## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITYHYDERABADM.TECH.(ENERGY SYSTEMS)

**EFFECTIVE FROM THE ACADEMIC YEAR 2022- 2023.**

**COURSESTRUCTUREAND SYLLABUS**

## I Year I Semester

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **L** | **T** | **P** | **Credits** |
| Professional  Core -I | Renewable Energy Technologies | 3 | 0 | 0 | 3 |
| Professional  Core-II | Engineering Heat transfer | 3 | 0 | 0 | 3 |
| Professional  Elective-I | 1. Thermal and Nuclear Power Plants 2. Energy Efficient Buildings / 3. Waste Management and Recycling | 3 | 0 | 0 | 3 |
| Professional  Elective-II | 1. Measurement Systems in Energy Engineering 2. Applied Thermodynamics 3. Environmental Pollution and Control | 3 | 0 | 0 | 3 |
| Core | Research Methodology & IPR | 2 | 0 | 0 | 2 |
| Lab-I | Renewable Energy Conversion Laboratory | 0 | 0 | 4 | 2 |
| Lab -II | Energy Computational laboratory | 0 | 0 | 4 | 2 |
| Audit-I | Audit Course-I | 2 | 0 | 0 | 0 |
|  | **Total** | **16** | **0** | **8** | **18** |

**I Year II Semester**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **L** | **T** | **P** | **Credits** |
| Professional  Core-III | Direct Energy Conversion | 3 | 0 | 0 | 3 |
| Professional  Core -IV | Energy Conservation in Thermal Systems | 3 | 0 | 0 | 3 |
| Professional Elective- III | 1. Energy Efficiency in Electrical Utilities 2. Nuclear Power Plants 3. Modern Control systems | 3 | 0 | 0 | 3 |
| Professional Elective- IV | 1. Optimization of Energy Systems 2. Wind Energy Conversion Systems 3. Solar Energy Applications | 3 | 0 | 0 | 3 |
|  | Mini Project with Seminar | 0 | 0 | 4 | 2 |
| Lab-III | Energy Conversion Laboratory | 0 | 0 | 4 | 2 |
| Lab -IV | Computer Simulation Laboratory | 0 | 0 | 4 | 2 |
| Audit-II | Audit Course -II | 2 | 0 | 0 | 0 |
|  | **Total** | **14** | **0** | **12** | **18** |

## II Year I Semester

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **L** | **T** | **P** | **Credits** |
| Professional Elective-V | 1. Energy Storage Systems 2. Smart Grid Technologies 3. Hydrogen and Fuel Cells | 3 | 0 | 0 | 3 |
| \*Open Elective | Open Elective | 3 | 0 | 0 | 3 |
| Dissertation | Dissertation Work Review-II | 0 | 0 | 12 | 6 |
|  | **Total** | **6** | **0** | **12** | **12** |

**IIYEARII-SEMESTER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **L** | **T** | **P** | **Credits** |
| Dissertation | Dissertation Work Review-II | 0 | 0 | 12 | 6 |
| Dissertation | Dissertation Viva-Voce | 0 | 0 | 28 | 14 |
|  | **Total** | **0** | **0** | **40** | **20** |

## \*For Dissertation Work Review-I, please refer7.10in R22AcademicRegulations.

## Audit Course I&II:

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

Open Electives

1. Business Analytics
2. Waste to Energy
3. Basics of Refrigeration Systems
4. Introduction to Thermal Storage Systems

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY

## HYDERABAD

**MTech I Year, 1 Sem**

**RENEWABLE ENERGY TECHNOLOGIES**

## (Professional Core–I)

|  |  |  |  |
| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

**Course Objectives:** The course is intended to

* To explain the concepts of Non-renewable and renewable energy systems
* To outline renewable energy sources' utilization for domestic and industrial applications.
* To analyse the environmental and cost economics of renewable energy sources compared

to fossil fuels.

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

1. Understanding the importance of renewable energy sources.
2. Know the working principle of various energy systems.
3. Have a capability to carry out the basic design of certain renewable energy systems.

