# MECHANICAL ENGINEERING DEPARTMENT
# M. M. M. UNIVERSITY OF TECHNOLOGY
# GORAKHPUR

## Credit Structure of M.Tech. (Energy Technology and Management)

| Category Semesters | I | II | III | IV | Total |
|---|---|---|---|---|---|
| Maths (M) | 5 | - | - | - | 5 |
| Programme Core (PC) | 13 | 10 | - | - | 22 |
| Program Electives (PE) | - | 8 | 8 | - | 16 |
| Minor Project (MP) | - | - | 4 | - | 4 |
| Dissertation (D) | | | 4 | 14 | 18 |
| Seminar (S) | - | - | - | 2 | 2 |
| **Total** | **18** | **18** | **16** | **16** | **68** |

## Curriculum for M.Tech. (Energy Technology and Management)

**Junior Year, Semester-I**

| S.N. | Category | Paper Code | Subject Name | L | T | P | Credit |
|---|---|---|---|---|---|---|---|
| 1. | M | MAS-101 | Numerical Methods &Engineering Optimization | 3 | 1 | 2 | 5 |
| 2. | PC | MME-201A | Advanced Energy Conversion System | 3 | 1 | 2 | 5 |
| 3. | PC | MME-102A | Computational Methods in Engineering | 3 | 1 | 0 | 4 |
| 4. | PC | MME-204A | Clean Energy System | 3 | 1 | 0 | 4 |
| 5. | AC | | Audit subject | | | | |
| | | | **Total** | **12** | **4** | **4** | **18** |

**Junior Year, Semester-II**

| S.N. | Category | Paper Code | Subject Name | L | T | P | Credit |
|---|---|---|---|---|---|---|---|
| 1. | PC | MME-204 | Advanced Heat Transfer | 3 | 1 | 2 | 5 |
| 2. | PC | MME-206 | Refrigeration and Air Conditioning System Design | 3 | 1 | 2 | 5 |
| 3. | PE1 | MME-*** | Program Elective-1 | 3 | 1 | 0 | 4 |
| 4. | PE2 | MME-*** | Program Elective-2 | 3 | 1 | 0 | 4 |
| 5. | AC | | Audit subject | | | | |
| | | | **Total** | **12** | **4** | **2** | **18** |

**Senior Year, Semester-III**

| S.N. | Category | Paper Code | Subject Name | L | T | P | Credit |
|---|---|---|---|---|---|---|---|
| 1. | PE3 | MME-*** | Program Elective-3 | 3 | 1 | 0 | 4 |
| 2. | PE4 | MME-*** | Program Elective-4 | 3 | 1 | 0 | 4 |
| 3. | MP | MME-220 | Minor Project | 0 | 0 | 8 | 4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4. | D | MME-230 | Dissertation Part-I | 0 | 0 | 8 | 4 |
| | | | **Total** | **6** | **2** | **16** | **16** |

**Senior Year, Semester-IV**

| S.N. | Category | Paper Code | Subject Name | L | T | P | Credit |
|---|---|---|---|---|---|---|---|
| 1. | S | MME-240 | Seminar | 0 | 0 | 4 | 2 |
| 2. | D | MME-250 | Dissertation Part-II | 0 | 0 | 28 | 14 |
| | | | **Total** | **0** | **0** | **32** | **16** |

## Program Core (Energy Technology and Management)

| S.N. | Paper Code | Subject | Prerequisite Subject | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| 1. | MAS-101 | Numerical Methods & Engineering Optimization | -- | 3 | 1 | 2 | 5 |
| 2. | MME-102A | Computational Methods in Engineering | -- | 3 | 1 | 0 | 4 |
| 3. | MME-201A | Advanced Energy Conversion System | -- | 3 | 1 | 2 | 5 |
| 4. | MME-206 | Refrigeration and Air Conditioning System Design | -- | 3 | 1 | 2 | 5 |
| 5. | MME-204 | Advanced Heat Transfer | -- | 3 | 1 | 2 | 5 |
| 6. | MME-204A | Clean Energy System | -- | 3 | 1 | 0 | 4 |
| 7. | MME-220 | Minor Project | -- | 0 | 0 | 8 | 4 |
| 8. | MME-230 | Dissertation Part-I | -- | 0 | 0 | 8 | 4 |
| 9. | MME-240 | Seminar | -- | 0 | 0 | 4 | 2 |
| 10. | MME-250 | Dissertation Part-II | Dissertation Part-I | 0 | 0 | 28 | 14 |

