M. TECH. IN THERMAL ENGINEERING

NETAJI SUBHAS UNIVERSITY, JAMSHEDPUR

Estd. Under Jharkhand State Private University Act, 2018 Approved by AICTE, PCI, BCI, NCTE, INC & JNRC

EVALUATION SCHEME & SYLLABUS
FOR
MASTER OF TECHNOLOGY
IN
Thermal Engineering

(M. TECH-MT)

On Choice Based Credit System (Effective from the Session: 2025-26)

Netaji Subhas University
Pokhari, Near Bhilai Pahadi, Jamshedpur, Jharkhand

M. TECH. IN THERMAL ENGINEERING

VISION

To strive for excellence in education, research, and entrepreneurship, with the ultimate goal of becoming a global hub for innovation. Committed to advancing scientific and technological services, we aim to contribute meaningfully to society.

MISSION

- To provide high-quality education that nurtures innovation, entrepreneurship, and ethical values, shaping future professionals equipped for a globally competitive landscape.
- To collaborate with stakeholders by sharing institutional expertise in education and knowledge, fostering mutual growth in technical learning.
- To Cultivate an environment that encourages fresh ideas, groundbreaking research, and academic excellence, paving the way for future leaders, innovators, and entrepreneurs.
- To drive socio-economic progress by offering impactful scientific and technological solutions to society.

PROGRAMME EDUCATION OBJECTIVES (PEOs)

PEO1: Postgraduates will develop advanced theoretical and practical knowledge in thermal engineering to solve real-world and research-oriented problems.

PEO2: Postgraduates will engage in high-quality research, innovation, and development of new thermals engg. processes and technologies.

PEO3: Postgraduates will demonstrate professionalism, ethical responsibility, and leadership in academic, industrial, and research organizations.

PEO4: Postgraduates will pursue doctoral studies, postdoctoral research, or continuous professional development to stay updated with emerging trends.

PEO5: Postgraduates will apply their skills to contribute meaningfully to sustainable development and address societal and environmental challenges.

PROGRAMME OUTCOMES (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: An ability to handle techno-scientific challenges of the society.

M.Tech. in Thermal Engineering – Semester-wise Course Distribution

1st Semester

Course Code	Course Title	Credits
MTE501	Classical and Statistical Thermodynamics	4
MTE502	Advanced Incompressible Fluid Flow	4
MTE503	Conduction and Radiation Heat Transfer	3
MTE504	Renewable Energy Technology	3
MTE505	Theory and Design of I.C. Engines	3
MT506 (Optional I)	Computational Methods in Thermal Engineering	3
MTE508	Advanced Fluid Mechanics Lab	2

2nd Semester

Course Code	Course Title	Credits
MTE511	Convective Heat and Mass Transfer	4
MTE512	Modern Power Plant Engineering	4
MTE513	Design of Thermal Systems	3
MTE514	Computational Fluid Dynamics	3
MTE515	Advanced Energy Technology	3
MTE516	Advanced Heat Transfer Lab	2
MT517 (Optional II)	Energy Management Principles and Auditing	3

3rd Semester

Course Code	Course Title	Credits
TH501	Thesis / Research Work – Phase I	20

4th Semester

Course Code	Course Title	Credits
TH 502	Thesis / Research Work – Phase II (Final Submission)	20

COURSE INFORMATION SHEET

1st Semester

MTE501: Classical and Statistical Thermodynamics

Subject Code	MTE501	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1:

Review of I and II Laws of Thermodynamics: Transient flow analysis, entropy balance for flow and non- flow systems, entropy generation. properties of pure substance, PVT surface, Third law of thermodynamics, Nerst heat theorem. (8L)

Module 2:

Exergy Analysis: Concepts, exergy balance analysis for flow, non-flow and transient systems, exergy transfer, exergetic/ Second Law efficiency, Second Law analysis of different thermal systems. (8L)

Module 3:

Real Gases and Mixtures: Equations of state- vander wall's equation of state and other equation of state, virial expansion, Law of corresponding state, compressibility factor, reduced coordinate system and generalized compressibility chart.

Thermodynamic Relationships: First order phase transition and Clapeyron's equation, second order phase transition and Ehrenfest's equations, Maxwell's equations: equations for internal energy, enthalpy, entropy, specific heat, and Joule-Thomson coefficient. (8L)

Module 4:

Chemical Thermodynamics: Gibb's theorem, Gibb's function of mixture of inert ideal gases. Chemical equilibrium, Thermodynamics equation for phase, degree of Reaction, equation of reaction equilibrium, Law of Mass Action, Heat of Reaction and Vant hoff Isobar, Saha's equation for standard Gibb's function change, affinity. (8L)

Module 5:

Statistical Thermodynamics: Importance of statistical anlysis, Stirling's approximation, Bose-Einstein statistics and Fermi-Dirac statistics, classical Maxwell-Boltzman model, equilibrium distribution, microscopic interpretation of heat and work, entropy, second law of thermodynamics, partition function and its properties. (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Explain fundamental laws of thermodynamics and apply them to steady and unsteady systems.	K2, K3
CO2	Analyze exergy and second law efficiencies in thermal systems.	K4
CO3	Evaluate thermodynamic properties of real gases and mixtures using various equations of state.	K4
CO4	Apply principles of chemical thermodynamics to equilibrium and reaction kinetics.	K3, K4
CO5	Interpret thermodynamic behavior using statistical mechanics concepts.	K2, K4

