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 latest technology with responsibility
- Creation of congenial atmosphere and excellent research facilities for undertaking quality research by faculty and students
- To strive for more internationally recognized publication of research papers, books and to obtain patent and copyrights
- To provide excellent technological services to industry.

Programme Educational Objectives (PEOs) – Energy Technology

PEO 1: To develop capability to understand the fundamentals of Science and Energy Technology 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 (ENERGY TECHNOLOGY)

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: Apply software skills in the field of modeling, analysis and system simulation such as MATLAB, ANSY- CFX, Fluent for performance evaluation and optimization of nonrenewable/ renewable energy systems like bio, wind, solar and hybrid systems.

PO5: Recognize the need for lifelong learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

COURSE INFORMATION SHEET

Course code: ME 541
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

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

Reference Books

1. G.D. Rai, Non-Conventional Energy Sources, Khanna Publications, New Delhi, 2011.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
3. Khandelwal, K.C., Mahdi, S.S., Biogas Technology – A Practical Handbook, Tata McGraw-Hill, 1986.
4. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modeling & Applications", Narosa Publishing House, New Delhi, 2002.
5. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
6. 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 542
Course title: Fuel Technology
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.	Present a comprehensive and rigorous study of fuel while retaining an engineering perspective.
2.	Lay the groundwork for subsequent studies in such fields as coal, petroleum and to prepare the students to effectively use fuel in the practice of engineering.
3.	Develop an intuitive understanding of fuel technology by emphasizing the physics and physical arguments.

Course Outcomes

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

CO1.	Classify various type of fuel.
CO2.	Analyze coal from technical prospective.
CO3.	Examine the liquid fuel extraction methods.
CO4.	Explain the production methodology of gaseous fuels
CO5.	Analyse various nuclear fuels.

SYLLABUS

Module 1: INTRODUCTION TO FUEL

Different fuel energy resources, it's Indian and global perspective, Classification of Solid, liquid and gaseous fuels, Combustion appliances for solid, liquid and gaseous fuels (8L)

Module 2: ORIGIN AND FORMATION OF COAL

Different theories on coal formation, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, Fundamentals of coal combustion, combustion stoichiometry, Flue gas composition, Fundamentals of coal gasification, producer gas, water gas. (8L)

Module 3: EXTRACTION OF LIQUID FUELS

Petroleum and its derived products, Petroleum refining processes, Interconversion of fuels, Liquid fuel resources, world and Indian statistics, methods for characterization of crude oil and its products, refinery operations, testing of liquid fuels, industrial process design, utilization of petroleum products, synthetic liquid fuels. (8L)

Module 4: PRODUCTION OF GASEOUS FUELS

Natural gases and its derivatives, sources, potential, Gas hydrates Different types of gaseous fuels and its resources and their characteristics, principles of manufacturing of gaseous fuels from coal and oil, kinetics and mechanism of gasification, production of industrial fuel gases, rich gases such as SNG, purification, storage and transportation of gaseous fuels. (8L)

Module 5: NUCLEAR FUELS

Oxide fuel, Metal fuel, Ceramic fuel, liquid fuel, Refused-derived fuel, Bio-fuels: Biomass, Algae, biodiesel, Alcohol Fuels: Methanol, Ethanol, Butanol, Propane, etc. (8L)

Text Books

1. J.G. Speight and B. Ozum, Petroleum Refining Process, CRC Press, 2009.
2. J. G. Speight, The Chemistry and Technology of Coal, CRC Press, 2013.

Reference Books

1. F. Peter, Fuels and Fuel Technology, Wheaten & Co. Ltd., 1st edition, 1965.
2. S. Sarkar, Fuels and Combustion, Orient Longman, 2nd edition, 1990.
3. J. G. Speight, The chemistry & Technology of Petroleum, 4th edition, CRC Press, 2006.
4. Ke Liu, C. Song and V. Subramani, Hydrogen and Syngas Production and Purification Technologies, John Wiley & Sons, 2010

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

Gaps in the syllabus (to meet Industry/Profession requirements) :
Clean Coal technology
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Advance nuclear 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	1	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: ME543
Course title: Energy Conversion System
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.	Critically examine the technology of energy systems that will be acceptable in a world faced with global warming, local pollution, and declining supplies of oil.
2.	Focus on renewable energy sources and other non-carbon/reduced-carbon emitting sources.
3.	Analyse both the devices and the overall systems are analyzed.