## Program Electives PE1 & PE2 (Energy Technology and Management)

| S.N. | Paper Code | Subject | Prerequisite Subject | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| 1. | MME-254 | Combustion Engineering | - | 3 | 1 | 0 | 4 |
| 2. | MME-256 | Energy Storage Systems | - | 3 | 1 | 0 | 4 |
| 3. | **MME-263** | **Nuclear Science and Engineering** | - | 3 | 1 | 0 | 4 |

## Program Electives PE3& PE4(Energy Technology and Management)

| S.N. | Paper Code | Subject | Prerequisite Subject | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| 1. | MME-161 | Finite Element Method | - | 3 | 1 | 0 | 4 |
| 2. | MME-253 | Design of Heat Transfer Equipments | - | 3 | 1 | 0 | 4 |
| 3. | MME-261 | Energy Management and Audit | -- | 3 | 1 | 0 | 4 |
| 4. | MME-262 | Alternative Fuels for Transportation | - | 3 | 1 | 0 | 4 |
| 5. | MME-264 | Environmental Impact of Energy Systems | - | 3 | 1 | 0 | 4 |

## Audit Courses for M.Tech. (Energy Technology and Management)

| S.N. | Paper Code | Subject | | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| | | **Semester-I** | | | | | |
| 1. | MAS-105 | Applied Probability and Statistics | - | 3 | 1 | 0 | 4 |
| 2. | BOE-04 | Principles of Remote Sensing | | 2 | 1 | 0 | 3 |
| 3. | BOE-07 | Introduction to Data and File Structures | - | 2 | 1 | 2 | 4 |
| 4. | MBA-109 | Research Methodology | - | 3 | 1 | 0 | 4 |
| | | **Semester-II** | | | | | |
| 1. | BAS-27 | Discrete Mathematics | - | 3 | 1 | 0 | 4 |
| 2. | BCE-21 | Environmental Impact Assessment & Management | - | 3 | 1 | 0 | 4 |
| 3. | BCS-73 | Neural Network & Fuzzy Systems | - | 3 | 1 | 0 | 4 |
| 4. | BEE-15 | Introduction to Microprocessors | - | 3 | 1 | 2 | 5 |
| 5. | MBA-106 | Human Resource Management | - | 3 | 1 | 0 | 4 |

**Department of Mechanical Engineering**

# Madan Mohan Malaviya University of Technology, Gorakhpur-273 010, India

## M. Tech. (Energy Technology & Management) Syllabus

| MME-102A | Computational Methods in Engineering | | |
|---|---|---|---|
| **Course Category** | : | Program Core (PC) | |
| Pre-requisites | : | NIL | |
| Contact Hours/Week | : | Lecture: 3, Tutorial: 1, Practical: 0 | |
| Number of Credits | : | 4 | |
| Course Assessment Methods | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test and one major examination | |
| Course Outcomes | : | The students are expected to be able to demonstrate the following knowledge and skills after completing this course | |

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions
2. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Ability to select appropriate numerical methods for various types of problems in engineering.
4. Analyse and evaluate the accuracy of common numerical methods.