CO–PO Mapping Matrix:

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	0	0	0	1	1	0
CO2	3	3	2	2	1	0	0	0	1	1	0
CO3	3	2	2	2	1	0	0	0	1	1	0
CO4	2	2	3	2	1	0	0	0	1	1	0
CO5	2	2	2	2	1	0	0	0	1	1	0

Text Books

1. P.K. Nag, Basic and Applied Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd., 2010.
2. Yonus A Cengel and Michale A Boles, Thermodynamics: An Engineering Approach, McGraw Hill, 2002.
3. A. Bejan, Advanced Engineering Thermodynamics, John Wiley & Sons, 2006.

Reference Books

1. M. J. Moran and H. N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons, 1999.
2. J. B. Jones and R. E. Duggan, Engineering Thermodynamics, Prentice-Hall of India, 1996.

MTE502: Advanced Incompressible Fluid Flow

Subject Code	**MTE502**	**IA Marks**	**30**
Number of Lecture Hours/Week	**04**	**Term End Exam Marks**	**70**
Total Number of Lectures per Hour	**40**	**CREDITS**	**04**

SYLLABUS

Module 1:

Definition and properties of fluids, fluid as continuum, Lagragian and Eulerian description of fluid flow, velocity and stress field, fluid statics, fluid kinematics. stream and velocity potential function, circulation, irrotational vortex.

Potential flows: Uniform stream, source and sink, vortex flow, doublet, superposition of basic plane potential flows, flow past a half body, flow past a Rankine Oval body, flow past a circular cylinder, concept of lift and drag. (8L)

Module 2:

Reynolds transport theorem, Integral and differential forms of governing equations, mass, momentum and energy conservation equations, Navier Stokes equations and its formulation, solution of Navier Stokes equations like Couette flow, Poiseuille flow, Hagen Poiseuille flow, flow between two concentric rotating cylinders, theory of Hydrodynamic lubrication, flow around a sphere, Stokes first and second problem. (8L)

Module 3:

Boundary layer equations, boundary layer thickness, boundary layer on a flat plate, similarity solutions, integral form of boundary layer equations, approximate methods, flow separation, developing flow in a duct. (8L)

Module 4:

Introduction to Hydrodynamic Stability, Why do instabilities occur ?,Concept of small-disturbance stability,Linear stability theory, Rayleigh–Taylor instability, Kelvin-Helmholtz instability, Orr-Sommerfeld and Squire equations, Squire’s transformation and Squire’s theorem, inviscid stability theory, capillary Instability of a Jet, asymmetric instability of a liquid jet ,instability due to shear, stability of parallel shear flows, boundary layer stability, thermal instability, mechanics of boundary layer transition. (8L)

Module 5:

Characteristics of turbulent flow, general equations of turbulent flow, turbulent boundary layer equation, flat plate turbulent boundary layer, turbulent pipe flow, Prandtl mixing hypothesis. Turbulence modeling - Zero equation model: mixing length model, One equation model: Spalart-Almaras, Two equation models: k- ε models (standard, RNG, realizable), k- ω model, and ASM, Seven equation model: Reynolds stress model, free turbulent flows. Numerical examples. Basic concepts on flow simulation using softwares. (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Describe fundamental fluid dynamics concepts and their mathematical formulation.	K2, K3
CO2	Analyze laminar and turbulent flow using Navier-Stokes equations.	K4
CO3	Evaluate boundary layer flow and stability under various conditions.	K4
CO4	Apply turbulence models and flow simulations to practical problems.	K3, K5
CO5	Use hydrodynamic stability theory in analyzing flow instabilities.	K4, K5

CO–PO Mapping Matrix:

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	0	0	0	1	1	0	0
CO2	3	3	2	3	2	0	0	0	1	1	0	0
CO3	2	3	3	3	2	0	0	0	1	1	0	0
CO4	2	2	3	3	3	0	0	0	1	1	0	0
CO5	2	2	2	3	3	0	0	0	1	1	0	0

Text Books

1. Advanced Engineering Fluid Mechanics, Muralidhar K. and Biswas G., Narosa, 2016.
2. Fluid Mechanics, Pijush K. Kundu and Ira M. Cohen, Academic Press ELSEVIER, 2011.
3. Introduction to Fluid Mechanics and Fluid Machines, Som S. K. Biswas G, Chakraborty S , Tata McGraw Hill, 2017.

Reference Books

1. Fluid Mechanics, Frank M. White, Tata McGraw-Hill, 2017.
2. Boundary Layer Theory, Schlichting H., Springer Verlag, 2014.
3. Turbulence: An Introduction for Scientists and Engineers, Davidson P.A., Oxford Publication, 2015.

