transfer**" –Wiley Publication, 2011.
2. Ozisik M.N.: "**Heat Transfer – A Basic Approach"** McGraw-Hill Publications, 1985.
3. Holmon J.P.: "**Heat Transfer"** McGraw-Hill Publications, 2002.

Cryogenic Engineering

Subject Code: 14TEEL11 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Introduction: Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures, Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications**.**

10 Hrs

Unit II

Liquefaction Cycles: Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Ortho-Para hydrogen conversion, Eollins cycle, Simpson cycle, Critical Components in Liquefaction Systems.

14 Hrs

Unit III

Separation of Cryogenic Gases: Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis -McCabe Thiele Method. Adsorption Systems for purification.

10 Hrs

PART - B

Unit IV

Cryogenic Refrigerator: J.T. Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Pulse Tube Refrigerators**,** Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Magnetic Refrigerators.

10 Hrs

Unit V

Handling of Cryogens: Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature.

08 Hrs

Unit VI

Applications of Cryogenics: Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.

08 Hrs

TEXT / REFERENCE BOOKS:

1. Klaus D. Timmerhaus and Thomas M. Flynn, "Cryogenic Process Engineering", Plenum Press, New York, 1989
2. Randall F. Barron, "Cryogenic Systems", McGraw-Hill, 1985.
3. Scott R.B., "Cryogenic Engineering", Van Nostrand and Co., 1962.
4. Herald Weinstock, "Cryogenic Technology", 1969.
5. Robert W. Vance, "Cryogenic Technology", Johnwiley & Sons, Inc., New York, London

Advanced Refrigeration and Air Conditioning

Subject Code: 14TEEL12 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Method of Refrigeration and Non-conventional Refrigeration System: Ice refrigeration, Evaporative refrigeration, Refrigeration by expansion of air, Refrigeration by throttling of gas, Vapor refrigeration system, Steam jet refrigeration system, Refrigeration by using liquid using liquid gases, Dry ice refrigeration, Types of refrigerants, Properties of refrigerants, Thermoelectric refrigeration, Vortex tube refrigeration, Cooling by adiabatic demagnetization, Pulse tube refrigeration.

08 Hrs

Unit II

Air Refrigeration System: Bell Coleman air refrigerator, Advantages and disadvantages of air refrigeration system, Necessity of cooling the aero plane, Factors considered in selecting the refrigeration system for aero plane, Simple cooling with simple evaporative type aero plane air conditioning, Boot strap and boot strap evaporative type, Regenerative type, Reduced ambient type, Comparison of different systems, Actual air conditioning system with control, Limitations, Merits and demerits.

10 Hrs

Unit III

Vapour Compression Refrigeration System: Simple vapour refrigeration system, T-s, h-s, p-h diagrams for vapor compression refrigeration system, wet, dry and super-heated compression, vapor compression refrigeration systems with multiple evaporators and compressors.

08 Hrs

Unit IV

Vapour Absorption Refrigeration System: Basic- absorption system, actual ammonia absorption system, Electrolux refrigeration system, lithium bromide absorption refrigeration system, analysis of ammonia refrigeration system, comparison of compression and absorption refrigeration system.

08 Hrs

PART – B

UNIT V

Psychrometry: Psychrometry and psychrometric properties, psychrometric relations, psychrometric chart, psychrometric processes, requirements of comfort air conditioning, comfort chart, design consideration, summer, winter and year round air conditioning.

08 Hrs

UNIT VI

Cooling Load Calculations and Design of Air Conditioning System: Different heat sources, conduction heat load, radiation load of sun, occupants load, equipment load, infiltration air load, miscellaneous heat sources, fresh air load, design of air conditioning system, bypass factor consideration, effective sensible heat factor, cooling coils and dehumidifying air washers.

06 Hrs

UNIT VII

Air Conditioning Systems: Air conditioning systems central station air conditioning system, unitary air conditioning system, direct air conditioning system, self-contained air conditioning units, direct expansion system, all eater system, all air system, air water system , arrangement of the components of some air conditioned systems used in practice, factory air conditioning. **06 Hrs**

UNIT VIII

Refrigeration and Air Conditioning Equipments: Refrigeration equipments- Compressors, condensers and cooling towers, evaporators, expansion devices, electric motors air conditioning equipments- air cleaning and air filters, humidifiers, dehumidifiers from different reputed companies.

06 Hrs

TEXT / REFERENCE BOOKS:

1. Arora and Domkundawar: **"A Course in refrigeration and Air- Conditioning"** Danpat Rai & Co Publications
2. P.N. Ananthanarayanan: **"Basic Refrigeration and Air Conditioning",** McGraw-Hill Publications
3. Manohar Prasad.: **"Refrigeration & Air Conditioning"** New Age International Publications.

Thermal Power Stations - I

Subject Code: 14TEEL13 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Steam Generator and Auxiliaries: High pressure boilers, classification, schemes¸ circulation, nature of fuels and its influence on design, furnaces, PF burners, PF milling plant, oil and gas burner types and location, arrangement of oil handling plant.

08 Hrs

Unit II

Waste Heat Recovery Systems: Furnace circuit, steam side and waterside corrosion, pressure parts, super heater, re-heater, and economizer, de-super heater, air heater, on-load cleaning of boilers.

08 Hrs

Unit III

Dust Extraction Equipment: Bag house, electrostatic precipitator, draught systems, FD, ID and PA fans, chimneys, flues and ducts, dampers, thermal insulation and line tracing, FBC boilers and types, waste heat recovery boilers

08 Hrs

Unit IV

Feed Water System: Impurities in water and its effects, feed and boiler water corrosion, quality of feed water, boiler drum water treatment and steam purity, water treatment, classification, demineralization, evaporation and reverse osmosis plant.

08 Hrs

PART - B

Unit V

Circulating Water System: Introduction, System classification, The circulation system, Wet-Cooling towers, Wet-cooling tower calculations, Dry cooling towers, Dry-cooling towers and plant efficiency and economics, wet dry cooling towers, cooling-tower icing, Cooling lakes and ponds, Spray ponds and canals.