Course Outcomes

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

CO1.	Analyze the solar thermal conversion system.
CO2.	Evaluate the solar thermal conversion systems for high temperature applications.
CO3.	Analyze the Photovoltaic & Bio-Energy Conversion Systems
CO4.	Design the Fuel cells.
CO5.	Examine various Electric Energy Conversion Systems.

SYLLABUS

Module 1: SOLAR THERMAL CONVERSION SYSTEM

Relevance of solar thermal power generation; Components of solar thermal power plant, Design and performance, characteristics of different solar concentrator types suitable for thermal power generation. (8L)

Module 2: SOLAR THERMAL CONVERSION SYSTEM FOR HIGH TEMPERATURE APPLICATIONS

Types of solar thermal conversion system used in high temperature application, Tracking of solar concentrators; performance characterization of solar concentrators both line focus and point focus, Comparative analysis of the both mode focus system, Optical design and concentration characteristics of line and point focus based system. (8L)

Module 3: THERMAL ENERGY CONVERSION & BIO-ENERGY CONVERSION SYSTEMS:

Thermo-electric generator, Concepts and design considerations of MHD generators, Cycle analysis of MHD systems, Thermionic power conversion and plasma diodes, Thermo chemical Conversion. Bio-energy conversion, bio methanation technology, Thermo chemical conversions. . (8L)

Module 4: FUEL CELL TECHNOLOGY

Overview of fuel cells, Fuel cell thermodynamics, fuel cell efficiency, Fuel cell characterization, Fuel cell modelling and system integration, Balance of plant, Hydrogen production from renewable sources and storage, life cycle analysis of fuel cells. (8L)

Module 5: ELECTRIC ENERGY CONVERSION SYSTEM

Generation of electricity using different sources, Transmission and distribution losses, AC to DC and DC to AC conversions, Electric motors: Types, losses, efficiency, Lightning systems, Diesel generating systems. (8L)

Text Books

1. S. S. L. Chang, Energy Conversion, Prentice Hall, 1963.
2. S. W. Angrist, Direct Energy Conversion, Pearson, 1982.
3. R. J. Rosa, Magneto hydrodynamic Energy Conversion, Springer, 1987.
4. V. S. Bagotsky, Fuel Cell Problems and Solutions, John Wiley & Sons, 2009.

Reference Books

1. Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970
2. Green M.A., Solar Cells, Prentice-Hall, Englewood Cliffs, 1982
3. Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984.

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

Gaps in the syllabus (to meet Industry/Profession requirements) :
Cost reduction in the fuel cell technology
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Advance energy conversion process
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	2	-	2
CO2	1	2	3	-	2
CO3	1	2	2	-	2
CO4	1	2	2	-	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: ME544
Course title: Wind 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.	Understand the technologies that are used to harness the power of the wind.
2.	Develop an intuitive understanding of wind turbine design criterion and its conversion system.
3.	Discuss the positive and negative aspects of wind energy in relation to natural and human aspects of the environment.

Course Outcomes

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

CO1.	Explain the existing wind energy potential.
CO2.	Analyze the various aerodynamic loads and its design criterion on wind turbine system.
CO3.	Describe the existing Wind Energy Conversion System.
CO4.	Analyze the control mechanism of wind turbine.
CO5.	Understand the application of wind energy with case studies and its environmental impacts.