MTE503: Conduction and Radiation Heat Transfer

Subject Code	MTE503	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1:
Multidimensional conduction-I: Introduction, integral form of governing equation, differential form of governing equation, simplified form of energy equation, thermal diffusivity, one-dimensional transient conduction: transient in a semi-infinite solid, approximate integral method due to Goodman, one dimensional transient problem: space domain finite, steady conduction in two dimensions: steady conduction in rectangle, steady conduction in a rectangle with heat generation, steady two-dimensional conduction in cylindrical co-ordinates, shape factors for some useful configurations, solution to Laplace equation in cylinder, solution to a practical problem, solution to Laplace equation in spherical co-ordinates. (8L)

Module 2:
Multidimensional conduction-II: Introduction, basic problem in Cartesian coordinates, basic problem in cylindrical coordinates, basic problem in spherical co-ordinates, one term approximation and Heisler charts: one term approximation of the slab transient, one term approximation of the cylinder transient, one term approximation of the sphere transient, transient conduction in more than one dimension: Introduction, transient conduction in an infinitely long rectangular bar, transient heat conduction in a rectangular block in the form of a brick, transient heat conduction in a circular cylinder of finite length. (8L)

Module 3:
Thermal radiation: the physics of radiation, thermodynamics of black body radiation, Planck distribution, properties of the Planck distribution functions, shape factor of complicated geometry, use of graphs for finding shape factors, radiation irradiation method of enclosure analysis, Enclosure containing diffuse non-gray surfaces, gray enclosures containing diffuse and specular surfaces. (8L)

Module 4:
Radiation in participating media: Introduction, definitions, equation of transfer, absorption of radiation in different media: transmittance of a solid slab, absorption of radiation by liquids, absorption of radiation by gases, radiation in an isothermal gray gas slab and the concept of mean beam length, modeling of gas radiation: basics of gas radiation modeling,

band models, radiation in a non-isothermal participating medium: radiation transfer in a gray slab, radiation equilibrium, solution of integral equation, enclosure analysis in the presence of an absorbing and emitting gas: zone method, example of zone analysis. (8L)

Module 5:

Exact solution for one-dimensional gray media: Introduction, general formulation for a plane parallel Medium, radiative equilibrium of a non-scattering medium, radiative equilibrium of a scattering medium, plane medium with specified temperature field, radiative transfer in spherical media, radiative transfer in cylindrical media, numerical solution of the governing integral equations. (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Formulate and solve multidimensional heat conduction problems.	K3, K4
CO2	Apply transient heat conduction analysis in different coordinate systems.	K4
CO3	Explain thermal radiation principles and calculate heat exchange.	K2, K3
CO4	Analyze radiative transfer in participating media.	K4
CO5	Model radiation using analytical and numerical techniques.	K4, K5

CO–PO Mapping Matrix:

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	0	0	0	1	1	0	0
CO2	3	3	3	2	2	0	0	0	1	1	0	0
CO3	2	2	2	2	1	0	0	0	1	1	0	0
CO4	2	2	3	3	2	0	0	0	1	1	0	0
CO5	2	2	3	3	2	0	0	0	1	1	0	0

Text Books

1. Heat Transfer, S. P. Venketeshan, Ane books Pvt. Ltd, 2016.
2. Radiative Heat Transfer, M. F. Modest, McGraw-Hill, Inc, 2013.

Reference Books

1. Heat and Mass transfer, P. K. Nag, McGraw-Hill Publications, 2011.
2. Heat transfer, A. F. Mills and V. Ganeshan, Pearson Education, 2009.
3. Fundamental of heat and mass transfer by Sarit k das , Narosa publication, 2010.
4. Heat and Mass transfer by Domkundwar and Arora, Dhanpat rai & sons, 2007.

MTE504: Renewable Energy Technology

Subject Code	MTE504	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1:
Introduction, Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system, Solar Cookers, Solar driers, Solar Still, Solar Furnaces, Solar Green Houses. Solar Photovoltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies. (8L)

Module 2:
Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram. (8L)

Module 3:
Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifiers, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass, Biomass programs in India. (8L)

Module 4:
Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts. Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy: Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation. Geothermal Energy: Introduction, Capacity and Potential, Resources of geothermal energy. (8L)

Module 5:

Energy and Exergy Analysis: Energy Matrices, Embodied Energy, Embodied Energy and Annual Output of Renewable Energy Technologies, Exergy Analysis, CO_2 Emissions, Earned Carbon Credit. (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Understand the fundamentals and applications of solar energy systems.	K2, K3
CO2	Evaluate the design and performance of wind energy systems.	K4
CO3	Analyze biomass energy conversion techniques and their impacts.	K4
CO4	Explain the working of hydropower, tidal, and geothermal systems.	K2, K3
CO5	Perform energy and exergy analysis of renewable energy systems.	K4, K5

CO–PO Mapping Matrix:

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	2	3	1	1	1	0	0
CO2	2	3	2	3	2	2	3	1	1	1	0	0
CO3	2	2	3	3	2	3	3	1	1	1	0	0
CO4	2	2	2	2	2	3	3	1	1	1	0	0
CO5	2	3	3	3	3	3	3	1	1	1	0	0

Text Books

1. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, 2000.
2. Non-Conventional Energy Resources, B. H. Khan, The McGraw Hill, 2017.
3. G N Tiwari, R K Mishra, Advanced renewable energy sources, RSC Publishing, 2012
4. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN Spon Ltd., UK, 2006.
5. Solar Energy – Principles of Thermal Collection and Storage, S. P. Sukhatme and J.K. Nayak, Tata McGraw-Hill, New Delhi, 2008.
6. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill, 2017.

