Department of Mechanical Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

To educate students at Undergraduate, Post Graduate, Doctoral, and Post Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To become an internationally recognized centre of excellence in academics, research and technological services in the area of ***Mechanical Engineering*** and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently.
- Developing engineers with managerial attributes capable of applying appropriate technology with responsibility.
- Creation of congenial atmosphere and ample research facilities for undertaking quality research to achieve national and international recognition by faculty and students.
- To strive for internationally recognized publication of research papers, books and to obtain patent and copyrights.
- To provide excellent technological services to industry for the benefit of society.

Programme Educational Objectives (PEOs) – Heat Power Engineering

PEO 1: To develop capability to understand the fundamentals of Science and Heat Power Engineering for analyzing the engineering problems with futuristic approach.

PEO 2: To foster a confident and competent post graduate capable to solve real life practical engineering problems fulfilling the obligation towards society.

PEO 3: To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning enabling to excel in competitive participations at global level.

PEO 4: To nurture and nourish effective communication and interpersonal skill to work in a team with a sense of ethics and moral responsibility for achieving goal.

PROGRAM OUTCOMES (POs)
M. Tech. in Mechanical Engineering (Heat Power Engineering)

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: Clear insight to appreciate the multidisciplinary nature of the technological field in heat power engineering.

PO5: Develop an ability to work in team, apart from having awareness of social needs and professional code of conduct, ethics and behavior.

COURSE INFORMATION SHEET

Course code: ME561
Course title: CLASSICAL AND STATISTICAL THERMODYNAMICS
Pre-requisite(s): B.E. /B. Tech. Thermodynamics
Co- requisite(s): Partial Differential Equations
Credits: 4 L:3 T:1 P:0
Class schedule per week: 04
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	Present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective.
2.	Lay the groundwork for subsequent studies in such fields as heat transfer and energy conversion systems and to prepare the students to effectively use thermodynamics in the practice of engineering.
3.	Develop an intuitive understanding of thermodynamics by emphasizing the engineering and engineering arguments.
4.	Present a wealth of real world engineering examples to give students a feel for how thermodynamics is applied in engineering practice.

Course Outcomes:

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

CO1	Review and Apply the concepts of I and II law of thermodynamics.
CO2	Analyse and evaluate the concept of exergy in different thermodynamic cycles
CO3	Analyze the concept of Real Gases and Mixtures and to apply the thermodynamic relations of gas mixtures.
CO4	Evaluate the Thermodynamic properties of homogeneous mixtures.
CO5	Analyze the concept of statistical thermodynamics.

SYLLABUS

Module I:

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. (8 L)

Module II:

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. (8 L)

Module III:

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.

(8 L)

Module IV:

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. (8 L)

Module V:

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. (8 L)

Books recommended:

Text Book

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

Reference Book

1. Fundamentals of Engineering Thermodynamics, John Wiley and Sons by Moran, M. J. and Shapiro, H. N. (1999).

2. Engineering Thermodynamics by J. B. Jones and R. E. Duggan, Prentice-Hall of India (1996).

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Detailed analysis of different transient thermodynamics systems using software EES

POs met through Gaps in the Syllabus: **PO4 & PO5**

Topics beyond syllabus/Advanced topics/Design:

Irreversible thermodynamics.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 & PO4**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	1
CO2	3	3	3	3	1
CO3	3	3	3	3	1
CO4	3	3	3	3	1
CO5	3	3	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME562
Course title: ADVANCED INCOMPRESSIBLE FLUID FLOW
Pre-requisite(s): B.E. /B. Tech. Fluid Mechanics
Co- requisite(s): Partial Differential Equation
Credits: 4 L:3 T:1 P:0
Class schedule per week: 04
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	Present a comprehensive and rigorous treatment of classical incompressible fluid mechanics while retaining an engineering perspective.
2.	Lay the groundwork for subsequent studies in such fields as analysis of various incompressible fluid flows and to prepare the students to effectively use incompressible fluid mechanics theory in the practice of engineering.
3.	Develop an intuitive understanding of incompressible fluid mechanics by emphasizing the engineering and engineering arguments.
4.	Present a wealth of real world engineering examples to give students a feel for how incompressible Fluid mechanics is applied in engineering practice.