SYLLABUS

Module 1: BASICS OF WIND ENERGY TECHNOLOGY

Wind statistics- Measurements and data Presentation, Historical developments, latest developments, state of art of wind energy technology, turbine rating, economic analysis of wind turbine, Indian scenario and worldwide developments, present status and future trends. Wind turbine aerodynamics. (8L)

Module 2: CHARACTERISTICS OF WIND ENERGY

Nature of atmospheric winds- Wind resource characteristics and assessment– Anemometry, speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography. effect of Reynolds's number, actuator disc, Betz coefficient, design of wind turbine blade, effect of stall and blade tip speed ratio and coefficient of torque. (8L)

Module 3: WIND ENERGY CONVERSION SYSTEM (WECS)

Rotor Selection, Annual Energy Output, HAWT, VAWT, Rotor Design Considerations-Number of Blades, Blade Profile -2/3 Blades and Teetering, Coning- Upwind/Downwind, Power Regulation, Yaw System- Tower, Synchronous and Asynchronous Generators and Loads, Integration of Wind Energy Converters to Electrical Networks, Inverters- Testing of WECS, WECS Control System - Requirements and Strategies. . (8L)

Module 4: CONTROL MECHANISMS

Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism. Wind turbine dynamics with DC and AC generators: induction and synchronous generators, variable speed operation, effect of wind turbulence. Case study of design of wind mill. (8L)

Module 5: WIND ENERGY APPLICATION

Wind pumps - Performance analysis, design concept and testing, Principle of WEG- Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Wind energy in India- Case studies, environmental impacts of wind farms. (8L)

Text Books

1. Steve Parker, "Wind power", Gareth Stevens Publishing, 2004.
2. Freris L.L., Wind Energy Conversion Systems, Prentice Hall 1990.
3. Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.

Reference books

1. Wind Energy Engineering *Trevor M. Letcher* ISBN: 978-0-12-809451-8
2. Paul Gipe, "Wind Energy Comes of Age", John Wiley & Sons Inc., 2000.
3. Tony Burton, Nick Jenkins, David Sharpe, Ervin Bossanyi, "Wind Energy Handbook", 2nd ed., John Wiley & Sons, 2011.
4. Paul A Lin, "Onshore and offshore wind energy", Wiley, 2011.

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

Gaps in the syllabus (to meet Industry/Profession requirements) :
Modelling of wind turbine
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
New materials for the wind turbine blade
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	1	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 545
Course title: Solar Passive Architecture
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.	Present a comprehensive and rigorous study of Solar passive architecture while retaining an engineering perspective.
2.	Lay the groundwork for subsequent studies in such fields as solar passive architecture and to prepare the students to effectively use solar passive architecture in the practice of engineering.
3.	Develop an intuitive understanding of fuel technology by emphasizing the physics and physical arguments.

Course Outcomes

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

CO1.	Outline the need of solar passive architecture.
CO2.	Explain the passive solar heating of buildings
CO3.	Discuss the passive solar cooling of the building
CO4.	Explain the Climate And Human Thermal Comfort
CO5.	Point out the building rating systems

SYLLABUS

Module 1: INTRODUCTION

Need for passive architecture - Building form and functions – General aspects of solar passive heating and cooling of buildings – Thumb rules - Thermal comfort – Sun's motion - Building orientation and design – Heat transfer in buildings. (8L)

Module 2: PASSIVE SOLAR HEATING OF BUILDINGS

Direct gain – Indirect gain – Isolated gain - Passive heating concept - Thermal modeling of passive concepts – Thermal storage wall and roof – Sunspace – Prediction of heating loads in a building. . (8L)

Module 3: PASSIVE COOLING OF BUILDINGS

Passive cooling concept - Solarium Passive cooling - Ventilation cooling - Nocturnal radiation cooling -Evaporative cooling - Roof surface evaporative cooling (RSEC) - Direct evaporative cooling using drip-type (desert) coolers – Radiation cooling - Earth coupling - Basic principles and systems. . . (8L)

Module 4.: CLIMATE AND HUMAN THERMAL COMFORT

Factors affecting climate - Climatic zones and their characteristics - Urban climate - Microclimate - Implications of climate on building design - Principles of energy conscious design - Building materials - Embodied energy of building materials - Alternative building materials (8L)

Module 5: BUILDING RATING SYSTEMS

Zero energy building concept and rating systems - Energy conservation building codes – Energy management of buildings – Green globe assessment Standards –BREEAM – CASBEE – Green star–Review of CDM Techniques - GRIHA and others (8L)

Text Books

1. Jan F. Kreider, The solar heating design process: active and passive systems, McGraw-Hill, 2007.
2. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
3. N.K. Bansal, G. Hauser, G. Minke. Passive Building Design: A Handbook of Natural Climatic Control. . Elsevier Science. 1994.