Reference Books

1. Solar Energy, Sukhatme. S.P., Tata McGraw Hill Publishing Company Ltd., 1997.
2. Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, U.K., 1996.
3. Biogas Technology – A Practical Handbook, Khandelwal, K.C., Mahdi, S.S., Tata McGraw-Hill, 1986.
4. Solar Energy – Fundamentals Design, Modelling & Applications, Tiwari. G.N., Narosa Publishing House, New Delhi, 2002.
5. Wind Energy Conversion Systems, Freris. L.L., Prentice Hall, 1990.
6. Principles of Solar Energy, Frank Krieth & John F Kreider, John Wiley, New York, 1987.

MTE505: Theory and Design of I.C. Engines

Subject Code	MTE505	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1:

Performance Parameters and Characteristics: Indicated and brake mean effective pressure, IP &BP, air standard, indicated and brake thermal, mechanical, relative, volumetric, scavenging, charge and combustion efficiencies, effect of spark timing, mixture composition, load, speed, and compression ratio on engine performance and efficiency. Performance characteristics and variables affecting the performance characteristics, Methods of improving Engine performance, Performance maps. (8L)

Module 2:

Alternate Fuels: Solid, Liquid and gaseous fuels, Liquid fuels- Alcohol, methanol, ethanol, reformulated gasoline, water gasoline mixture, Gaseous fuels- Hydrogen, natural gas, CNG,LPG, their advantages and disadvantages, Biogas, dual fuel operation. Emission from alternative fuels, status of alternative fuels in India. (8L)

Module 3:
Air Capacity of Four-Stroke Engines and Supercharging: Ideal air capacity, volumetric efficiency, effect of engine variables on volumetric efficiency, supercharging for S.I. and C.I. engines, types of superchargers and their characteristics, exhaust supercharging, performance of supercharged engines. Multi-Point Fuel Injection (MPFI) system, Electronic Diesel Injection System, CRDI system and its advantages and disadvantages. (8L)

Module 4:
Engine Emissions and their control: Air pollution due to IC engines, Exhaust and non-exhaust emissions, HC, CO and NOx emissions and their causes, Photochemical smog, Particulates, Aldehyde, sulphur, lead, phosphorous emissions, Emission control methods. (8L)

Module 5:
Engine Design: General design concept of IC engine, design of principal parts of IC engine cylinder head, pistons, connecting rod, crank shaft, radiator and fin. (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Explain fundamental principles of IC engine design	K2, K3
CO2	Analyze engine performance parameters	K4
CO3	Evaluate emission control techniques	K4
CO4	Design engine components for efficiency	K5
CO5	Optimize engine systems using modern tools	K6

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. Internal Combustion Engine, Ganesan,V., McGraw Higher Ed., 2012.
2. Internal Combustion Engines, Obert,E.F., International Textbook Co., 1968.

3. The Internal Combustion Engines in Theory and practice, Taylor,C.F., MIT Press, 1985.

Reference Books

1. Internal Combustion Engines, Mathur,R.P. & Sharma,M.L., Dhanpat Rai Publication, 2014.
2. Diesel Engine Design, Purdey,H.F.P., Nabu Press, 2010.
3. Internal Combustion Engines, Maleev,V.L., McGraw-Hill Book Company, 1945.

MTE506: Computational Methods in Thermal Engineering

Subject Code	MTE506	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1:

Root finding: Complex algebraic and transcendental equations. Solution of linear equations by LU decomposition and Newton Raphson method, Root finding used in integration, evaluation of areas, surface of revolution, length of curve and volumes. (8L)

Module 2:

Evaluation of centroid of regular geometric bodies, Double integration to compute areas, triple integration to compute volumes and quadruple integration to compute view factors, Interpolation and its use in thermal engineering. (8L)

Module 3:

Solution of ordinary differential equations, Runge-Kutta method and Euler method, Solution of non-linear equations of any order and any degree, Solution of initial value problems and boundary value problems, Solution of boundary value problem through initial value problems, shooting method, optimization of objective functions to determine the solution of boundary value problems. (8L)

Module 4:

Application of shooting method or the optimization method to solve thermal engineering problems like: boundary layer flow on a flat plate, thermal boundary layer on a vertical and flat plate, flow near a rotating disk, Falkner-Skan wedge flow, travel of projectile in air with drag, temperature distribution in a circular fin, triangular fin and general solution to steady 1D heat conduction in any shape. (8L)

Module 5:
Introduction to finite difference (FD) method, Forward, Backward, CD and upwind schemes, Solution of ODE by FD method, Introduction to stability, numerical errors and accuracy, Application of finite difference method to thermal engineering problems, Solution of hydrodynamic and thermal boundary layer equations by FD method, Solution of Falkner-Skan problem by FD method, Extensive Application to transient heat transfer by FD method. FD method used for 2D and 3D problems. Demonstration and use of software such as EES to apply different methods and solve system of equations (linear or nonlinear) mentioned above.
(8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Apply numerical methods to solve thermal problems	K3, K4
CO2	Analyze ODEs/PDEs in heat transfer contexts	K4
CO3	Evaluate computational fluid dynamics techniques	K4
CO4	Simulate thermal systems using software tools	K5
CO5	Optimize solutions using finite difference methods	K6

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. Iyenger, Jain, Numerical Methods Numerical Methods for Scientific & Engineering Computation, New age international Pvt. Ltd., 2003.
2. Dennis Zill, Warren Wright, Advanced Engineering Mathematics, Jones and Bartlett Publishers, 2010.
3. K. E. Atkinson, An Introduction to Numerical Analysis, John Wiley & Sons, 1989.