**Topics Covered**

| | |
|---|---|
| **UNIT-I** | |
| Introduction to Linear Algebraic Equation, Roots of Equation, Numerical differentiation and Integration, Initial and boundary value problems.<br>**Systems of Linear Algebraic Equations:** Gauss Elimination Method, LU Decomposition Methods, Interpolation and Curve Fitting: Polynomial Interpolation, Interpolation with Cubic Spline. | 9 |
| **UNIT-II** | |
| **Roots of Equations:** Incremental Search Method, Method of Bisection, Methods Based on Linear Interpolation, Newton–Raphson Method, Systems of Equations | 9 |
| **UNIT-III** | |
| **Numerical Differentiation and Integration:** FiniteDifferenceApproximations, RichardsonExtrapolation, DerivativesbyInterpolation, Implicit and explicit integration schemes. | 9 |
| **UNIT-IV** | |
| **Initial and Boundary ValueProblems**: TaylorSeriesMethod, Runge–KuttaMethods, ShootingMethod.**SymmetricMatrixEigenvalueProblems**. | 9 |

**Textbooks**


1. JaanKiusalaas, Numerical Methods in Engineering with Matlab , Second Edition, Cambridge University Press.
2. Arnold Neumaier, Introduction to Numerical Analysis, , Cambridge University Press.

| **Reference books** | |
|---|---|
| 1. | Rao. V. Dukkipati ,MATLAB an Introduction with Application, , New Age Publisher |

| **MME-201A** | **ADVANCED ENERGY CONVERSION SYSTEM** |
|---|---|

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|---|---|---|
| **CourseCategory** | : | Program Core (PC) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 2 |
| **Number of Credits** | : | 5 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Ability to apply the concept of Exergy in energy conversion systems.
2. Ability to analyze the different parameters of combined vapour power cycles which affects the overall efficiency of the thermal power plant.
3. Ability to analyze the different operating and design parameters of the air propulsion system.
4. Ability to analyze the performance of energy conversion utility system.

| **Topics Covered** | |
|---|---|
| **UNIT-I** | |
| **Introduction of energy conversion systems:** Energy sources and demand, $CO_2$ emissions and global temperature, Direct and indirect energy conversion, Energy efficiencies.<br>**Energy and Exergy Analysis:** Reversible work and irreversibility, Exergy change of a closed and open system, Exergy transfer by heat, work and mass, Decrease of exergy principle and exergy destruction, Exergy balance in closed and open system, Energy efficiency based on the second law of thermodynamics. | 9 |
| **UNIT-II** | |
| **Combined Gas and Vapour Power Cycles:** Parameter affecting the performance of Rankine cycle, Recapitulation of simple and reheat-regenerative Rankine cycle, Supercritical Rankine cycle, Binary vapour power cycle, Organic Rankine cycle, Parameter affecting the performance of Brayton cycle, Recapitulation of simple and reheat-regenerative-intercooled Brayton cycle, Co-generation and Tri-generation, Combined gas and vapour power cycle, Second law analysis of combined cycles. | 9 |
| **UNIT-III** | |
| **Gas Turbine and Air Propulsion:** Introduction of gas turbine engines, Thrust equations, propulsive efficiency, Components of gas turbine engines, Parametric cycle analysis of ideal engine. Turbojet, Turboprop, Turbofan, Ram jet and Scram jets engine. | 9 |
| **UNIT-IV** | |
| **Energy Conversion Utility Systems:** Review of low pressure and high pressure boilers, supercritical boiler, FBC Boiler, performance evaluation of boiler, theory of steam and gas nozzles, steam turbine, compounding of steam turbine, Impulse steam turbine and its performance, Impulse reaction steam turbine and its performance, energy losses in steam turbine, condensers and its thermodynamic analysis. | 9 |

**EXPERIMENTS**

**Minimum Eight experiments are to be performed**

1. Study and analysis of modern high pressure Boilers.
2. Experiment on condenser.
3. Experiment on MPFI four stroke multi cylinder petrol engine.
4. Experiment on CRDI four stroke multi cylinder diesel engine.
5. Experiment on axial flow compressor.
6. Experiment on Hydraulic Turbines.
7. Experiment on Sterling Engine.
8. Experiment on cooling tower and their performance characteristics.
9. Experiment on exhaust gas analyser.