08 Hrs

Unit VI

Operation and Maintenance of Steam Generators and Auxiliaries: Pre commissioning activities, Boiler start up and shut down procedures, emergencies in boiler operation, Maintenance of Steam generator and auxiliaries.

08 Hrs

Unit VII

Performance: Boiler efficiency and optimization, coal mill, fans, Electro Static Precipitator

06 Hrs

Unit VIII

EIA Study: Pollutants emitted, particulate matter, SOx and NOx and ground level concentration, basic study of stack sizing.

06 Hrs

REFERENCE BOOKS:

1. P.K. Nag **: "Power Plant Engineering"**, Tata McGraw-Hill Publications.
2. M.M. EI-Wakil **: "Power Plant Engineering",** McGraw- Hill Publications
3. **"Steam generator and auxiliaries"** –BHEL training book.

Compressible Fluid Flow

Subject Code: 14TEEL14 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Fundamental Equations of Steady Flow: Continuity and momentum equations, The thrust function, The dynamic equation and Euler's Equation. Bernoulli's Equation. Steady flow energy equation.

06 Hrs

Unit II

Isentropic Flow: Acoustic velocity, Mach number, Mach cone and Mach angle. Flow parameters, stagnation temperature, pressure, and density.

08 Hrs

Unit III

Flow with Heat Trnsfer: Stagnation temperature change. Rayleigh line, Pressure ratio and temperature ratio, Entropy considerations, maximum heat transfer.

08 Hrs

PART - B

Unit IV

Flow With Friction: The fanning equation, Friction factor and friction parameter, Fanno line, Fanno equations.

08 Hrs

Unit V

Wave Phenomena: Classification of wave phenomena, analysis of shock phenomena, Hugoniot equation. Weak waves, compression waves, Normal shock waves, oblique shock waves, Entropy considerations, Rayleigh Pilot equations, detonation and deflageration.

15 Hrs

Unit VI

Variable Area Flow: Velocity variation with Isentropic flow, Criteria for acceleration and deceleration. Effect of pressure ratio on Nozzle operation. Convergent nozzle and convergent divergent nozzle. Effect of back pressure on nozzle flow. Isothermal flow functions. Comparison of flow in nozzle. Generalized one dimensional flow.

15 Hrs

TEXT/REFERENCE BOOKS:

1. **Fundamentals of Compressible flow**: Yahya, 2nd Edn. 1991; Wiley Eastern.
2. **Gas Dynamics,** E Radhakrishnan PHI-2006
3. **Introduction to Gas Dynamics:** Rolty, Wiley 1998
4. **Elements of Gas Dynamics:** Liepmann and Roshko, Wiley 1994.
5. **The dynamics and thermodynamics of compressible fluid flow:** Shapiro Ronold press. 1994.

Energy Resources

Subject Code: 14TEEL21 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 03 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Introduction: World production and reserves of commercial energy sources, Energy Scenario in India, Energy alternatives, Environmental aspects of energy, Forms of non- conventional energy sources.

06 Hrs

Unit II

Solar Energy Systems: Solar radiation geometry, Estimation and measurement of solar energy. Thermal systems: Water heating, Drying, Cooking, solar distillation, Solar pumping, solar furnace. Photovoltaic systems: Characteristics of Photovoltaic cells, Solar cell arrays, Balance of system (BOS).

10 Hrs

Unit III

Biomass Energy Systems: Biomass conversion technologies, Biochemical route, Biogas generation, Classification of biogas plants, Bio-gas from plant wastes, Problems related to biogas plants, Utilization of biogas. Thermal gasification of biomass, classification of biomass gasifier, Thermochemical reactions, Applications of the gasifier, Problems in the developments of Gasifiers, Biomass energy program in India, Case study of Hosahalli biomass gasifier engine generator system.

08 Hrs

Unit IV

Wind Energy Systems: Basic principles of wind energy conversion, Wind data and energy estimation, Wind energy conversion systems, Horizontal axis wind machines, Vertical axis wind machines, Performance of wind machines, Applications: Pumping, Direct heating, electric power generation, Environmental aspects, Wind Energy Program in India.

08 Hrs

PART - B

Unit V

Geothermal Energy: Structure of earth, Geothermal Regions, Hot springs. Hot Rocks, Hot Aquifers. Analytical methods to estimate thermal potential. Harnessing techniques, Electricity generating systems**.**

06 Hrs

Unit VI

Direct Energy Conversion: Nuclear Fusion: Fusion, Fusion reaction, P-P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic. Thermionic & thermoelectric generation, MHD generator.

06 Hrs

Unit VII

Hydrogen Gas as Fuel: Production methods, Properties, I.C. Engines applications, Utilization strategy, Performances.

06 Hrs

Unit VIII

Other Energy Sources: OTEC–Principle of operation, Open & Closed OTEC cycles, Wave energy: Wave energy conversion machines and recent advances, Tidal Energy: Single basin and double basin tidal systems, Small-Mini-Micro hydro system: concepts, Types of turbines.

10 Hrs

TEXT / REFERENCE BOOKS:

1. S. P. Sukhatme: **"Solar Energy-Principles of Thermal Collection & Storage"**, TMH Publishing Co.1996, New Delhi. ISBN: 0074624539, 9780074624531
2. G. D. Rai: **"Non Conventional Energy Sources",** Khanna publisher, New Delhi, 2005.
3. B.H.Khan: **"Non Conventional Energy Resources",** TMH New Delhi, 2008.
4. John A Duffie & William A Beckman: **"Solar energy Thermal Processes"** Wiley–Inter science publication, New York , 1974, ISBN:0471223719, 9780471223719
5. Klaus Von Mitzlaff: **"Engine for biogas",** Published by Friedr Vielveg and Sohn Braunschweig, Germany – 1988
6. Desire Le Gouriers: **"Wind Power Plants: Theory & Design",** Pergamon Press, 1982
7. H P Garg & J Prakash: **"Solar Energy – Fundamentals and Applications",** Tata McGraw Hill Publishing company limited, New Delhi, 2000, ISBN: 0074636316, 9780074636312
8. Srivatsava, Shukla and Ojha: **"Technology and Application of Biogas",** Jain Brothers, New Delhi, 1993.
9. Renewable Energy Resources- Basic Principles and Applications/ G.N.Tiwari and M.K.Ghosal/ Narosa Publications

Finite Elements Methods

Subject Code: 14TEEL22 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 03 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Introduction: Importance of stress analysis, heat transfer and fluid flow, conservation laws for mass, momentum and energy; Fourier equation, N-S equations; energy principles in stress analysis; Basic equations in elasticity; Boundary conditions. Some Basic Discrete Systems: Discrete systems as basis for FEM analysis; Examples of discrete systems in stress analysis, heat transfer and fluid flow.