Reference Books

1. John D Anderson Jr, Computational Fluid Dynamics, McGraw Hill, 2017.
2. Hoffman Klaus, Computational Fluid Dynamics, Vol-1 & 2, 2000.
3. Sukanta K Dash, Engineering Equation Solver: Application Engineering and thermal engineering problems, Alpha Science International Ltd., 2013.

MTE507: Safety Aspects of Nuclear Power Plants

Subject Code	MTE507	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1:

Introduction: Energy sources, Nuclear Power Production, medical and Societal applications of radiation, Nuclear fuel cycle.
Basic Physics of Nuclear Reactors: Atomic Structure, isotopes, Radioactivity, half life, Basics of fission reaction, Moderation, Criticality, Decay heat, Reactivity and Feedback, Breeding. (8L)

Module 2:
Nuclear Reactor Types: Components of Nuclear Reactor, Present Reactor Types, Generation IV Concepts.
Radiation sources and Protection: Radiation and its units, Natural background and manmade Radiation, Biological Effects, Exposure limits and protection, Sources of radiation, shielding. (8L)

Module 3:
Safety Principles and approach: Safety objectives, Defence in depth philosophy, Multiple barriers, Rad-waste management, Levels of defence, Redundancy, Diversity Principles, Event analysis, core inventory, emergency response.
Deterministic approach- Design Basis Events & Beyond Design Basis Events, Acceptance Criteria, Probabilistic approach- Fault tree, event tree, failure rates.
Engineered Safety Systems: Shutdown systems in PWR, BWR,PHWR, Reactivity Worth of shutdown system, Trip Signals, Safety Logic, Operating Environment, Grouping of safety systems, Heat Removal systems, Emergency Core Cooling, Containment and subsystems. (8L)

Module 4:
Analysis of Some Events in NPP: Heat transfer and Fluid flow prediction, validation, Safety set points, Safety actions for events, Spurious opening of Pressuriser valve in a PWR, LOCA analysis Indian PHWR, Station Blackout without Reactor Trip, FBTR.
Siting of Nuclear plants: Site evaluation Stages, Site Rejection Criteria, Earthquake, Geological criteria, Meteorological considerations, Flooding, Tsunami, Shoreline erosion, chemical explosion, Radiological impact study, Radioactivity pathways to humans, environmental Impact study. (8L)

Module 5:

Safety Regulation In India: Atomic Energy Regulatory Board, functions, safety Documents, Safety Review of site, design, regulatory inspections, safety review for PFBR, Koodankulam, Regulatory review of operating plants, Licensing stages, licensing of operating personnel, Training simulator, safety up-gradation Review after TMI Chernobyl, Review after Fukushima, safety review for decommissioning, Safety Review of Radiation Facilities, medical X-ray units, Gamma irradiators. (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Explain nuclear reactor safety principles	K2, K3
CO2	Analyze radiation shielding techniques	K4
CO3	Evaluate probabilistic risk assessment methods	K4
CO4	Design safety protocols for nuclear plants	K5
CO5	Assess post-Fukushima safety upgrades	K6

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. G. Vaidyanathan, Nuclear reactor Safety- principles and concept, Yes Dee Publishing, 2017.

Reference Books

1. Samuel Glasstone, Nuclear Reactor Engineering, CBS Publishers & Distributors, 2004.
2. John R. Lamarsh, Introduction to Nuclear Engineering, Pearson Education India, 2014.

MTE511: Convective Heat and Mass Transfer

Subject Code	MTE511	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module1:

Similarity concepts in heat transfer for laminar and turbulent flows; Boundary layer equations; Boundary layer integral equation; similarity and integral solutions of flow over isothermal and non-isothermal flat plate, Numerical solution of the laminar boundary layer flow over a flat plate and viscous dissipation effects on flow over a flat plate. (8L)

Module 2:

Introduction to Turbulent Flows: governing equations, mixing length turbulence models, analogy solutions for heat transfer in turbulent flows, near walls region, transition from laminar to turbulent flow, analogy solution for boundary layer flows, numerical solution of turbulent boundary layer equations, viscous dissipation effects on turbulent boundary layer flow over a flat plate. (8L)

Module3:

Fully developed pipe and plane duct flow under constant heat flux and constant wall temperature; Pipe flow with developing temperature field; Fully developed laminar flow in ducts with other cross-sectional shapes. (8L)

Module 4:

Concept of free convection for vertical, horizontal and inclined plate and cylinders at constant heat flux and constant wall temperature; free convection in finned surfaces and PCBs; free convection in horizontal, inclined and vertical plane enclosures and in horizontal, inclined and vertical concentric cylindrical enclosures. (8L)

Module 5:

Significant parameters in convective mass transfer, application of dimensional analysis to Mass Transfer, Analogies among mass, heat, and momentum transfer, Convective mass transfer correlations, Mass transfer between phases, Simultaneous heat and mass transfer.
(8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level