## UNIT–I:

**Fundamentals of Energy**: Energy consumption and standard of living, Oil crisis, Classification of energy resources, Consumption trend of primary energy resources, conventional energy sources and their distribution, Energy chain, common forms of energy, importance and salient features of non-conventional energy resources, environmental aspects of energy, Environment-economy-energy and sustainable development, Energy densities of various fuels, World energy status, Energy scenario in India

**UNIT- II:**

**Solar energy:** Solar energy basics, Sun-Earth relation spectrum, Terrestrial and extra-terrestrial radiation, spectral energy distribution of solar radiation, Depletion of solar radiation, measurement of solar radiation, solar radiation data, Solar time, Solar radiation geometry, Solar day length, Empirical equations for estimation of solar radiation on horizontal surfaces, Global, diffused and beam radiation, Solar radiation on inclined surface (Problems on energy availability on surfaces)

**UNIT-III:**

## Wind Energy: Wind origin, nature, types, Wind data and wind rose, wind speed variation, Wind siting Wind turbine classification and types of rotors, Wind turbine aerodynamics, power extraction from wind, Betz criteria, Axial thrust on the turbine, torque developed by the turbine, Dynamic matching, speed control strategies, Wind turbine operational characteristics, wind energy conversion systems, environmental aspect, Wind energy potential and installation in India (Problems on energy Conversion)

## UNIT-IV:

**Biomass Energy:** Biomass resources and their classification**,** Biomass conversion technologies: Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – operational parameters of biogas plants, Types of biogas Plants and biogas plant design – Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy program in India (Problems on biogas plant design)

**UNIT-V:**

**Ocean Energy:** Origin and nature of tidal energy, Tidal range power, tidal energy conversion schemes - Principle of Ocean Thermal Energy Conversion (OTEC) - Ocean thermal power plants-wave energy, power in waves, wave energy technologies- Geothermal power plants - Various types.

**Small Hydro Power Plant:** Importance of small hydro power plants and their Elements - Types of turbines for small hydro - Estimation of primary and secondary power.

## TEXTBOOK:

1. Renewable Energy Sources, Twidell, J.W. and Weir, A., EFN Spon Ltd., 1986.
2. Renewable Energy Engineering and Technology, Kishore VVN, Teri Press, New Delhi,

2012

1. Renewable Energy Power for a Sustainable Future, Godfrey Boyle, Oxford University Press,

U.K, 1996.

## REFERENCE BOOKS:

1. Solar Energy - Principles of thermal collection and storage, S. P. Sukhatme
2. Solar Engineering of Thermal Processes, J. A. Duffie and W. A. Beckman
3. Principles of Solar Engineering, Kreith, F and Kreider, J. F., McGraw-Hill, 1978.
4. Renewable Energy, Bent Sorensen, Elsevier, Academic Press, 2011
5. Power Plant Technology, J Wakil
6. Non-Conventional Energy Sources, G.D Rai

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY HYDERABAD

**MTech I Year, 1 Sem**

**ENGINEERING HEAT TRANSFER**

## (Professional Core–II)

|  |  |  |  |
| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

**Course Objectives:** The course is intended to

* To understand the fundamental laws of Heat transfer modes
* To develop the skills to correlate the Physics of energy transfer with applications

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

* + - 1. Use the concepts of Heat Transfer and fluid flow in the field of energy applications.

## UNIT-I:

**Conduction:** Introduction – Modes of heat transfer – Basic Equations - Combined modes – Steady one-dimensional – Steady heat source system – Conduction Shape Factor - Unsteady heat conduction - Lumped heat capacity system - Infinite solid flat plate - cylinder (Heisler charts).

**Types of fins** – Analysis of fins of uniform cross section, effectiveness - Efficiency of fin. Applications.

## UNIT-II:

**Forced Convection:** Flow over a flat plate – Analogy between fluid flow and heat transfer - Flow with heat transfer on a Flat Plate – Hydrodynamic and thermal Boundary layer - Laminar and Turbulent Flow - Forced convection over a flat plate – External Flow over other geometries – Internal Flow in a tube - Empirical relations – Numerical Heat transfer.

**Free convection** - Free convection from vertical and horizontal surfaces - Enclosed spaces. Applications to flat plate Collectors.

## UNIT-III:

## Radiation: Overview of Mechanism – laws of radiation- Radiant heat exchange in gray - non-gray bodies – Furnaces – Performance terms and definitions – Furnace heat balance method – Factors affecting furnace performance

## UNIT-IV:

**Boiling Heat Transfer:** Regimes of pool boiling – Correlations – Boilers – Performance terms and definitions – Reference standards – Direct Method of Testing – Boiler Efficiency Calculation.