Course Outcomes:

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

CO1	Outline the concepts of continuum, system of control volume, incompressible fluid and flow properties.
CO2	Apply the appropriate fundamental laws of incompressible fluid dynamics to various flow passages and over the bodies.
CO3	Analyse various incompressible fluid dynamics problems.
CO4	Evaluate the applicability governing equations of incompressible fluid mechanics where an exact solution of the problem is possible.
CO5	Create optimum design of simple(2D)/complex(3D) fluid flow geometry using conventional methods and modern tools.

SYLLABUS

Module I:

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. (8 L)

Module II:

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. (8 L)

Module III:

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. (8 L)

Module IV:

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. (8 L)

Module V:

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. (8 L)

Books recommended:

Text Book

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 Book

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.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Detailed analysis of different transient fluid flow systems/devices. Outline of various CFD software used in industries.

POs met through Gaps in the Syllabus: **PO4 & PO5**

Topics beyond syllabus/Advanced topics/Design:

Turbulence and Multiphase flow, Simple fluid flow simulation methods.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO4 & PO5**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	1
CO2	3	2	3	2	1
CO3	3	2	3	3	1
CO4	3	2	2	2	1
CO5	3	3	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME563
Course title: CONDUCTION AND RADIATION HEAT TRANSFER
Pre-requisite(s): B.E. /B. Tech. Heat Transfer
Co- requisite(s): Partial Differential Equations
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students:

1.	To present a comprehensive and rigorous treatment of conductive and radiative heat transfer while retaining an engineering perspective.
2.	To lay the groundwork for subsequent studies in such fields as heat transfer systems and to prepare the students to effectively use of conductive and radiation heat transfer analysis in the practice of engineering.
3.	To develop an intuitive understanding of conductive and radiative heat transfer by emphasizing the engineering and engineering arguments.

Course Outcomes:

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

CO1	Identify modes of heat transfer and model basic heat transfer processes.
CO2	Apply different methods for solution of multi-dimensional engineering problems of conductive heat transfer.
CO3	Apply different methods for solution of radiative heat transfer problems in non-participating medium.
CO4	Analyse gray and non-gray problems in the field radiative heat transfer in participating medium.
CO5	Evaluate the solution for one dimensional gray medium.

SYLLABUS

Module I:
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. (8 L)

Module II:
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. (8 L)

Module III:
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. (8 L)

Module IV:
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. (8 L)

Module V:
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. (8 L)

Books recommended:

Text Book

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

Reference Book

1. 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.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Analysis of radiation and conduction problems related to industries.

POs met through Gaps in the Syllabus: **PO4 & PO5**

Topics beyond syllabus/Advanced topics/Design:

Multi-dimensional radiative heat transfer in participating medium and its different approximations

POs met through Topics beyond syllabus/Advanced topics/Design: **PO4 & PO5**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	1
CO2	3	3	3	1	1
CO3	3	3	3	2	2
CO4	3	3	3	3	2
CO5	3	3	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME564
Course title: RENEWABLE SOURCE OF ENERGY
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students:

1.	To identify renewable energy sources and their utilization.
2.	To provide basic knowledge of different renewable energy conversion principle.
3.	To harness the environment friendly RE sources and to enhance their contribution to the socio-economic development.

Course Outcomes:

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

CO1	Outline the principles of energy conversion from alternate sources.
CO2	Outline the energy scenario in India and world.
CO3	Apply different methods to harness renewable energy sources.
CO4	Analyse the performance of different renewable energy conversion machines.

SYLLABUS

Module I:
Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources, Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario.
(8 L)

Module II:
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. (8 L)

Module III:
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.
(8 L)

Module IV:
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. (8 L)

Module V:
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. (8 L)

Books recommended:

Text Book

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. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN Spon Ltd., UK, 2006.

4. Solar Energy – Principles of Thermal Collection and Storage, S. P. Sukhatme and J.K. Nayak, Tata McGraw-Hill, New Delhi, 2008.
5. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill, 2017.

Reference Book

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.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Application of solar energy to automobiles field.