CO1	Extend the similarity concept in velocity and thermal boundary layer for isothermal and non-isothermal cases.	K3
CO2	Examine the basics of turbulence model and analogy between flow field and heat transfer.	K4
CO3	Apply the boundary layer concept in pipe and duct flow for CHF and CWT conditions	K4
CO4	Formulate and estimate free convection heat transfer for CHF and CWT conditions.	K5
CO5	Explain and estimate convective mass transfer and simultaneous heat and mass transfer	K3

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books:

1. Y. A. Cengel and A. J. Ghajar, Heat and Mass Transfer, McGraw-Hill Education, 2014.
2. P. H. Oosthuizen and D. Naylor, An Introduction to convective Heat Transfer Analysis, 1999.

References Books:

1. Frank P. Incropera, David P. Dewitt, Principles of Heat and Mass transferr, John Wiley & Sons, 2011.
2. William M. Kays & Michael E Crawford, Convective Heat and Mass Transfer, McGraw-Hill Science/Engineering/Math, 1993.
3. Frank Kreith and Mark S. Bohn, Principles of Heat Transfer, West Publishing Company, 1993.
4. D.Q. Kern, Heat Exchange Design, McGraw-Hill Book Co., Inc., New York, 1950.

MTE512: Modern Power Plant Engineering

Subject Code	MTE512	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1

Steam powerplant: site selection, coal to electricity, general layout of thermal powerplant, high pressure boilers, waste heat boilers, boiler circulation theory, working principle of ESP, construction and working principles of main oil pumps, starting of oil pumps, AC, DC oil pumps, oil coolers, working principle and constructional detail of LP heaters, deaerators, HP heaters, HP/LP bypass circuit and its utility, various interlocks for operation, oil circuits in HP and LP bypass system, steam piping, design of steam piping, steam piping materials, insulation of steam piping. (10L)

Module 2

Nuclear powerplant: general components of nuclear reactor, heavy water reactors, breeder reactors, reactor containment design, cladding and structural materials, moderating and reflecting materials, control rod materials, shielding materials, Control and safety measures adopted in nuclear powerplant, types of nuclear wastes, radioactive wastes disposal systems, gas disposal systems. (5L)

Module 3

Combined cycle powerplant: introduction, classification of combined gas/ steam, mixed and cogeneration cycle, combined cycle powerplant in India, Various configurations of combined cycle powerplant, mixed cycle, thermodynamic analysis of combined cycle and cogeneration plant, advantage of combined-cycle power generation, exergy analysis of combined cycle. (9L)

Module 4

Non-conventional power generation: magneto hydro-dynamic power, thermo-ionic power generation, thermoelectric power generation, fuel cells, geo thermal energy, hydrogen energy system, solar power plant. (6L)

Module 5

Layout of electrical equipment, generator and exciter, switch gear installations, circuit breaker, relays, earthing of power system, protective devices and control systems used in powerplants, voltage regulation, selection of generating equipment, performance and operating characteristics of powerplants, load division, Definitions and different tariffs for domestic, commercial, industrial application, power factors and its effects, methods of improving powerplants. (10L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Explain and analyse the working principle of various components and improvement of efficiency in a steam power plant	K3
CO2	Explain and analyse the nuclear power plant and its safety measures.	K4
CO3	Analyse and evaluate the performance of combined cycle and its exergy analysis for further improvement.	K4
CO4	Explain the working principle of non-conventional power plant. Understand the mechanism of nuclear fission reaction and working principle of various nuclear power plants	K5
CO5	Explain different electrical components, operating characteristics of power plant and its improvements	K3

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. P. K. Nag, Power Plant Engineering, McGraw Hill publication, 2002.
2. M. M. EiWakil, Power Plant Technology, McGraw Hill publication, 2016.
3. F.T. Mores, Power Plant Engineering, D. Van Nostrand Company inc., 1953.

Reference Books

1. P. C. Sharma, A Textbook of Power Plant Engineering, Kataria publication, 2013.
2. Arora and Domkundwar, Power Plant Engineering, Dhanpat Rai and Co., 2016.

MTE513: Design of Thermal Systems

Subject Code	MTE513	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1: FORMULATION OF DESIGN PROBLEM

Engineering design, Design variables, Constraint or Limitation, Requirement and specifications, Conceptual design, Steps in design process, Material properties and thermal characteristics for thermal systems, Selection and substitution of materials. (9L)

Module 2: MODELLING OF THERMAL SYSTEMS

Basic features of modelling, Types of Models, Mathematical modelling, Physical modelling, Modelling Thermal equipment. (8L)

Module 3: NUMERICAL MODELING AND SIMULATION

Development of a numerical model, Modeling of individual components, Merging of different models, Accuracy and validation, System simulation, Dynamic simulation of lumped system and large system. (9L)

Module 4: ACCEPTABLE DESIGN OF THERMAL SYSTEM

Initial design, Design strategies, Application illustrations with suitable examples, Optimization of thermal systems. (7L)

Module 5: USE OF ARTIFICIAL INTELLIGENCE TECHNIQUES

Neural network, Fuzzy logic and genetic algorithm in thermal systems design and optimization with examples, Introducing idea of knowledge-based design in thermal systems. (7L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Outline the thermal and material characteristics for selection of materials for thermal systems.	K3

CO2	Select suitable mathematical and physical model for different thermal equipment.	K4
CO3	Analyse numerical model for system simulation for accuracy and validation	K4
CO4	Evaluate performance of thermal systems using optimization technique.	K5
CO5	Testing the thermal systems performance using neural network, fuzzy logic and genetic algorithm.	K3

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. Design and Optimization of Thermal Systems, Y. Jaluria, R.C Press, 2007.
2. Optimization in Engineering Design, K. Deb, Prentice Hall, 2002.
3. Design of Thermal Systems, W.F Stoecker, McGraw-Hill, 1971.