**Condensation**: Types – Nusselt’s theory of laminar film condensation - Film condensation on horizontal and vertical surfaces - Condensers.

## UNIT-V:

**Heat Exchanger:** Definition and classification – Heat Exchanger Types by flow design, construction, and application - Concept of LMTD and overall heat transfer coefficient - Fouling factor- Derivation of LMTD and effectiveness for parallel and counter flow heat exchangers - NTU approach and design procedure. Purpose of the Performance Test - Performance terms and definitions – Indus Heat exchanger performance assessment methodology.

## TEXTBOOKS:

1. Engineering Heat transfer, Cengel and Ghajar, Tata McGraw Hill
2. Engineering Heat Transfer - A basic approach, NecatiOzisik, Mc Graw Hill

## REFERENCE BOOKS:

1. Fundamentals of Heat and Mass transfer, Incropera and Dewit, Wiley
2. Heat Transfer, Ghoshdastidar, Oxford University Press
3. Convective Heat Transfer Analysis, Patrick H.Oosthuizen, David Naylor, Mc Graw Hill
4. Engineering heat and mass transfer, Mahesh M Rathore, Laxmi Publications
5. Energy Efficiency in Thermal Utilities (Book 2)
6. Energy Performance Assessment for Equipment And Utility Systems (Book 4)

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY HYDERABAD

**MTech I Year, 1 Sem**

**THERMAL AND NUCLEAR POWER PLANTS**

## (Professional Elective–I)

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| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

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

* Obtain knowledge of power generation techniques
* Suggest suitable methods to improve the performance of thermal power plants

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

* + - 1. Exposure to different cycles and their working principle related to thermal power plants.

## UNIT–I:

**Introduction to Energy resources**: Types of Resources – Resource availability - Types of power plants - Selection of the power plants – Working of modern thermal power plants -Site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator - Review of primary thermodynamic cycles used in power plants.

## UNIT–II:

**Steam Generators and accessories:** Steam generators - Classification – Types – Fluidized bed combustion boilers -High-pressure boilers – Supercritical boilers – Steam Piping Accessories. Super heaters – Re-heaters – Economizers – Air Preheaters - Pumps and Fans - Types of Condensers – Direct contact condensers - Surface condensers - Feed water heaters – Types – Boiler Makeup – Evaporators - Condensate circulation system – Cooling towers – Types – Wet and dry cooling towers.

**Steam Turbines**: Classification – Steam Compounding - Advantages and disadvantages – Governing – Turbine losses – Turbine efficiencies – Turbine materials.

## UNIT–III:

**Gas turbines:** Open and Closed Cycle gas turbines – Design for high temperature - Combined cycles with heat recovery boiler – Combined cycle for power plant – Combined cycle with multi-pressure steam - Influence of component efficiencies on cycle performance – IGCC plant.

**Combined Cycles:** Constant pressure gas turbine power plants, Arrangements of combined plants (steam& gas turbine power plants), re- powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermodynamic efficiency of combined cycles.

## UNIT–IV:

**Nuclear Power Plants**: Principles of nuclear energy, basic nuclear reactions, nuclear reactors PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas-cooled. Advantages and limitations, nuclear power station, waste disposal.

**Environmental Aspects:** Environmental aspects of thermal power plants - Constituents of the atmosphere – Power plant pollutants - Oxides of Sulfur, Nitrogen and Carbon – Greenhouse effect – Acid precipitation – Particulate matter – Electrostatic precipitators – Thermal pollution.

## UNIT–V:

**Power Plant Performance**: General layout of modern thermal power plants – Components / Equipment in thermal power plant – Coal Mills – Boiler – Draft system – Water pumping system – LP and HP heaters – Turbine – Condenser -– Performance terms and definitions - Performance Evaluation.