| **Textbooks** | |
|---|---|
| | APPLIED Thermodynamics by P. K. Nag, TMH Edition. |
| | Thermodynamics and Heat power ($8^{th}$ Edition): Irving Granet, Maurice Bluestein, CRC Press Taylor & Francis Group. |
| | Principles of Energy Conversion: A.W.Culp( McGrawHill International) |
| | Thermodynamics: An engineering approach ($8^{th}$ Edition), Tata McGraw Hill. |
| | Advanced Engineering Thermodynamics ($2^{nd}$ Edition), John Wileys& Sons, Inc. |
| **Reference books** | |
| | Aircraft Propulsion and Gas Turbine Engines, Second Edition:Ahmed F. El-Sayed**,** CRC Press Taylor & Francis Group. |
| | Energy Conversion Principles:Begamudre,Rakoshdas |
| | Applied Thermodynamics: Availability and Energy Conversion Method: Kam W. Li, CRC Press Taylor & Francis Group. |
| | Combined Cycles and Steam Turbine Power Plant: Rolf Keh and FrenkHennemann, PennWell Books; 3rd Edition. |
| | Boilers for Power and Process: Kumar Rayaprolu, CRC Press Taylor & Francis Group. |
| | Thermal power Plant Design & operation: Dipak Sarkar, Elsevier**;** 1 edition |

| **MME-206** | **REFRIGERATION & AIR CONDITIONING SYSTEM DESIGN** | |
|---|---|---|
| **Course Category** | : | Program Core (PC) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 2 |
| **Number of Credits** | : | 5 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, class tests and One Minor test and One Major Theory Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Understand the basics of refrigeration, different refrigeration cycles and different types of refrigeration systems.
2. Understand the properties of refrigerants, its impact on environment and designing of different components of refrigeration and air conditioning system.

3. Basics and design calculations of air conditioning systems.

4. Knowledge of different types of non-conventional refrigeration systems.

| | |
|---|---|
| **Topics Covered** | |
| **UNIT-I** | |
| **Recapitulation of basic refrigeration:**<br>Reversed Carnot cycle, Joule cycle, Simple vapour compression systems, Multistage vapour compression system, Multi evaporator refrigeration systems, Cascade systems, Vapourabsorbtion refrigeration systems, Ejector compression system | 9 |
| **UNIT-II** | |
| **Refrigerants:**<br>Classification of Refrigerants, Refrigerant properties, ODP and GWP, Environmental Impact-Montreal/ Kyoto protocols-Eco Friendly Refrigerants<br>**Design of components of refrigeration and air conditioning system:**<br>Design of compressors, Design of expansion devices, Duct design | 9 |
| **UNIT-III** | |
| **Air Conditioning:**<br>Properties of moist air, Psychrometry of Air Conditioning processes, Design conditions of air conditioning, Heat transfer through building structure, Heating and cooling load calculations | 9 |
| **UNIT-IV** | |
| **Non-Conventional Refrigeration Systems:**<br>Thermoelectric Refrigeration, Vortex tube refrigeration, Pulse tube refrigeration, Cooling by adiabatic demagnetization, Solar refrigeration and air conditioning systems | 9 |
| **EXPERIMENTS**<br>Minimum Eight experiments are to be performed<br>1. Experiment on refrigeration test rig and calculation of various performance parameters.<br>2. Experiment on vapour absorption refrigeration test rig.<br>3. To study different types of expansion devices used in refrigeration system.<br>4. To Study window air conditioner.<br>5. Experiment on Ice-plant.<br>6. Experiment on air-conditioning test rig & calculation of various performance parameters.<br>7. Experiment on Vortex tube test rig.<br>8. To study air washers and determine efficiency of air washer.<br>9. Visit of a central air conditioning plant and its detailed study.<br>10. Visit of cold-storage and its detailed study. | |