Reference Books

1. Thermal Design and Optimization, Bejan, G. Tsatsaronis, M.J Moran, Wiley, 1996.
2. Design and Simulation of Thermal Systems, N.V. Suryanarayana, McGraw Hill, 2002.

Course Evaluation:
Individual assignment, Seminar, Theory (Internal Exam and End semester) examinations

MTE514: Computational Fluid Dynamics

Subject Code	MTE514	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1:

Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, A brief overview of the basic conservation equations for fluid flow and heat transfer, conservative and non-conservative forms of equation, classification of partial differential equations and pertinent physical behaviour, parabolic, elliptic and hyperbolic equations, role of characteristics. (7L)

Module 2:

Common methods of discretization: an overview of finite difference, finite element and finite volume methods. Numerical solution of parabolic partial differential equations using finite-difference and finite volume methods: explicit and implicit schemes, consistency, stability and convergence. Numerical solution of systems of linear algebraic equations: general concepts of elimination and iterative methods, Gaussian elimination, LU decomposition, tridiagonal matrix algorithm. (9L)

Module 3: Jacobi and Gauss-Seidel iterations, necessary and sufficient conditions for convergence of iterative schemes, gradient search methods, steepest descent and conjugate gradient methods. The finite volume method of discretization for diffusion problems: one dimensional steady diffusion problems, specification of interface diffusivity, source-term linearization. Discretization of transient one-dimensional diffusion problems. (8L)

Module 4: Discretization for multi-dimensional diffusion problems. Solution of discretized equations using point and line iterations, strongly implicit methods and pre-conditioned conjugate gradient methods. Convection diffusion problems: Central difference, upwind, exponential, hybrid and power law schemes, concept of false diffusion, QUICK scheme. (8L)

Module 5: Numerical solution of the Navier-Stokes system for incompressible flows: stream-function vorticity and artificial compressibility methods, requirement of a staggered grid. MAC, SIMPLE, SIMPLEC and SIMPLER algorithms. An introduction to unstructured grid finite volume methods. Special topics: Turbulence and its modeling, interface/free-surface tracking methods. (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Understand the basic equations of fluid flow and heat transfer.	K3
CO2	Apply different methods of discretisation for solution of governing equation	K4
CO3	Analyze convergence criteria used in multi-dimensional problem.	K4
CO4	Explain different schemes for convergence of convection diffusion problems.	K5
CO5	Evaluate Navier-Stokes equation by different algorithm.	K3

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. John A. Anderson, Jr., Computational Fluid Dynamics, The Basic with applications by
1. McGraw Hill International editions, Mechanical Engineering series, 2017.
2. Suhas Patankar, Numerical Methods in Fluid Flow & Heat Transfer, 1980.
3. H.K. Versteeg & W.Malalasekera, An Introduction to Computational Fluid Flow (Finite Volume Method), Printice Hall, 2008.

Reference Books

1. Ferziger and Peric, Computational Methods for Fluid Dynamic, Springer Publication, 1996.
2. Chuen-Yen Chow, An Introduction to Computational Fluid Mechanics, Wiley
1. Publication, 2011.
2. Murlidhar and Sundarrajan, Computational Fluid Flow & Heat Transfer, Narosa
3. Publication, 2009.
4. J. Blazek, Computational Fluid Dynamics by principles and applications, Elsevier Science Ltd, 2001.

MTE515: Advanced Energy Technology

Subject Code	**MTE515**	**IA Marks**	**30**
Number of Lecture Hours/Week	**04**	**Term End Exam Marks**	**70**
Total Number of Lectures per Hour	**40**	**CREDITS**	**04**

SYLLABUS

Module 1:

Total energy system for industry, Integrated gasification combined cycle plant, combined cycle power plant with cogeneration, fuels for combined cycle power plants. Natural gas cycles, Integrated power generation. Cogeneration principles. (10L)

Module 2:

Advanced energy storage systems – Mechanical energy storage, chemical energy storage, Electromagnetic energy storage, electrostatic energy storage, Thermal energy storage and biological storage. (7L)

Module 3:

Hydrogen Energy – Properties of hydrogen; hydrogen production – Thermo-chemical methods, Electrolysis of water, thermolysis of water and biophotolysis; Storage of hydrogen, delivery, conversion, applications and safety issues, present status. (7L)

Module 4:

Clean Coal technologies – Coal washing, gasification etc., application of coal gas in heat engines and gas turbines, Pressurized fluidized bed combustion. Coal bed methane. Energy conservation opportunities in power plants, economic and environmental aspects of energy conservation in power plants, economic load sharing of power plants, waste heat utilization. (10L)