Power Plant Economics: load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance &operating characteristics of power plants- incremental rate theory, input-outputcurves, efficiency, heat rate, economic load sharing, Problems**.**

## TEXTBOOKS:

1. Power Plant Engineering, P.K.Nag / Tata McGraw Hill.
2. Power Plant Technology, El Wakil/ Mc Graw Hill.
3. Energy Efficiency In Thermal Utilities (Book 2)
4. Energy Performance Assessment For Equipment And Utility Systems (Book 4)

## REFERENCEBOOKS:

1. A course in Power Plant Engineering, Arora and Domkundwar, Dhanpat Rai.
2. Power Plant Technology, El Wakil/ Mc Graw Hill.
3. Power Plant Engineering, G.R. Nagpal/Khanna Publishers.

Power Plant Technology, Rajput

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY

## HYDERABAD

**MTech I Year, 1 Sem**

**ENERGY-EFFICIENT BUILDINGS**

## (Professional Elective–I)

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| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

**Course Objectives:** The course is intended to:

* The course provides knowledge regarding building physics and related problems
* Apply technologies for developing energy-efficient and healthy buildings.

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

1. Ability to calculate the energy balance of buildings without the aid of available energy calculation programs
2. Ability to assess for potential conflict between energy conservation and indoor climate for different energy-saving measures
3. Ability to analyze and interpret results both critically and independently regarding energy and indoor climate in buildings based on values from both calculations and measurements
4. Ability to demonstrate ability to work independently on investigating energy and indoor climate issues for buildings and present the results orally and in writing in well-prepared technical reports.

## UNIT-I:

**Introduction To Electric Vehicle:** Introduction to energy efficiency in buildings-Architecture- Building Science and its significance- Indoor Environment. Components of Indoor Environment - Classification of building materials based on energy intensity-Energy Management of Buildings and Energy Audit of Buildings.

## UNIT-II:

Quality of Indoor Environment. Human Comfort-Thermal, Visual, Acoustical and Olfactory comfort. Concept of Sol- air temperature and its significance. Building technology and building services engineering (HVAC) Contribution to lower energy consumption, with different conditions for new and existing buildings.

## UNIT-III:

Ventilation and is significance. Cooling and heating concepts, Passive solar heating, active solar heating and solar electricity - Passive concepts appropriate for the various climatic zones in India- Electric efficiency for fans, pumps, lighting etc. Heat pumps. Heat exchangers. Experiences from existing energy efficient buildings.

Building related problems and health issues. Indoor climate issues regarding air quality, thermal indoor climate and acoustics. The importance of ventilation for energy efficiency and indoor climate. Building technology and calculations regarding moisture problems.

## UNIT-IV:

## Energy management matrix monitoring and targeting. Energy Efficient Landscape Design -Modification of microclimate through landscape elements for energy conservation.

## UNIT-V:

**Case studies**: Calculations of the energy balance of buildings without available energy calculation programs, primarily monthly calculations for residential buildings. Energy efficiency and conservation requirements for existing buildings – contradictions and opportunities. Energy efficiency and healthy buildings – contradictions and opportunities – Softwares

## TEXTBOOKS:

1. SodhaM.,Bansal N.K., Bansal,P.K Kumar, A. and Malik, M.A.S.,”SolarPassive Buildings”, Pergamon Press, 1986.
2. Koenigsberger, O.H., Ingersoll, T.G., Mayhew Alan and Szokolay, S. V., “Manual of Tropical Housing and Building part 1: Climatic Design”, OLBN 0 002120011,OrientLongman Limited, 1973.
3. Energy Efficiency In Thermal Utilities (Book 2)
4. Energy Performance Assessment For Equipment And Utility Systems (Book 4)

## REFERENCEBOOKS:

* + - 1. Levenspiel, *Octave.*Understanding Engineering Thermo*.* Upper Saddle River, NJ: Prentice Hall, 1996. ISBN: 978013531203*2.*

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITYHYDERABAD

**MTech I Year, 1 Sem**

## WASTE MANAGEMENT AND RECYCLING

## (Professional Elective–I)

|  |  |  |  |
| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

**Course Objectives:** The course is intended to:

* To make the students realize the importance of waste treatment
* To characterize disposal and energy recovery methods from industrial and other wastes.
* To know the equipment and materials used in the treatment of industrial waste
* Methods to treat industrial waste for pollution control.