08 Hrs

Unit II

1-D Finite Elements: Introduction; Elements and shape functions - one dimensional linear element (bar element), one dimensional quadratic element. **2-D Finite Elements:** two dimensional linear triangular elements, Local and Global coordinate systems, quadratic triangular elements, two dimensional quadrilateral elements, iso-parametric elements, three dimensional elements, beam, plate and shell elements, composite materials.

10 Hrs

Unit III

Formulation: Introduction; Variational approach; methods of weighted residuals for heat transfer problems, principle of virtual work for stress analysis problems; mixed formulation; penalty formulation for fluid flow problems. Primitive variables formulation for flow problems.

08 Hrs

PART - B

Unit IV

Heat conduction problems: FEM analysis of steady state heat conduction in one dimension using linear and quadratic elements; steady state heat conduction in two dimensions using triangular and rectangular elements; three dimensions problems, Axi-symmetric problems.

06 Hrs

Unit V

Transient and Phase change problems: Transient heat conduction in one and multi-dimensional problems; time stepping scheme using finite difference and finite element methods; phase change problems - solidification and melting; Inverse heat conduction problems.

06 Hrs

Unit VI

Convective Heat Transfer Problems: Introduction; Galerkin method of Steady, convection-diffusion problems; upwind finite element in one dimension - Petro-Galerkin formulation, artificial diffusion; upwind method extended to multi-dimension; transient convection - diffusion problems - FEM solutions, extension to multi dimensions; primitive variables approach (u, v, w, p, t formulation); characteristic - based split scheme (CBS); artificial compressibility scheme; calculation of Nusselt number, drag and stream function; mesh convergence; Introduction to convection in Porous media; Laminar and turbulent flows.

10 Hrs

TEXT / REFERENCE BOOKS:

1. **Fundamentals of the finite element method for heat and fluid flow -** R.W. Lewis, P. Nithiarasu and K. N. Seetharamu, John Wiley and Sons, 2004.
2. **The finite element method in heat transfer analysis -** R.W. Lewis, K Morgan, H.R. Thomas, K.N. Seetharamu, John Wiley and Sons, 1996.
3. **The finite element method in heat transfer and fluid dynamics -**J.N. Reddy and Gartling D.K., CRC publications, 2000.
4. **The finite element method volume 3: fluid dynamics -** O.C. Zienkiewicz and R.L. Taylor, John Wiley & Sons, 2001.
5. **The finite element and for solid and structural mechanics -** O.C. Zienkiewicz and R.L. Taylor, Elsevier Publishers, 2005.
6. **Introduction to Finite Elements in Engineering -** Tirupathi R. Chandrupatla, Ashok D. Belegundu, Prentice-Hall Ltd., 2002.
7. **Finite Element Analysis -** S.S. Bavikatti, New Age International, 2005.

Nuclear Energy Conversion

Subject Code: 14TEEL23 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 03 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Nuclear Reactions: Mechanism of Nuclear Fission, Nuclides, Radioactivity, Decay chains, Neutron reactions, The fission process, Reactors, Types of Fast Breeding reactors, Design and construction of Nuclear reactors, Heat transfer techniques in Nuclear reactors, Reactor Shielding.

14 Hrs

Unit II

Reactor Materials: Nuclear fuel cycles, Characteristics of Nuclear fuels, Uranium, its production and purification, Conversion to UF4 and UF6, Other fuels like Zirconium, Thorium, Beryllium.

10 Hrs

Unit III

Reprocessing: Nuclear fuel cycles, Spent fuel characteristics, Role of solvent extraction in Reprocessing, Solvent extraction equipment.

08 Hrs

PART - B

Unit IV

Separation of Reactor Products: Processes to be considered, Fuel element Dissolution, Precipitation process, Ion exchange, Red ox, purex, TTA, Chelation, U 235, Hexone, TBP and Thorax processes, Oxidative slaging and Electro refining, Isotopes, Principles of Isotope separation.

12 Hrs

Unit V

Waste Disposal and Radiation Protection: Types of Nuclear wastes, Safety and Pollution Control and abatement, International convention on safety aspects, Radiation Hazards prevention.

08 Hrs

Unit VI

Environmental Impact: Natural and Artificial radio activity, Reactions from nuclear power plants, effluents.

08 Hrs

TEXT / REFERENCE BOOKS:

1. J. R. Lamarsh : **"Introduction to Nuclear Reactor Theory",** Wesley Publication,
2. Duderstadt and L. J. Hamilton : **"Nuclear Reactor Analysis",** John Wiley Publication

Fluid Power Engineering

Subject Code: 14TEEL24 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 03 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Introduction: Pascal Law, Advantages of Fluid Power, Applications of Fluid Power, Components of a Fluid Power. **Hydraulic Power Unit:** Introduction, Pumping Theory, Pump Classification, Gear Pumps, (Vane Pumps- simple, balanced & pressure compensated vane pump, Vane design) Piston Pumps- Radial, Axial (Bent axis & Swash plate), Pump Performance, Pump Noise, Ripple in pumps.

10 Hrs

Unit II

Hydraulic Actuators: Linear actuator- cylinders, Mechanics of Hydraulic cylinder loading, limited rotation hydraulic actuator, cylinder cushioning, Gear, Vane & Piston motor, Motor performance, Hydrostatic transmission.