Module 5:
Fuel Cell – Principles, classification of fuel cells, working of different types of fuel cells, fuels for fuel cells, Development stages and relative performances of various fuel cells, efficiency, V-I Characteristics of fuel cell, fuel cell power plant, environmental effects. (6L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Understand the working principle of combined and cogeneration power cycle used for integrated power generation.	K3
CO2	Understand different advanced energy storage systems.	K4
CO3	Apply different methods for production and applications of hydrogen energy and coal gas..	K4
CO4	Analyse economic and environmental aspects of energy conservation in power plants and waste heat recovery.	K5
CO5	Evaluating the performance characteristics and relative efficiency of fuel cells.	K3

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Sec. Ed.2000.

Reference Books

1. G. Rai, Non-Conventional Energy Sources, Khanna Publishers.
2. Fuel Cells, by W. Vielstich, translated by D. J. G. Ives, Willey Interscience, 1965.
3. Microbial Fuel Cells, by B. E. Logan, John Willey & Sons, 2008.
4. I. Boustead and G. F. Hancock, Handbook of Industrial Energy Analysis, Ellis Horwood Ltd., A division of John Wiley and Sons, 1979.

MTE517: Energy Management Principles and Auditing

Subject Code	MTE517	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lectures per Hour	40	CREDITS	04

SYLLABUS

Module 1: INTRODUCTION

Energy and Sources of energy, Energy consumption and GDP, Costs of exploration and utilization of resources, Energy pricing, Energy demand and supply, National energy plan, Need for Energy Policy, National and State level Energy Policies. Basic concepts of Energy Conservation and its importance, Energy Strategy for the Future, The Energy Conservation Act and its Features, Energy conservation in household, Transportation, Agricultural, Service and Industrial sectors, Lighting, HVAC Systems. (8L)

Module 2: ENERGY MANAGEMENT

History of Energy Management, Definition and Objective of Energy Management and its importance. Need of energy management, General Principles of Energy Management, Energy Management Skills, and Energy Management Strategy. Energy Management Approach. Understanding Energy Costs, Benchmarking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution. Organizing, Initiating and Managing an energy management program. Roles, responsibilities and accountability of Energy Managers. (8L)

Module 3: ENERGY AUDIT

Energy audit concepts, Definition, Need and Types of energy audit. Energy Audit Approach and Methodology. Systematic procedure for technical audit. Understanding energy audit costs, Benchmarking and Energy Performance. Energy audit based on First law and Second law of thermodynamics, Mass and Energy balances, Availability analysis, Evaluation of energy conserving opportunities, Economic analysis and life cycle costing. Duties and responsibilities of energy auditors. Energy audit instruments and their usage for auditing. Report-writing, preparations and presentations of energy audit reports. (8L)

Module 4: ENERGY CONSERVATION AND ENVIRONMENT

Energy conservation areas, Energy transmission and storage, Plant Lecture wise energy optimization Models, Data base for energy management, Energy conservation through controls, Computer aided energy management, Program organization and methodology.

Energy environment interaction, Environmental issues, Global Warming, Climate Change Problem and Response, Carbon dioxide emissions, Depletion of ozone layer, Governments Regulations, Energy Economy interaction. Energy Conservation in Buildings, Energy Efficiency Ratings & ECBC (Energy Conservation Building Code). (8L)

Module 5: INTERDISCIPLINARY CASE STUDIES

Study of 4 to 6 cases of Energy Audit & Management in Industries (Mechanical, Chemical and other systems). (8L)

Course Outcomes (COs):

CO No.	Course Outcome Description	Bloom's Level
CO1	Outline energy management system and related policies and Acts.	K3
CO2	Apply the concept of Energy Management in energy related issues.	K4
CO3	Work with energy management system and energy audit of whole system.	K4
CO4	Analyze energy conservation related to environmental issues.	K5
CO5	Carry out Auditing of relevant interdisciplinary systems.	K3

CO-PO Mapping Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	1	1	1	1	0	0	0
CO2	3	3	2	2	2	1	1	1	1	1	0	0	0
CO3	2	2	3	3	2	1	1	1	1	1	0	0	0
CO4	2	2	3	3	3	1	1	1	1	1	0	0	0
CO5	2	2	2	3	3	1	1	1	1	1	0	0	0

Text Books

1. Amlan Chakrabarti, Energy Engineering and Management, PHI, Eastern Economy Edition.
2. Smith CB, Energy Management Principles, Pergamon Press, New York.
3. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington
4. L. C. Witte, P. S. Schmidt and D. R. Brown, Industrial Energy Management and Utilization, Hemisphere Publications, Washington.

Reference Books

1. W.R.Murphy, G.Mckay, Energy Management, Butterworths.
2. C.B.Smith Energy Management Principles, Pergamon Press.
3. L.C. Witte, P.S. Schmidt, D.R. Brown , Industrial Energy Management and Utilization, Hemisphere Publication, Washington
4. Archie, W Culp , Principles of Energy Conservation, McGraw Hill
5. Munasinghe, Mohan Desai, Ashok V, Energy Demand: Analysis, Management and Conservation, Wiley Eastern Ltd., New Delhi