Reference Books

1. HP Garg and J Prakash: Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2010.
2. Tom P. Hough, Trends in Solar Energy Research, Nova Publishers, 2006.
3. Source Wikipedia, Books LIc, Solar Architecture: Passive Solar Building Design, Active Solar, Daylighting, Passive House, Cool Roof, Earthship, Solar Air Conditioning, General Books LLC, 2010.

4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
5. S Sukhatme and J Nayak: Solar Energy: Principles of Thermal Collection and Storage, Third Edition, Tata McGraw Hill, 2008.

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

Gaps in the syllabus (to meet Industry/Profession requirements) :
Low cost solar passive heating and cooling
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Modelling of Solar passive architecture
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	1	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: ME546
Course title: Hydrogen Energy System
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 to:

1.	To provide comprehensive and logical knowledge of hydrogen production, storage and utilization.
2.	To develop skills in critical thinking and reasoning about issues associated with hydrogen fuel.
3.	To understand hydrogen generation techniques and hydrogen economy.
4.	To emphasize on the hydrogen energy safety techniques.

Course Outcomes

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

CO1.	Demonstrate the basic concepts of Hydrogen Energy.
CO2.	Illustrate the various hydrogen storage & transportation techniques.
CO3.	Examine the usage of Hydrogen Energy in various day to day applications.
CO4.	Usage of Hydrogen Energy in Advanced Applications.
CO5.	Analyze the safety issues related to use of hydrogen as fuel.

SYLLABUS

Module 1: HYDROGEN PROPERTIES AND PRODUCTION PROCESSES

Physical and Chemical properties of hydrogen. Production from fossil fuels, Steam, water. Advanced production methods- production using nuclear energy and renewable, photochemical, photocatalytic, hybrid, etc. (8L)

Module 2: HYDROGEN STORAGE, HANDLING & TRANSPORTATION

Storage Technologies, Compressed hydrogen, Cryo-adsorption, Liquid hydrogen, Slush hydrogen, Underground hydrogen storage, Hydrogen tank, Automotive Onboard hydrogen storage, Hydrogen transportation methods, Challenges associated with hydrogen transport. (8L)

Module 3: HYDROGEN UTILIZATION

I.C. Engines, power plant, gas turbines, hydrogen burners, domestic and marine applications, durability studies, field trials and effect on environment, Current use scenario, eco-friendly nature. . . (8L)

Module 4: ADVANCED TECHNOLOGIES

Fuel cells, Hydrogen Vehicles, Hydrogen Powered Cars, Hydrogen Powered planes, Hydrogen powered rockets. (8L)

Module 5: HYDROGEN SAFETY

History of accident, Safety barrier diagram, Hydrogen safety codes and standards, Hydrogen sensing, risk analysis, safety in handling, safety management. Hazard spotting and evaluation. . (8L)

Text Books

1. M. Ball and M. Wietschel, The Hydrogen Economy Opportunities and Challenges, Cambridge University Press, 2009
2. Ram B. Gupta, Hydrogen Fuel: Production, Transport, and Storage, CRC Press-Taylor & Francis, 2008
3. Peschka, Walter, Liquid hydrogen: fuel of the future, Springer-Verlag Wien, 1992.
4. Kenneth D., Jr.; Edeskuty, F. J. Williamson, Recent Developments in Hydrogen Technology, CRC Press, 1986.

Reference Books

1. M.K.G. Babu, K.A. Subramanian, Alternative Transportation Fuels: Utilization in Combustion Engines, CRC Press, 2013
2. Kazunari Sasaki et al. Hydrogen Energy Engineering: A Japanese Perspective-Springer, 2016
3. David Anthony James Rand, Ronald Dell, Hydrogen Energy: Challenges and Prospects, RSC Publishers, 2008

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

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

Topics beyond syllabus/Advanced topics/Design:
Modelling of the hydrogen energy storage 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	1	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

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

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

Topics beyond syllabus/Advanced topics/Design:
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

6. Sukhatme. S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
7. B. H. Khan, Non-Conventional Energy Resources, , The McGraw Hill
8. Twidell, J.W. & Weir, A. Renewable Energy Sources, EFN Spon Ltd., UK, 2006.
9. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
10. 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

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

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

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

Cost effective energy management

POs met through Gaps in the Syllabus: **PO3**

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

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: ME547
Course title: Energy Laboratory I
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 02
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	To expose students to the real working environment and get acquainted with the literature available of the various research challenges in the field of Energy Technology.
2.	To promote and develop presentation skills and import a knowledgeable society.
3.	To set the stage for future recruitment by potential employers.