06 Hrs

Unit III

Power Controlling Elements – **Valves:**

a) Directional Control Valves – Classification, 2/2, 3/2,4/2 & 4/3 ways Dcv's, Different Centre configurations in 4/3 way valves, actuation of DCV's, Indirect actuation, Valve Lap – Lap during Stationary and during switching.
b) Pressure Control Valves: Classification, opening & Closing Pressure difference, Cracking Pressure, Pressure Relief Valve – Simple & Compound type, Pressure reducing valve, sequence, unloading & Counter balance valve, Pressure switches.
c) Flow Control valves – Fixed throttle, Variable throttle, Pressure Compensation principles, pressure compensated Flow control valve – Reducing & Relief type.
d) Check valve, Pilot operated check valve.

12 Hrs

Unit IV

Hydraulic Circuit Design & Analysis: Control of Single & double acting cylinder, Regeneration circuit, cylinder sequencing & Synchronizing circuit. Speed control of cylinder & Motors, Analysis of Hydraulic system with frictional losses, Accumulators & accumulator circuits.

08 Hrs

PART - B

Unit V

Pneumatic System: Introduction, – Generation of compressed air, air receiver, servicing FRL unit, Air filter, pressure regulation, lubricator, Pneumatic cylinder & air motor – different types of cylinder, cushion assembly. Cylinder performance.

06 Hrs

Unit VI

Pneumatic Valve: Directional control valves, impulse valve, Quick exhaust valve, shuttle valve, Twin pressure valve, Time delay valve.

05 Hrs

Unit VII

Pneumatic Circuit & Logic Circuits:- Control of single and double acting cylinder, impulse operation, speed control, sequencing, Pneumatic Vacuum system AND,OR, NOT, NAND, NOR, YES Function, Logic circuits design using shuttle valve & twin pressure valve, Binary Arithmetic, logic & Boolean Algebra, use of kannaugh veitch map for pneumatic circuit design.

07 Hrs

Unit VIII

Electrical Control in Fluid Power: Contactors, & Switches, Relays, Limit switch, Electro hydraulic & Electro Pneumatic Circuits, Simple Cylinder reciprocation, interlocking using relays, Proximity switches, application of proximity switches, Time dependent will dependent and travel dependent circuits.

06 Hrs

TEXTS / REFERENCE BOOKS:

1. **Fluid Power with Application** - Anthony Esposito - Peason Education - 5th edition.
2. **Oil hydraulics -Principles & maintenance** - S. R. Majumdar - Tata M C Graw Hill
3. **Components & Application** - Bosch Rexroth didactic - Hydraulics Trainer - vol 1. Publication
4. **Pneumatic System, Principles and Maintenance** - S. R. Majumdar - Tata M C Graw Hill Publication.
5. **Pneumatics: Theory and Applications** - Bosch Rexroth didactic - Publication
6. **Electro Pneumatics** - Bosch Rexroth didactic - Vol. 2, Publication
7. Hydraulics and Pneumatics by Andrew Parr, Elsevier Publications, 2005
8. Engineering applications of pneumatics and Hydraulics , Ian C. Turner, Institution of Plant Engineers, Arnold, 1996, 0340625260, 9780340625262

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

Master of Technology

CET - Thermal Engineering

II

Semester

Syllabus

Energy Conversion Devices

Subject Code: 14TE21 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Internal Combustion Engine: Reciprocating devices and internal combustion engines, Types of internal combustion engines, Some terms and definitions relating to IC engines, The gas engine, The actual indicator diagram.

06 Hrs

Unit - II

Combustion in IC Engines: Volumetric efficiency, Knocking and detonation in IC engines, Performance characteristics of IC engines, Testing of IC engines, Energy balance on an IC engine, Problems.

06 Hrs

Unit III

Principles of Turbo Machinery: The Turbo machine and positive displacement machines, Static and stagnation states, Application of first and second laws to Turbo machines, Efficiency of compressors and turbines, Preheat factor and Reheat factor, Multi stage compression and expansion, Problems.

08 Hrs

Unit IV

Energy Exchange in Turbo Machines: The Euler turbine Equation, Fluid Energy changes, Impulse and Reaction, General analysis of Radial and axial flow turbines, Turbine utilization factor and Degree of reaction, General analysis of Compressors and Pumps. Problems.

08 Hrs

PART - B

Unit V

Reciprocating Compressors: The air compressor, Work input for single – stage compressor, Effect of clearance, Real indicator diagram, Multistage air compressors, Optimum inter-stage pressure, Energy exchange in multistage compression, Problems.

08 Hrs

Unit VI

Flow through Nozzles and Blade passages: Introduction, Steady flow through nozzles, Area changes and one-dimensional isentropic flow, Effects of friction in flow passages, Characteristics of Converging and Diverging Nozzles, Flow of Wet steam through nozzles, Diffusers, Problems.

08 Hrs

Unit VII

Axial Compressors: Axial Compressors: Stage velocity triangles, enthalpy – entropy diagrams, flow through blade rows, stage losses and efficiency, work done factor, low hub-tip ratio stages, supersonic and trans sonic stages, performance characteristics, problems.

08 Hrs

Unit VIII

Centrifugal Compressors: Elements of centrifugal compressor stage, stage velocity diagrams, enthalpy entropy diagram, nature of impeller flow, slip factor, diffuser, volute casing, stage losses, performance characteristics, problems. **08 Hrs**

TEXTS / REFERENCE BOOKS:

1. V. Kadambiand Manohar Prasad: **"An Introduction to Energy Conversion"** Volume II and III, 2002
2. S M Yahya: **"Turbines, Compressors and Fans",** Tata Mc Grawhill Co. Second Edition, 2002.
3. Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H.: "**Gas Turbine Theory"**, Longman Group Ltd, 2001
4. Ganesan, V.: "**Gas Turbines"**, Tata McGraw-Hill Pub.Co.Ltd., New Delhi, 1999.