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

1. Categorize the waste from various industries & recycle for energy extraction.

## UNIT-I:

**Integrated Solid Waste Management:** Solid waste in history – Economics and solid waste – Legislation and regulation – Materials flow – Reduction – Reuse – Recycling – Recovery – Disposal of solid waste in landfills – Energy conversion – The need for integrated solid waste management – Special wastes – E-waste materials and its recovery.

## UNIT-II:

**Landfills:** Planning, siting and permitting of landfills – Planning – Siting – Permitting – Landfill processes – Biological degradation – Leachate production – Gas production – Landfill design – Liners – Leachate collection – Treatment and disposal – Landfill gas collection and use – Geotechnical aspects of landfill design – Storm water management – Landfill cap – Landfill operation – Landfill equipment – Filling sequences – Daily cover – Monitoring – Post closure care and use of old landfills – Landfill mining.

## UNIT-III:

**Process Effluents:** Manufacturing process and sources of effluent from the process of industries like chemical – Fertilizer – Petroleum – Petrochemical –Paper –Sugar – Distillery – Textile – Tannery – Food processing – Dairy and steel manufacturing – Characteristics and composition of effluent and different methods of treatment & disposal of effluent for the following industries steel – Petroleum refineries – Textiles – Tanneries - Atomic energy plants and other mineral processing industries.

## UNIT-IV:

## Waste Water Treatment Methods: Nitrification and de-nitrification – Phosphorous removal – Heavy metal removal – Membrane separation process – Air stripping and absorption processes – Special treatment methods – Disposal of treated waste.

## UNIT-V:

**Environmental Issues in Agriculture:** Types of farming systems – Agro meteorology – Water and nutrients requirement – Fertilizers – Types of fertilizers – Pesticides and other agrochemicals – Solid and water conservation practices.

## TEXTBOOKS:

* + 1. J Industrial Solid Waste Management and Landfilling practice, M. Dutta, B.P. Parida, B.K. Guha and T. R. Surkrishnan. Narosa Publishing House, New Delhi (1999).
    2. Environmental Pollution
    3. Control Engineering, C.S.Rao Wiley Eastern Ltd. New Delhi (1995).

## REFERENCEBOOKS:

* + - 1. Industrial Waste Water Pollution Control, W. Wesley Eckenfelder Jr., McGraw Hill,2000.
      2. Wastewater Treatment for Pollution Control, McGraw- Hill, Arceivala, S.J.,1998. M. N. Rao & Datta, Waste Water Treatment, 3rd Edition, Oxford & IBH publishing Company Pvt Ltd.
      3. Treatment of Industrial Effluent, Callegy, Forster and Stafferd, Hodder and Stonghton, 1988.
      4. Hand book of solid waste management and Waste Minimization Technologies

Nicholas P. Chermission off. An imprint of Elsevier, New Delhi (2003).

5. Solid Waste Engineering, P. AarneVesilind, William A. Worrell and Debra R. Reinhart.

Thomason Asia Pte Ltd. Singapore (2002).

6. Design, Construction and Monitoring of Landfills, AmalenduBagchi,.John Wiley and

Sons..,New York. (1994).

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY

## HYDERABAD

**MTech I Year, 1 Sem**

**MEASUREMENT SYSTEMS IN ENERGY ENGINEERING**

## (Professional Elective–II)

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| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

**Course Objectives:** The course is intended to:

* To study the characteristics of instruments.
* To analyse various types of transducers based on the principle of operation and construction.
* To understand various measuring devices and their calibration.

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

1. Select a suitable transducer for use and operation.
2. Ability to calibrate the various instruments.
3. Under stand the concept of measurement errors and undertake uncertainty estimation.

## UNIT–I:

**Basic concepts:** Calibration – Standards- Dynamic measurement- System response.

**Elements of a Measurement System:** Basic Instrumentation system – Classification of instruments - Errors and Uncertainties in measurement.

**Electrical transducers:** Resistive Transducers - Inductive Transducers – Capacitive transducers - Thermoelectric Transducers and Photoelectric Transducers - Piezoelectric Transducers.

## UNIT–II:

**Basic Signal Conditioning Elements:** Amplifiers- Non-Electrical and Electrical types - Op Amps- Summing, Differential, and Charge Amplifiers - Differentiating and Integrating Elements – Filters – A to D and D to A Converters - Data Transmission Elements- Electrical, Pneumatic, Position and Radio Frequency Transmission types.