POs met through Gaps in the Syllabus: **PO4 & PO5**

Topics beyond syllabus/Advanced topics/Design:

Design aspects of solar vehicles and power plants

POs met through Topics beyond syllabus/Advanced topics/Design: **PO4 & PO5**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	1
CO2	3	2	2	2	1
CO3	3	3	3	3	2
CO4	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME565
Course title: THEORY AND DESIGN OF I.C. ENGINES
Pre-requisite(s): B.E. /B. Tech. I.C. Engine
Co- requisite(s): NA
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students:

1.	To explore the knowledge of performance parameters and its characteristics, variables effects the performance of engine and methods of improving engine performance of internal combustion engine.
2.	Examination and selection of different alternative fuel and its emissions and control.
3.	To explore principle of different electronic fuel injection system, supercharging and its effect on performance of internal combustion engine.
4.	To design and recommend low cost and high performance engine components, which finds applications in modern internal combustion engines.

Course Outcomes:

At the end of the course, a student should be able:

CO1	To explain performance parameters and characteristics; and calculation of performance parameters.
CO2	Interpret different alternative fuels and its emissions, then the method to control these emissions.
CO3	Analyze different electronic fuel injection system, supercharging and its effect on performance of SI and CI engine.
CO4	Specify and interpret data of alternative fuels and its emission which effect the environment.
CO5	To design low cost and high performance cylinder, cylinder head, crank case piston, connecting rod, crank shaft and radiator of Internal combustion engine.

SYLLABUS

Module I:

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. (8 L)

Module II:

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. (8 L)

Module III:

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. (8 L)

Module IV:

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, suplhur, lead, phosphorous emissions, Emission control methods. (8 L)

Module V:

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. (8 L)

Books recommended:

Text Book

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 Book

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.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Performance parameters of IC engine, Air pollution of IC engine and design of IC parts.

POs met through Gaps in the Syllabus: **PO4 & PO5**

<u>Topics beyond syllabus/Advanced topics/Design:</u>
Air pollution of IC engine.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4 & PO5**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	2	2
CO2	2	2	1	2	1
CO3	1	1	1	2	2
CO4	1	2	1	2	2
CO5	2	2	1	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME566
Course title: COMPUTATIONAL METHODS IN THERMAL ENGINEERING
Pre-requisite(s): B.E. /B. Tech. Fluid Mechanics and Heat Transfer
Co- requisite(s): Partial differential equation
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students:

1.	To utilize modelling and computational tools to predict system behaviour and performance.
2.	To develop the knowledge to model thermal systems and processes, including the mathematical representation of their components and the numerical solution of the resulting equations,
3.	To apply finite differences methods with application to distributed systems involving heat transfer and fluid mechanics.

Course Outcomes:

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

CO1	Understand different methods for finding roots of Complex algebraic and transcendental equations.
CO2	Understand different integration methods to compute area, volume and view factor.
CO3	Apply different methods for solution of linear, nonlinear equations using initial value and boundary value problems.
CO4	Apply different methods for solution of thermal engineering problems.
CO5	Analyse thermal and fluid problems using finite difference methods.

SYLLABUS

Module I:

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.

(8 L)

Module II:

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. (8 L)

Module III:

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. (8 L)

Module IV:

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. (8 L)

Module V:

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.

(8 L)

Books recommended:

Text Book

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

Reference Book

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

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Optimisation of industrial related problems
POs met through Gaps in the Syllabus: **PO4 & PO5**

Topics beyond syllabus/Advanced topics/Design:
Finite volume method and its applications.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4 & PO5**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	1
CO2	3	3	3	3	1
CO3	3	3	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME567
Course title: SAFETY ASPECTS OF NUCLEAR POWER PLANTS
Pre-requisite(s): B.E. /B. Tech. Energy conversion system
Co- requisite(s): NA
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students:

1.	To familiarize the students on the future benifits of Nuclear power plants.
2.	To develop an intuitive understanding of safety of Nuclear power plants
3.	To study the regulatory approaches adopted, which assures the safety of NPP.

Course Outcomes:

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

CO1	Outline the basic concept of Nuclear reactors.
CO2	Analyse the various Radiation sources and Protection of NPP
CO3	Analyze the safety principles.
CO4	Evaluate and Analyze some events in NPP and Sitings of Nuclear plants
CO5	Analyze the safety regulations in india.