Hydro Power Conversion

Subject Code: 14TE22 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit I

Elements of Hydrology: Definition, The hydrological cycle, Precipitation, Measurement of rainfall and snowfall, Mean depth of rainfall over area, Evaporation, transpiration and evapotranspiration, Infiltration, Runoff and factors affecting runoff, Hydrograph, Methods of determination of runoff, Numerical Problems.

06 Hrs

Unit II

Water Power Engineering: Hydroelectric power development in India and world, Comparison of Thermal and Hydroelectric power costs, Assessment of available power, Storage and Pondage, Essential stream flow data for water power studies, Flow duration curve, Mass curve, Types of hydro power plants, Primary and Secondary power, Load factor, Utilization factor and Capacity factor, Components of Hydro electric Power plants, Numerical Problems.

08 Hrs

Unit III

Impact of Free Jets: Introduction, Force exerted by a by a fluid on a stationary curved vane with jet striking symmetrical curved vane at the centre and jet striking an unsymmetrical curved vane tangentially at one of the tips, Force exerted by a by a fluid on a moving curved vane with jet striking the moving curved vane at the centre and jet striking an unsymmetrical moving curved vane tangentially at one of the tips, Torque exerted on a wheel with radial curved vane, Numerical Problems.

08 Hrs

Unit IV

Hydraulic Turbines: Layout of Hydroelectric power plant, Heads and Efficiencies of Hydraulic Turbines, Classification of Hydraulic turbines, Pelton Wheel, Expression for maximum work and efficiency of a Pelton wheel, Design of Pelton wheel, Multiple jet Pelton wheel, Reaction turbines, Francis turbine, Work done and efficiency of a Francis turbine, Design of Francis Turbine Runner, Draft Tube Theory, Kaplan Turbine, New types of turbines, Governing of turbines, Runway of turbines, Surge Tanks, Numerical Problems.

10 Hrs

PART - B

Unit V

Performance of Turbines: Performance under Unit head – Unit quantities, Performance under specific conditions, Expressions for Specific speeds in terms of known coefficients for different turbines, Performance Characteristic curves, Model Testing, Cavitation, Selection of turbines, Numerical Problems.

06 Hrs

Unit VI

Centrifugal Pumps: Parts of a Centrifugal pump, Working of Centrifugal pump, Types, Work done by the impeller, Heads, Losses and Efficiencies, Minimum Starting Speed, Loss of head due to reduced or increased flow, diameter of impeller and pipes, Specific speed, Model testing, Multistage pumps, Characteristic curves, Limitations of suction lift, NPSH, Cavitation, Computation of Total Head of Pumping – System Head curves, Priming devices, Centrifugal Pump Troubles and Remedies, Numerical Problems.

08 Hrs

Unit VII

Reciprocating Pumps: Main components and working of reciprocating pumps, Types of Reciprocating Pumps, Work done on single and double acting pump, Coefficient of discharge, Slip, Percentage slip and negative slip, Effects of acceleration of piston on velocity and pressure in the suction and delivery pipes, Indicator diagram, Air vessels, Multi cylinder pumps, Characteristic curves, Numerical Problems.

08 Hrs

Unit VIII

Miscellaneous Hydraulic Machines: Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Press, Hydraulic Crane, Hydraulic Lift, Hydraulic Ram, Hydraulic Coupling and Torque converter, Air lift pump.

06 Hrs

TEXT / REFERENCE BOOKS:

1. P.N. Modi and S. M. Seth: **"Hydraulics, Fluid Mechanics and Hydraulic Machines",** Standard Book House, 2005.
2. R. K. Bansal: **"Fluid Mechanics and Hydraulic Machines",** Lakshmi Publications, 2002.

Combustion Engineering

Subject Code: 14TE23 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

Introduction: Definition, Essential conditions for combustion, classification of combustion systems based on fuels and oxidizers, Industry applications, Fuel properties, Calorific values, Proximate and Ultimate analysis of fuels.

06 Hrs

Unit-II

Thermo-chemistry of combustion: stoichiometry, calculation of air fuel ratio, equivalence ratio, excess air; heat of formation, calculation of heat of reaction.

06 Hrs

Unit-III

Chemical kinetics: Introduction, **c**lassification of reactions (homogeneous/heterogeneous; explosive/non-explosive reactions); Basic Reaction Kinetics, Collision theory; Reaction rate and it's functional dependence; Arrhenius equation; Order of reaction, Chain reactions and Multi step reactions.

08 Hrs

Unit-IV

Review of Thermodynamics: Extensive and Intensive properties, Ideal gas laws for gas mixtures, I and II law of Thermodynamics, Clausius-Clapeyron equation.

06 Hrs

PART - B

Unit-V

Modeling of combustion: Combustion physics and its connection with Fluid Mechanics, Heat Transfer, Mass Transfer, Chemical Kinetics & Conservation Equations for combustion process. Basics of Boundary layer theory and turbulence modeling.

08 Hrs

Unit-VI

Laminar Premixed flames: Definition, principal characteristics; simplified analysis: assumptions, conservation (mass, species & energy) equations with boundary conditions and their solutions to find out temperature & mass-fraction distribution; determination of flame velocity & thickness; quenching; flammability & ignition.

08 Hrs

Unit-VII

Laminar Diffusion flames: Non-reacting & reacting laminar jet; Burke Schumann Flame: assumptions, simplification and solution of mass, species, momentum & energy equation with the boundary conditions; determination of temperature & mass-fraction distribution as well as flame height .

08 Hrs

Unit-VIII

Droplet evaporation & combustion: Assumptions, simplification and solution of mass, species & energy equation with the boundary conditions; determination of temperature & mass-fraction distribution, mass evaporation rate, flame stand-off ratio, flame temperature, expression for transfer numbers, evaporation/burning rate constant, droplet life-time**.** Introduction to advanced combustion systems: Ignition; spray combustion; finite rate chemistry; fuel vapor accumulation; laminar/turbulent flow.