**Velocity Measurement:** Contact type - AC-DC Tachometers Non-contact type - Magnetic, Photoelectric & stroboscopic methods. Flow measurement and Flow meters-Visualization methods.

## UNIT–III:

**Acceleration measurement:** Seismic Accelerometer & Piezoelectric Accelerometer.

**Solar radiation:** Pyranometer, Pyrheliometer, sunshine recorder

**Measurement of Radiation:** Radiation Fundamentals - Radiation detectors - Optical pyrometer.

## Measurements of thermal-and-transport-property: viscosity, thermal conductivity, diffusion coefficient, pH, humidity, heat transfer coefficient, heat flux, etc. Thermal Imaging.

## UNIT–IV:

**Mechanical Transducers: Measurement of Temperature:** Bimetallic Element and Fluid Expansion type Thermometers. **Measurement of Pressure:** Manometers and Bourdon Gauges - Load Cells and Elastic Force Devices. **Measurement of Force**: Different methods - Strain gauge load cell method.

**Measurement of torque**: Strain gauge method. Data analysis: Error analysis, Uncertainty analysis, Statistical analysis, Graphical analysis and curve fitting, Multivariable regression, Goodness of fit.

## UNIT–V:

**Feedback in Instruments:** Principles of Feedback - Advantages & Disadvantages of Feedback

Digital Voltmeters: Ramp and Dual Slope types – Servo type Potentio metric and Magnetic tape Recorders – Digital Recorders of Memory type-Data displays: Analog and Digital types..

## TEXTBOOKS:

1. Modern Electronic Instrumentation and Measurement Techniques; Albert D Helfrick and William D Cooper; 2004, PHI.

## REFERENCEBOOKS:

1. Instrumentation, Measurement and Analysis; BC Nakra, and KK Chaudhry, 2ed, 2004, Tata McGraw-Hill
2. Transducers and Instrumentation; DVS Murthy, 2003, PHI
3. Instrumentation Devices and Systems, CS Rangan, GR Sarma, and VSV Mani, 2nd Ed, Tata McGraw-Hill
4. Measurement Systems Application and Design; Doeblin and Ernest; 5th Ed, 2004, Tata McGraw-Hill.
5. Measurement Systems – Applications & design, Doeblin E.O. 4th Ed. Mc. Graw Hill
6. Principles of Industrial Instrumentation, Patranabis D. ,Tata McGraw Hill – 1997.
7. Mechanical & Industrial Measurements, Jain R.K, Khanna Publishers – 1986.

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY

## HYDERABAD

**MTech I Year, 1 Sem**

**APPLIED THERMODYNAMICS**

## (Professional Elective –II)

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| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

**Course Objectives:** The course is intended to:

* To understand various systems and cycles and analyze them.
* To apply the concepts of advanced thermodynamics to combustion systems and refrigeration systems.

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

1. Analyze the thermodynamic systems for optimization of their performance

2. Understand the working principles of combustion systems and refrigeration systems.

## UNIT-I:

**Introduction:** Thermodynamic system - types – properties – Zeroth Law of Thermodynamics – Measurement of Temperature - Work Transfer and Heat Transfer – First Law of Thermodynamics applied to Closed and Open Systems - Second Law of thermodynamics – Concept of entropy – Clausius inequality – Available energy - Availability – Irreversibility.

## UNIT-II:

**Properties of Perfect Gases:** Laws of Perfect gases – Boyle’s Law – Charles Law – Gay Lussac Law – General gas equation – Joule’s law – Characteristic equation of gas – Avagadro’s law – Universal gas constant – Specific heat of a gas – Specific heat and constant volume and pressure – Enthalpy of a gas – Relation between specific heats.

## UNIT-III:

**Gas Power Cycles:** Carnot cycle - Air standard assumptions - Otto cycle - Diesel cycle – Dual cycle – Stirling cycle – Ericsson cycle – Brayton cycle – Brayton cycle with Inter cooling, Reheating and Regeneration.

## UNIT-IV:

**Vapor Power Cycles (Elementary treatment only):**  Carnot vapor cycle – Ideal Rankine cycle – Deviation of Actual Vapor power cycle from Ideal cycle – Actual Rankine cycle – Methods to increase efficiency of Rankine cycle (Lowering of condenser pressure - Super heating steam to High temperature - Increasing Boiler pressure) – Reheat and Regenerative Rankine cycle.