SYLLABUS

Module I:

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. (8 L)

Module II:
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. (8 L)

Module III:
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.
(8 L)

Module IV:
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. (8 L)

Module V:
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. (8 L)

Text Book

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

Reference Book

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

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

<u>Gaps in the syllabus (to meet Industry/Profession requirements)</u> :

Various accidental studies of Indian NPP

POs met through Gaps in the Syllabus: **PO4 & PO5**

<u>Topics beyond syllabus/Advanced topics/Design:</u>

Design of Nuclear power plants.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO4 & PO5**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

<u>MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES</u>

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	1	1
CO2	3	3	3	1	1
CO3	3	3	2	1	3
CO4	3	3	2	1	1
CO5	3	3	2	1	3

< 34% = 1, 34-66% = 2, > 66% = 3

<u>MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD</u>

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

OPEN ELECTIVES

COURSE INFORMATION SHEET

Course code: ME582
Course title: DESIGN METHODOLOGY
Pre-requisite(s): NIL
Co- requisite(s):
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand advanced topics of rigid body kinematics and dynamics
2.	Analyse free and forced vibration of single and multi-degree of freedom system.
3.	Apply principles of classical mechanics to analyse dynamical systems.
4.	Design dynamical systems.
5.	Understand working principles of gyroscopic couple.

Course Outcomes

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

CO1.	Demonstrate various principles related to kinematics and dynamics of rigid bodies in space.
CO2.	Apply classical mechanical approach to construct equations of motion for dynamical systems
CO3.	Evaluate gyroscopic couple for systems with simultaneous spin and precession.
CO4.	Design and analyse simple dynamical systems.
CO5.	Evaluate natural frequencies and mode shapes of single and multi DOF vibrating systems.

SYLLABUS

Module 1

Introduction to design research: What and Why; Current issues with design research and the need for a design research methodology; Major facets of design and design research. Introduction to design research methodology - its main components, and examples to explain the components

(8 L)

Module 2

Starting design research: Clarification of requirements: Identifying research topics, carrying out literature search, consolidating the topic into research questions and hypotheses, and developing a research plan

(8 L)

Module 3

Descriptive study: Type, Processes for carrying out descriptive studies for developing an understanding a facet of design and its influences; Introduction to associated descriptive study real-time and retrospective research methods for data collection such as protocol analysis, questionnaire surveys, interviews etc; Introduction to quantitative and qualitative data analysis methods

(8 L)

Module 4

Prescriptive study: Types, Processes for developing design support and associated prescriptive study research methods. Types of support evaluation; Processes for evaluating a design support, and associated Evaluation study research methods

(8 L)

Module 5

Documentation: Types and structures of research documentation, Approaches and guidelines for documenting and reporting research process and outcomes

(8 L)

Text Books:

1. The Future of Design Methodology, Editors: Birkhofer, Herbert (Ed.) Springer-Verlag, 2011.
2. Design Thinking Methodology, Emrah Yayici
3. Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions, Bruce Hanington and Bella Martin 2012

Reference Books:

1. Blessing, L.T.M., Chakrabarti A. and Wallace, K.M. An Overview of Design Studies in Relation to a Design Research Methodology, Designers: the Key to Successful Product Development, Frankenberger & Badke-Schaub (Eds.), Springer-Verlag, 1998.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

<u>Gaps in the syllabus (to meet Industry/Profession requirements) :</u>
Various composite materials, their properties and applications.
POs met through Gaps in the Syllabus: PO1 TO PO5

<u>Topics beyond syllabus/Advanced topics/Design:</u>
Characterisation of the composite materials.
POs met through Topics beyond syllabus/Advanced topics/Design: PO1 TO PO5

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	1
CO2	3	2	3	3	1
CO3	3	2	3	1	1
CO4	3	1	3	3	1
CO5	3	1	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME586
Course title: RELIABILITY IN DESIGN
Pre-requisite(s): NIL
Co- requisite(s):
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand advanced topics of rigid body kinematics and dynamics
2.	Analyse free and forced vibration of single and multi-degree of freedom system.
3.	Apply principles of classical mechanics to analyse dynamical systems.
4.	Design dynamical systems.
5.	Understand working principles of gyroscopic couple.