10 Hrs

TEXT / REFERENCE BOOKS:

1. Stephen R. Turns, An Introduction to Combustion: Concepts and Applications, 2nd Edition, McGraw Hill International, 2000.
2. Kenneth K. Kuo , Principles of Combustion, 2nd Edition, John Wiley & Sons, 2005
3. Roland Borghi, Michel Destriau, Gérard De Soete**,** Combustion and Flames, TECHNIP, 1998
4. D P Mishra, "Fundamentals of Combustion"

Thermal Power Stations - II

Subject Code: 14TEEL31 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART – A

Unit-I

Power Station Layout and Siting: Planning for new power station, site selection and investigation, site layout.

06 Hrs

Unit-II

Power Station Design and Layout: Concept, station layout, T.G. systems, boiler systems, cooling water plant, coal handling, ash and dust handling, gas congregation and storage gas turbine plant.

08 Hrs

Unit-III

Turbine Generator and Auxiliaries: Schemes, turbine blading, casing, rotors and vibration and couplings, bearings pedestals, turning gears, lubrication system, jacking oil system, gland sealing, flange heating, LP exhaust cooling system,, drain system, by pass system.

10 Hrs

Unit-IV

Feed Water Heating System: HP feed heating, deaerator system; LP feed heating, auxiliary steam system, **Condenser:** On load cleaning, different pumps, cooling towers.

08 Hrs

PART - B

Unit-V

Instrumentation and Control: TG instruments, controls, boiler following turbine and turbine following boiler.

06 Hrs

Unit-VI

Operation and Maintenance of TG: Start up and shut down procedure, start up curves, maintenance of TG and axillaries, safety and fire protection, Performance of TG, condenser, feed water heater, cooling tower and pumps.

08 Hrs

Unit-VII

Piping: Fundamentals, pipeline sizing and specialties, piping layout engineering, piping analysis, pipe supports, thermal insulation.

08 Hrs

Unit-VIII

Economic Analysis of Power Plants and Tariffs: The cost of electrical energy calculation.

06 Hrs

TEXT / REFERENCE BOOKS:

1. **Modern Power Station Practice** - Vol A to .E.BEIL Pergramon press
2. EL -Wakil : **"Power Plant engineering",** Tata Mcgraw hill.

Power Plant Design / Systems

Subject Code: 14TEEL32 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

Design of Heat Exchangers: Design of Double Pipe Heat Exchanger, Design of Shell and Tube Heat Exchanger .

10 Hrs

Unit-II

Design of Air Pre Heater and Economizer: Design of Recuperative Air Pre Heater, Design of Economizer, Estimation of Sulphur acid due point.

10 Hrs

Unit-III

Super Heater and Reheater Design: Estimation of flow in each element of a tube assembly. Estimation of attenuation factor and direct radiation from furnace, flame, or cavity.

10 Hrs

PART – B

Unit-IV

Design of Steam Condenser: Effect of tube side velocity on surface area and pressure drop for various tube sizes (It involves estimation of tube side velocity, surface area and pressure drop for various tube sizes & Plot the graph) and estimation of shell diameter of steam condenser, Feed water heaters.

14 Hrs

Unit – V

Design of Cooling Tower: Natural draft, use of psychometric chart; Feed Water Treatment.

06 Hrs

UNIT – VI

Boiler Furnace Design: Heat transfer in coal fired boiler furnace (gas side) – Estimation of furnace exit gas temperature, estimation of fin-tip temperature. Heat transfer in two phase flow- Estimation of inside heat transfer coefficient using Jens & Lottes equation and Thom's correlation. Estimation of pressure drops in two phase flow using Thom's method.

10 Hrs

TEXT / REFERENCE BOOKS:

1. D.Q. Kern : **"Process Heat Transfer",** McGraw-Hill Publications,1950,ISBN: 0074632175, 9780074632178
2. V. Ganapathy: **"Applied Heat Transfer",** Penn Well Publishing Company, Tulsa, Oklahoma, 1982.
3. Sarit Kumar Das, A. R. Balakrishan: **"Process Heat Transfer",** Alpha Science International, 2005.
4. EI Wakel M.M : **"Power plant technology",** , McGraw Hill 1984, **ISBN: 0070702446, 9780070702448**
5. P.K.Nag: **"Power Plant Engineering",** 2"d Ed. Tata McGraw Hill, 2000
6. Bejan, Heat Transfer, Wiley, New York,1993

Dynamics of Energy Conversion

Subject Code: 14TEEL33 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

The Laws of Energy: Energy in motion, First Law, Second Law, Entropy, Entropy and Irreversibility, Cyclical and direct Energy Conversion.

06 Hrs

Unit-II

Equations for Transient Phenomenon: State, Properties and Processes, Enthalpy, Conservation of mass, Momentum, and energy, Exergy, Direct energy conversion, Heat transfer, Friction, Simple Analogies to formulate thermal problems.

08 Hrs

Unit-III

Predicting Reserves of Energy Disclaimer and Method: Resource lifetime and the Laws of Thermodynamics, Projecting into the past, Fuels, Renewable, Other types.

06 Hrs

Unit-IV

Fossil Fuels and their Technology: Natural Gas-Gas Turbine and cogeneration, Efficiencies, Basic operational Principle, Transient equations of heat transfer in Gas Turbines. Oil-The IC Engine, Expansion work and Temperature, Simulation of one cylinder Engine Coal-Coal fired power generation Nuclear Power.

10 Hrs

PART - B

Unit-V

Renewable Technology: Photovoltaic-PV Cells, Inverter, Batteries, Wind-Operational Principle of wind turbines, Rotor, Generator, Tower, Area requirements, Solar Thermal-Solar Collectors, Configuration of a solar collector, Bio-mass, Hydropower.

08 Hrs

Unit-VI

Après Conversion: Utilization Technology Residential-Electric Motors, Lighting, Heating/Cooling with Electricity, Heating with Natural Gas. Commercial Technologies: Industrial, Steel, Aluminum, Paper, Plastics, Transportation Chain Efficiencies, Steady State efficiencies, Extraction Costs, Energy Conversion/Distribution Efficiencies, Storage efficiency, End Use Efficiency, Energy Analysis.