## UNIT-V:

Psychometry & Air Conditioning: Dry and atmospheric air – Specific and relative humidity of air – Dew point temperature – Adiabatic saturation and wet bulb temperature – The psychometric chart – Human comfort and air conditioning.

**Refrigeration cycles:** Applications – air refrigeration – vapour compression refrigeration – effects of operating parameters – COP – vapour absorption refrigeration system.

**Converters and Energy Storage Devices:** Fundamentals of convertors - Thermo-electric- MHD - basics of energy storage devices – Thermo-chemical energy storage – Sensible and Latent heat storage – Chemical Energy Storage – Electromagnetic energy storage - Working – governing - parameters.

**TEXTBOOK:**

* + - 1. Thermodynamics – An Engineering Approach , Y.A.Cengel and Mc. A. Boles.
      2. Basic and Applied Thermodynamics, P.K.Nag, Tata Mcgraw Hill

**REFERENCEBOOKS:**

* 1. Thermodynamics / Sontag & Van Wylen
  2. Thermodynamics / YVC RAO.
  3. Introduction to the Thermodynamics of Materials – David R. Gaskell

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY

## HYDERABAD

**MTech I Year, 1 Sem**

**ENVIRONMENTAL POLLUTION AND CONTROL**

## (Professional Elective–II)

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| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |

**Course Objectives:** The course is intended to:

* To understand the concepts of pollution/pollutants and their impact on the environment

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

1. Understand the impact of continual degradation of environment due to pollutants.
2. Have an exposure to different types of pollution control methods.

## UNIT-I:

## Overview of Environmental Concepts: Global Warming - Ozone Layer & UV Radiations - Deforestation - Energy & Matter Cycles - Case Studies of Significant Environmental Problems and Disasters and the lessons learnt. Influence of pollution regionally and globally.

## UNIT-II:

**Air Pollution:** Natural and anthropogenic sources of pollution - Primary and Secondary pollutants - Transport and diffusion of pollutants - Gas laws governing the behavior of pollutants in the atmosphere - air sampling methods.

**UNIT-III**:

**Air Pollution Control:** Methods of monitoring and control of air pollutants S02 NO2, CO, SPM - Effect of pollutants on human beings – Plants – Animals - Materials and on climate - Acid Rain - Ambient Air Quality Standards - Air pollution control methods and equipment.

## UNIT-IV:

**Solid Waste:** Sources and classification of land pollutants - Industrial waste effluents and heavy metals - Their interactions with soil components - Degradation of different insecticides - Fungicides and weedicides in soil - Solid waste management - Process and equipment for energy recovery from municipal solid waste and industrial waste - MSW Act 2000.

## UNIT-V:

**Water Pollution:** Types - Sources and consequences of water pollution – Physical - chemical and Bacteriological sampling and analysis of water quality – Standards - Sewage and waste water treatment and recycling ASP/STP - Water quality standard – Treatment - Utilization and disposal of sludge - Government norms.

## TEXTBOOKS:

1. Environmental Pollution Control Engineering, C. S. Rao, Wiley Eastern Ltd., Delhi 1991.

## REFERENCEBOOKS:

1. Management of Energy Environment Systems, W.K.Foell, John Wiley and Sons.

2. Energy Management and Control Systems, M.C.Macedo, Jr. John Wiley and Sons.

3. Environmental Impact Analysis Handbook, J.G.Rau, D.C.Wood, Mc Graw Hill.

4. Energy & Environment, J.M. Fowler, Mc Graw Hill.

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY

## HYDERABAD

**MTech I Year, 1 Sem**

**RESEARCHMETHODOLOGY&IPR**

|  |  |  |  |
| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **2** | **0** | **0** | **2** |

**Course Objectives:** The course is intended to:

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

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

* + - Formulate and analyze research problems.
    - Understand the importance of research ethics
    - Understand that today’s world is controlled by Computer, Information Technology.
    - Understanding the importance of ideas, concept, and creativity for obtaining IPR in the growth of individuals & nations.
    - Emphasize the need for information about Intellectual Property Rights to be promote d among students in general &engineering.
    - Understand that IPR protection provides an incentive to inventors for further research workandinvestmentinR&D,whichleadstocreationofnewandbetterproducts,andinturnbringsabout,economic growth and social benefits.