Course Outcomes

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

CO1.	Locate the I-V and P-V characteristic with variation in temperature and radiation under series and parallel combination.
CO2.	Predicting the effect of shading and using of bypass and blocking diode.
CO3.	Calculate the work out and power flow in the standalone PV system with various combinations.
CO4.	Deducing the discharge and charge characteristic of battery.
CO5.	Calculate the various parameters in the inside solar water heater.

List of Experiments

Experiment 1: To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.
Experiment 2: To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
Experiment 3: To show the effect of variation in tilt angle on PV module power.
Experiment 4: To demonstrate the effect of shading on module output power.
Experiment 5: To demonstrate the working of diode as Bypass diode and blocking diode.
Experiment 6: Workout power flow calculations of stand-alone PV system of DC load with battery.
Experiment 7: Workout power flow calculations of stand-alone PV system of AC load with battery.
Experiment 8: Workout power flow calculations of stand-alone PV system of DC and AC load with battery.
Experiment 9: To draw the charging and discharging characteristics of battery.
Experiment 10: Evaluation of U_L ,F_R and η in thermosyphonic mode of flow with fixed input parameters
Experiment 11: Evaluation of U_L, F_R and η and drawing of different curves in forced mode of flow at different flow rate.
Experiment 12: Evaluation of U_L, F_R and η in forced mode of flow at different radiation level.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Semester Lab Examination Marks	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive evaluation Marks					
End Semester Lab Examination Marks					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

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
CO2	3	3	3	-	2
CO3	3	3	3	-	2
CO4	3	3	3	-	2
CO5	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,CD3,CD6
CO2	CD1,CD3, CD6
CO3	CD1, CD3,CD6
CO4	CD1,CD3,CD6
CO5	CD1,CD3,CD6

COURSE INFORMATION SHEET

Course code: ME548
Course title: Computational Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 02
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	To provide exposure to modern computational techniques in fluid dynamics and heat transfer.
2.	To apply computational methods for solving complex engineering problems.
3.	To set the stage for future recruitment by potential employers in the field of simulation.

Course Outcomes

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

CO1.	Recognize the importance of CFD in Heat and Fluid flow.
CO2.	Analyse forced convection heat transfer coefficient over regular bodies like cylinder.
CO3.	Solve computational problems related to fluid flows and heat transfer.
CO4.	Recognize how to handle different boundary conditions.
CO5.	Analyse how to apply different prebuilt Models in CFD.

List of Experiments

Experiment 1: To simulate a Simple Conduction Problem.
Experiment 2: To simulate a Mixed Boundary Problem (Conduction/ Convection/ Insulated).
Experiment 3: To simulate a Transient Thermal Conduction Problem.
Experiment 4: To do a Coupled Structural/Thermal Analysis.
Experiment 5: To simulate a Conjugate Heat Transfer Problem.
Experiment 6: To prepare a Computational Thermal Model of fluid flow in an elbow.
Experiment 7: To simulate fluid flow across a staggered uniformly-spaced tube arrangement.
Experiment 8: Understanding the simulation using Surface-to-Surface (S2S) Radiation Model.
Experiment 9: Simulation using the Discrete Ordinates Radiation Model.
Experiment 10: To simulate flow around an airfoil.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Semester Lab Examination Marks	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive evaluation Marks					
End Semester Lab Examination Marks					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

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	2
CO2	3	3	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	3	2
CO5	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,CD7
CO2	CD1, CD6,CD7
CO3	CD1, CD6,CD7
CO4	CD1, CD6,CD7
CO5	CD1, CD6,CD7