10 Hrs

Unit-VII

Energy and its Sequels: Combustion-Natural Gas, Oil, Coal, Nuclear, Renewables, **Dynamic Modeling**: Variables and Elements, General forms of commonly used Laws, Programming in VisSim, Constants and operations, Dynamic Simulation.

06 Hrs

Unit – VIII

The Future: Coal-Many possible futures, Co_2 capture and its Possibilities, Cogeneration Cycles, Waste Disposal, New Wind and Solar Concepts.

06 Hrs

TEXTS / REFERENCE BOOKS:

1. Horacio Perez-Blanco **: "The Dynamics of Energy: Supply, Conversion and Utilization**", CRC Press, 2009 Taylor and Francis Group, ISBN: 978-1-4200-7688-2(Hard Book)
2. **The dynamics of energy consumption: changing expectations for the supply of goods and services** - Issue 7 of Report (New Zealand Energy Research and Development Committee),Authors: James Talbot Baines, Nelson John Peet, University of Canterbury. Dept. of Chemical Engineering, New Zealand Energy Research and Development Committee
3. Khalid R. Al-Rodhan: "**The changing dynamics of energy in the Middle East",** Anthony H. Cordesman, Khalid R. Al-Rodhan Greenwood Publishing Group, Volume 2,ISBN20060275992624, 9780275992620

Jet and Rocket Propulsion

Subject Code: 14TEEL34 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

Gas Turbine Cycles: Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants.

10 Hrs

Unit-II

Thermodynamics of aircraft jet engines: aero-thermodynamics of jet propulsion subsystems, performance of rocket vehicles, chemical rocket thrust chambers, chemical rocket propellant combustion & expansion.

10 Hrs

Unit-III

Theory of Jet Propulsion - Thrust and efficiency - Ram Jet - Turbojet and Turbofan engines - Turboprop and Turbo shaft Engines - Thrust augmentations - Typical engine performance - Engine - Aircraft matching.

10 Hrs

PART - B

Unit-IV

Subsonic inlets - Supersonic inlets - Gas turbine combustors - After burners and Ramjet Combustors - Supersonic Combustion - Exhaust Nozzles.

10 Hrs

Unit-V

Static performance - Vehicle acceleration - Chemical rockets - Electrical rocket vehicles - Space missions. Performance Characteristics - Nozzles - Rocket Heat Transfer.

10 Hrs

Unit-VI

Liquid Propellant Rocket Performance : Liquid propellants - Equilibrium composition - Non equilibrium expansion - Liquid - Propellant combustion chambers - Combustion Instabilités.

10 Hrs

TEXT / REFERENCE BOOKS:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition - Wesley Publishing Company, New York, 1992.
2. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons Inc, New York, 1970.
3. Zucrow N.J. Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc, New York, 1975.
4. Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1985.
5. S.M. Yahya, Gas Dynamics and Jet Propulsion. McGraw Hill

Theory of IC Engines

Subject Code: 14TEEL41 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

Engine Design and Operating Parameters: Engine characteristics, geometrical properties of reciprocating engines, brake torque, indicated work, road load power, m.e.p., s.f.c. and efficiency, specific emissions and emission index, relationships between performance parameters, Engine design and performance data.

10 Hrs

Unit-II

Alternate fuels for I.C engines: Vegetable oils, alcohol's, L.P.G, C.N.G, properties, emission characteristics, F/ A ratio.

06 Hrs

Unit-III

Ideal models for engine cycles: Thermodynamic relation for engine process, Ideal Cycle analysis, fuel-air cycle analysis, over expanded engine cycles, Availability analysis of engine processes, comparison with real engine cycle.

08 Hrs

Unit-IV

SI Engines fuel metering, manifold phenomena: S.I. Engine mixture requirements, carburetors, fundamentals and design, fuel injection systems, feedback systems, flow past throttle plate, flow in in-take manifold.

08 Hrs

PART - B

Unit-V

Combustion in IC Engines: Combustion in SI Engines – Flame front propagation, flame speed, rate of pressure rise, knock in SI engines; combustion in CI engines – ignition delay period, rapid and controlled combustion, factors affecting delay period, knock in CI engines.

08 Hrs

Unit – VI

Engine Operating Characteristics: Engine performance parameters, Effect of spark-timing, Mixture composition, load and speed and compression ratio on engine performance, efficiency and emissions, SI engine combustion chamber design and optimization strategy, Testing of SI engine.

08 Hrs

Unit – VII

Instrumentation: Pressure measurement in engines, recording pressure and crank angle diagram, measurement of pollutants.

06 Hrs

Unit - VIII

Engine emissions and their control: Air pollution due to IC engines, Euro norms I & II, engine emissions, emission control methods – thermal converters, catalytic converters, particulate traps, Ammonia injection systems, exhaust gas recirculation.

06 Hrs

TEXT / REFERENCE BOOKS:

1. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill Education, 2008 ISBN: 0070648174, 9780070648173
2. John B. Heywood, "IC Engines fundamentals", McGraw-Hill Publications ,1988 ISBN: 007028637X, 9780070286375
3. C.R. Fergusan, "Internal Combustion Engines, Applied Thermo sciences", Wiley, 1986, ISBN: 0471881295, 9780471881292.

Thermal Storage Technologies

Subject Code: 14TEEL42 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

Introduction: Necessity of thermal storage – types-energy storage devices – comparison of energy storage technologies - seasonal thermal energy storage - storage materials.

10 Hrs

Unit-II

Sensible Heat Storage Systems: Basic concepts and modeling of heat storage units - modeling of simple water and rock bed storage system – use of TRNSYS – pressurized water storage system for power plant applications – packed beds.

14 Hrs

PART - B

Unit-III

Regenerators: Parallel flow and counter flow regenerators – finite conductivity model – non – linear model – transient performance – step changes in inlet gas temperature – step changes in gas flow rate – parameterization of transient response – heat storage exchangers. **16 Hours** **Unit-IV**

Latent Heat Storage Systems: Modeling of phase change problems – temperature based model - enthalpy model - porous medium approach - conduction dominated phase change – convection dominated phase change. **10 Hours**

Unit-V

Applications: Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries. **10 Hours**

TEXT / REFERENCE BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, JohnWiley & Sons 2002.
2. Schmidt.F.W and Willmott.A.J, Thermal Storage and Regeneration, Hemisphere Publishing Corporation, 1981.
3. Lunardini.V.J, Heat Transfer in Cold Climates, John Wiley and Sons 1981.