Course Outcomes

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

CO1.	Demonstrate various principles related to kinematics and dynamics of rigid bodies in space.
CO2.	Apply classical mechanical approach to construct equations of motion for dynamical systems
CO3.	Evaluate gyroscopic couple for systems with simultaneous spin and precession.
CO4.	Design and analyse simple dynamical systems.
CO5.	Evaluate natural frequencies and mode shapes of single and multi DOF vibrating systems.

SYLLABUS

Module 1:
Reliability Basics: Basic Concepts of Reliability, Definition of Reliability, Role of Reliability evaluation, Design for reliability, Design under uncertainty, Why use probabilistic methods, Success stories, bath-tub-curve, system reliability, reliability improvement, maintainability and availability, Life tests, Acceptance sampling based on life tests.

(8 L)

Module 2:
Reliability in Design and Development: Introduction to Design of Experiments (DOE) and Taguchi Method, Failure mode and effects analysis, Basic symbols, Fault Tree construction and analysis, Monte Carlo Simulation, Human factors in design and design principles.

(8 L)

Module 3:
Reliability Management: Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time, availability - inherent, achieved and operational availability (Numerical treatment). Introduction to Reliability Centered Maintenance. Design for maintainability and its considerations, Reliability and costs, Costs of Unreliability.

(8 L)

Module 4:
System reliability Analysis: Reliability Improvement, Redundancy, element redundancy, unit redundancy, standby redundancy types of stand by redundancy, parallel components single redundancy, multiple redundancies (problems).

(8 L)

Module 5:
Life Testing & Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems.

(8 L)

Text Book

1. Nikolaidis E., Ghiocel D. M., Singhal S., Engineering Design Reliability Handbook, CRC Press, Boca Raton, FL, 2004.
2. McPherson J.W., Reliability Physics and Engineering: Time to Failure Modeling, 2nd Edition, Springer, 2013.
3. Ebeling, C. E., An Introduction to Reliability and Maintainability Engineering, Waveland Press, Inc., 2009 (ISBN 1-57766-625-9).
4. Bryan Dodson, Dennis Nolan, Reliability Engineering Handbook, Marcel Dekker Inc, 2002.
5. Kapur, K. C., and Lamberson, L. R., Reliability in Engineering Design, John Wiley and Sons, 1977.

Reference Book

1. Reliability toolkit: Commercial practices edition. Reliability Analysis Center, 1995.
2. Blischke, Wallace R., and DN Prabhakar Murthy. Reliability: modeling, prediction, and optimization. Vol. 767. John Wiley & Sons, 2011.
3. Leemis, Lawrence M. Reliability: probabilistic models and statistical methods. Prentice-Hall, Inc., 1995.
4. Modarres, Mohammad, Mark P. Kaminskiy, and Vasiliy Krivtsov. Reliability engineering and risk analysis: a practical guide. CRC press, 2009.
5. O'Connor, Patrick, and Andre Kleyner. Practical reliability engineering. John Wiley & Sons, 2011.
6. Singiresu S Rao, Reliability Engineering, Pearson Education, 2014, ISBN: 978-0136015727.
7. Webpage : https://goremote.itap.purdue.edu/Citrix/XenApp/auth/login.aspx

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Variational and Complex Variables Methods

POs met through Gaps in the Syllabus: PO1, PO3, PO4

Topics beyond syllabus/Advanced topics/Design:

Nonlinear deformations of materials

POs met through Topics beyond syllabus/Advanced topics/Design: PO1 TO PO4

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	1
CO2	3	2	3	3	1
CO3	3	2	3	1	1
CO4	3	1	3	3	1
CO5	3	1	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME 583
Course title: Renewable Sources of Energy
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Create awareness about sources of energy and able to estimate how long the available conventional fuel reserves will last.
2.	Learn the fundamental concepts about solar energy systems and devices.
3.	Design wind turbine blades and know about applications of wind energy for water pumping and electricity generation.
4.	Understand the working of OTEC system and different possible ways of extracting energy from ocean; know about Biomass energy, mini-micro hydro systems and geothermal energy system.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Understand of renewable and non-renewable sources of energy
CO2.	Gain knowledge about working principle of various solar energy systems
CO3.	Understand the application of wind energy and wind energy conversion system.
CO4.	Develop capability to do basic design of bio gas plant.
CO5.	Understand the applications of different renewable energy sources like ocean thermal, hydro, geothermal energy etc.