## UNIT-I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting are search problem, Scope and objective so fresearch problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

## UNIT-II:

Effective literature studies approaches, analysis, Plagiarism, Research ethics

## UNIT-III:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Formatofre search proposal, a presentation and assessment by a review committee

## UNIT-IV:

NatureofIntellectualProperty:Patents,Designs,TradeandCopyright.ProcessofPatentingandDevelopment:technologicalresearch,innovation,patenting,development.InternationalScenario:InternationalcooperationonIntellectualProperty.Procedureforgrantsofpatents, Patenting underPCT.

## UNIT-V:

Patent Rights: Scope of Patent Rights. Licens in gandtransfer of technology. Patent information

anddatabases.GeographicalIndications.NewDevelopmentsinIPR:AdministrationofPatentSystem.Newdevelopments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge CaseStudies, IPR and IITs.

## TEXTBOOKS:

1. StuartMelvilleand WayneGoddard,“Researchmethodology:anintroductionforscience&engineeringstudents”
2. WayneGoddardand StuartMelville, “Research Methodology: An Introduction”.

## REFERENCES:

1. RanjitKumar,2ndEdition,“ResearchMethodology:AStepby Step Guideforbeginners”
2. Halbert,“ResistingIntellectualProperty”,Taylor&FrancisLtd,2007.
3. Mayall,“IndustrialDesign”,McGrawHill,1992.
4. Niebel,“ProductDesign”,McGrawHill,1974.
5. Asimov,“IntroductiontoDesign”,PrenticeHall,1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New TechnologicalAge”,2016.
7. T. Ramappa, “Intellectual Property Rights UnderWTO”,S. Chand,2008

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITYHYDERABAD

**MTech I Year, 1 Sem**

**RENEWABLE ENERGY LABORATORY**

## (Lab–I)

|  |  |  |  |
| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **0** | **0** | **4** | **2** |

**Course Objectives:** The course is intended to:

* To determine the efficiency of various renewable energy systems

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

1. Have operational experience on i) Pyranometer, ii) Sunshine recorder, and other measuring instruments.
2. Undertake experiments to determine the performance and efficiency of renewable energy experiments.

## List of Experiments:

1. Performance evaluation of a solar Flat Plate Thermosyphon water heating system.
2. Conversion efficiency of a solar Flat Plate Forced Circulation water heating system.
3. Conversion efficiency of a solar Evacuated Tube water heating system.
4. Determination of conversion efficiency of a solar Air Heating system.
5. Performance estimation of photovoltaic water pumping system.
6. Estimation of moisture removal from a solar dryer.
7. Determination of characteristics of a wind generator.
8. Performance evaluation of solar cooker.
9. Performance evaluation of horizontal axes wind turbine.
10. Study and analysis of a solar still / distillation plant.

## JAWAHARLALNEHRUTECHNOLOGICALUNIVERSITY

## HYDERABAD

**MTech I Year, 1 Sem**

## ENERGY COMPUTATIONAL LAB (Lab–II)

|  |  |  |  |
| --- | --- | --- | --- |
| **L** | **T** | **P** | **C** |
| **0** | **0** | **4** | **2** |

**Course Objectives:** The course is intended to:

* 1. To expose students to C / Fortran programming languages.
  2. To solve problems related to Renewable energy, heat transfer and regression analysis.

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

* The ability to solve problems in C language
  + - Expertise in developing programs for various applications.

## List of Experiments:

1. Fundamentals of C Programming
2. Applications of C programming in the following areas:
   * + 1. Problems related to Renewable Energy Sources such as Solar and Wind
       2. Problems related to Heat transfer
       3. Problems related to Measurements and Control Systems

1. Programming using a high-level language (C/C++/Fortran/MATLAB) (8)

2. Computer programming for solving linear simultaneous and non-linear equations.(8)

3. Numerical differentiation and integration.(8)

4. Solution of ordinary differential equations and solution of partial differential equations.(8)

5. Eigenvalue problems, Boundary value, and Initial value problems.(4)

6. Problems as assigned by the respective teachers.(4)