Experimental Techniques in Energy / Thermal Systems

Subject Code: 14TEEL43 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

Introduction: Basic concepts of measurement methods, single and multi point measurement Minimum space and time. Processing of experimental data, curve fitting and regression analysis.

06 Hrs

Unit-II

Optical Techniques: Pyrometers, Radiation thermometers and interferometers, **Humidity Measurement:** Conventional methods, electrical transducers: Dunmox humidity and microprocessor based dew point instrument, Calibration humidity sensors.

10 Hrs

Unit-III

Flow and Velocity Measurement: Industrial flow measuring devices, selection and calibration. velocity measurements, pitot tubes, yaw tubes, pitot static tubes; frequency response and time constant calculation. Hot-wire anemometer; 2d/3d flow measurement and turbulence measurement. Laser application in flow measurement. Flow visualization techniques. Combustion photography.

12 Hrs

Unit-IV

Pressure Measurement: Analysis of liquid manometer, dynamics of variable area and inclinedmanometer. Pressure transducers design and analysis.

08 Hrs

PART - B

Unit-V

Speed and Torque Measurement: Design and development of instrument for speed and torque measurement of rotating system; Application in IC engines.

06 Hrs

Unit-VI

Air Pollution Sampling and Measurement; Units for pollution measurement, gas sampling techniques, particulate sampling technique, gas chromatography.

06 Hrs

Unit-VII

Data Acquisition Systems: Fundamentals of digital signals and their transmission, A/D-and D/A converters, Basic components of data acquisition system.

06 Hrs

Unit – VIII

Computer interfacing of digital instrument and data acquisition systems; Digital multiplexes, Data acquisition board (DAQ), Digital image processing fundamentals.

06 Hrs

TEXT / REFERENCE BOOKS:

1. S J. P Holman: "**Experimental Methods for Engineers"** Mcgraw-Hill College; 6th Revised edition edition (September 1993), **ISBN-10:** 0070296669,**ISBN-13:** 978-0070296664
2. E. O Doebelon: "**Measurements systems Application and Design" Mc Graw Hill 1975**.
3. Beckwith and Buck: "**Mechanical measurements" Pearson Education India, 2007, 8131717186, 9788131717189**

Computational Fluid Dynamics

Subject Code: 14TEEL44 **IA Marks: 50**
Credits: 04 **Exam Marks: 50**
Hrs/week: 04 **Total hrs: 60**

Examination Question Paper Pattern

- All questions carry equal marks
- Answer any FIVE full questions, selecting at least two from each PART A & PART B

PART - A

Unit-I

Introduction: Difference between Experimental, Analytical and Computational approaches of solving heat transfer and fluid flow problems, Merits and Demerits of CFD, Reliability of CFD, Advantages of CFD, Applications of CFD as a research tool, as an education tool to learn basic thermal – fluid science, as a design tool, Application in aerospace, automotive Engineering, chemical and mineral processing, civil and environmental Engineering, power generation, sports, The future of CFD, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

08 Hrs

Unit-II

Governing Equations for CFD – Fundamentals: The continuity equation, Momentum equation, Energy equation, The physical interpretation of mass conservation, force balance and energy conservation equations.

06 Hrs

Unit-III

Partial Differential Equations: Classification, Physical and Mathematical, Equilibrium problems, Marching Problems, Hyperbolic, Parabolic and Elliptic Partial Differential equations.

06 Hrs

Unit-IV

Numerical Methods: Solution of simultaneous algebraic equations using Gauss Elimination, Gauss Jordan, Gauss Sidal Iteration, L-U Decomposition methods, Solution of first and second order ordinary Differential equations using Taylors method, Euler' s and Euler's modified method, Runge Kutta fourth order method.

10 Hrs

PART - B

Unit-V

Finite Difference: Discritization, consistency, stability and fundamentals of fluid flow modeling, application in heat conduction and convection, steady and unsteady flow.

10 Hrs

Unit-VI

Solution of viscous incompressible flow: Stream function and vorticity formulation. Solution of N S equations for incompressible flow using MAC and SIMPLE algorithms.

06 Hrs

Unit-VII

Finite volume method: Introduction, regular finite volume, discritization techniques, interpolation methods; central, upwind and hybrid and higher order formulations. application to steady fluid flow and heat transfer

07 Hrs

Unit – VIII

Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping, **Turbulence modeling:** Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES. **07 Hrs**

TEXT / REFERENCE BOOKS:

1. Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu: **"Computational Fluid Dynamics, A Practical Approach",** Butterworth – Heinemann, An imprint of Elsevier, 2008.
2. John C. Tannehill, Dale A. Anderson, Richard H. Pletcher: **"Computational Fluid Mechanics and Heat Transfer"**, Taylor and Francis, 1997
3. Muralidhar, K. and Sundararajan T.: "**Computational Fluid Flow and Heat Transfer"**, Narosa Publishing House, New Delhi, 1995.
4. Subas V Patankar: "**Numerical Heat Transfer Fluid Flow"**, Hemisphere Publishing Corporation, 1980.
5. Ozisik M.N.: "**Heat Transfer – A Basic Approach",** McGraw-Hill Publications, 1985**.**
6. Ghoshdasdidar, P.S, Computer Simulation of Flow and Heat Transfer, TATA - McGraw-Hill Publishing Company Ltd., 1998.
7. Versteeg and Malalasekera, Computational Fluid Dynamics – A Finite Volume Approach, 2nd Edition, Prentice Hall, 2007

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

Master of Technology

CET - Thermal Engineering

III

Semester

Industrial Training / Internship

JAIN UNIVERSITY
Declared as Deemed-to-be University u/s 3 of the UGC Act,1956

Master of Technology

Thermal Engineering

IV Semester

PROJECT WORK