SYLLABUS

Module 1: INTRODUCTION TO ENERGY STUDIES

Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources , Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario. (8L)

Module 2: SOLAR ENERGY

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 Greenhouse. 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 3: WIND ENERGY

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 4: BIOMASS ENERGY

Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifier, 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 5: HYDRO POWER AND OTHER RENEWABLE ENERGY SOURCES

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)

Text Books

4. Sukhatme. S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
5. B. H. Khan, Non-Conventional Energy Resources, , The McGraw Hill
6. Twidell, J.W. & Weir, A. Renewable Energy Sources, EFN Spon Ltd., UK, 2006.
7. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
8. Garg, Prakash, Solar Energy, Fundamentals and Applications, Tata McGraw Hill.

Reference Books

7. G.D. Rai, Non-Conventional Energy Sources, Khanna Publications, New Delhi, 2011.
8. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
9. Khandelwal, K.C., Mahdi, S.S., Biogas Technology – A Practical Handbook, Tata McGraw-Hill, 1986.
10. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modeling & Applications", Narosa Publishing House, New Delhi, 2002.
11. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
12. Frank Krieth& John F Kreider ,Principles of Solar Energy, John Wiley, New York

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
High temperature solar thermal application
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Advance bio fuels
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	-	2
CO2	1	2	3	-	2
CO3	1	2	3	-	2
CO4	2	2	3	-	2
CO5	1	2	3	-	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME 584
Course title: Energy Management and Auditing
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Gain introductory knowledge of Energy management and energy audit.
2.	Understand basic concepts of Energy conservation.
3.	Understand Energy efficiency and cost benefit.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Outline energy management system and related policies and Acts.
CO2.	Apply the concept of Energy Management in energy related issues.
CO3.	Work with energy management system and energy audit of whole system.
CO4.	Analyse energy conservation related to environmental issues.
CO5.	Carry out Auditing of energy equipment and to prepare energy flow diagrams and energy audit report

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: CASE STUDIES

Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.). (8L)

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.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Cost effective energy management
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Advance energy auditing system
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	-	2
CO2	1	2	3	-	2
CO3	1	2	3	-	2
CO4	2	2	3	-	2
CO5	1	2	3	-	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME568
Course title: ADVANCED FLUID MECHANICS LAB
Pre-requisite(s): Fluid Mechanics
Co- requisite(s): Nil
Credits: 2 L:0, T:0, P:4
Class schedule per week: 04
Class: M. Tech
Semester/Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To make student familiar with various types fluid flow measurement systems.
2.	To make the student confident how to perform experiments related Fluid mechanics, different measurement systems..
3.	To study in detail the flow field around and through complex passages to enable students to calculate the characteristics of those systems.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the procedure to conduct experiments related to fluid mechanics devices and components using different measurement systems and equipments.
CO2	Interpreting various parameters influence the performance of the fluid mechanics devices and components.
CO3	Analyze the observations made through experiments
CO4	Apply the experimental knowledge how to perform the experiments in different manner.
CO5	Predicting the sources of errors and minimizing them in the experiments.

List of experiments:

1. Performance study on calibration of a wind tunnel.
2. Performance study on flow field behind a circular cylinder using wind tunnel.
3. Performance study on flow field behind a square cylinder using wind tunnel.
4. Performance study on effect of circular cylinder in tandem on the flow field behind the rear cylinder using wind tunnel.
5. Flow visualization using woollen turf to find out the position of point of separation on a circular cylinder.
6. Performance study on calibration the pressure sensors used in pressure transducer.
7. Performance study on pressure distribution at different location on a conical/circular body.
8. Schlieren and shadowgraph flow visualization at supersonic speed.
9. Flow visualization over a cylinder using water tunnel.

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	-
CO2	2	1	2	1	-
CO3	2	1	2	1	-
CO4	3	1	2	1	1
CO5	3	1	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6
CO3	CD1, CD2, CD3,CD6
CO4	CD1, CD3,CD6
CO5	CD1,CD2,CD3,CD4,CD5