| **Textbooks** | |
|---|---|
| 1. | Refrigeration and Air Conditioning: Manohar Prasad, New Age publication |
| 2. | Refrigeration and Air Conditioning: C.P. Arora, Mc-Graw hill publication |
| 3. | Principles of Refrigeration: Roy. J Dossat, Pearson publication |
| | |
| **Reference books** | |
| 1. | Refrigeration and Air Conditioning:W.F. Stocker and J. W. Jones, Mc-Graw hill Inc. publication |
| 2. | Refrigeration and Air Conditioning: G.F. Hundy, A.R. Trott and T.C. Welch (Auth.) -Elsevier, Butterworth-Heinemann (2008) |
| 3. | Handbook of Air Conditioning and Refrigeration: Shan K. Wang-, Mc-Graw hill Inc. publication |
| 4. | Solar Air Conditioning and Refrigeration: A.A.M. SAYIGH and J.C. MCVEIGH, PERGAMON Press |

| MME-204 | ADVANCED HEAT TRANSFER | |
|---|---|---|
| **Course Category** | : | Program Core (PC) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 2 |
| **Number of Credits** | : | 5 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory and Practical Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course |

1. Student will be able to calculate the temperature profile and rate of heat transfer in 1D system with variable thermal conductivity and heat generation and also the study of various fin profiles.
2. Student will be able to make calculations for temperature and rate of heat transfer in steady state and unsteady state 2D systems using Groeber's and Heisler charts.
3. Ability to understand the basics of radiation and its various models of successive reflection and also radiation through absorbing media.
4. Ability to understand and calculate velocity and temperature profile and rate of heat transfer by convection over a flat plate and tubes.

| **Topics Covered** | |
|---|---|
| **UNIT-I** | |
| **Review:** Reviews of basic laws of Conduction, Convection and Radiation<br>**Conduction:** One-dimensional steady state conduction with variable thermal conductivity and with internaldistributed heat source and moving heat source problem, Local heat source in non-adiabatic plate, Thermocouple conduction error, Extended Surfaces-Review, Optimum fin of rectangular profile, straight fins of triangular and parabolic profiles, Optimumprofile, Circumferential fin of rectangular profile, spines, design considerations. | 9 |
| **UNIT-II** | |
| 2D steady state heat conduction, semi -infinite and finite flat plates, Temperature fields in finite cylinders and ininfinite semi-cylinders, spherical shells, Graphical method, relaxation technique, Unsteady state conduction,Sudden changes in the surface temperatures of infinite plates, cylinders and spheres using Groeber's and Heislercharts for plates, cylinders and spheres suddenly immersed in fluids. | 9 |
| **UNIT-III** | |
| **Radiation:** Review of radiation principles, Diffuse surfaces and the Lambert's cosine law. Radiation through nonabsorbingmedia, Hottel's method of successive reflections, Gebhart's unified method, Poljak's method. Radiationthrough absorbing media, Logarithmic decrement of radiation, Apparent absorptive of simple shaped gas bodies,Net heat exchange between surfaces separated by absorbing medium, Radiation of luminous gas flames. | 9 |
| **UNIT-IV** | |
| **Convection:** Heat transfer in laminar flow, free convection between parallel plates, forced internal flow throughcircular tubes, fully developed flow, Velocity and thermal entry length, solutions with constant wall temperatureand with constant heat flux, Forced external flow over a flat plate, two-dimensional velocity and temperatureboundary layer equations, Karman Pohlhousen approximate integral method. Heat transfer in turbulent | 9 |

| | |
|---|---|
| flow, Eddy heat diffusivity, Reynold's analogy between skin friction and heat transfer, Prandtl-Taylor, Von Karman andMartineli's analogies, Turbulent flow through circular tubes. | |

**EXPERIMENTS**

**Minimum Eight experiments are to be performed**

1. Experiment on Conduction - Composite wall experiment
2. Experiment on Conduction - Composite cylinder experiment
3. Experiment on Convection - Pool Boiling experiment
4. Experiment on Convection - Experiment on heat transfer from tube-natural convection.
5. Experiment on Convection - Heat Pipe experiment.
6. Experiment on Convection - Heat transfer through fin-natural convection.
7. Experiment on Convection - Heat transfer through tube/fin-forced convection.
8. Experiment on Any experiment on Stefan's Law, on radiation determination of emissivity, etc.
9. Experiment on Any experiment on solar collector, etc.
10. Experiment on Heat exchanger - Parallel flow experiment
11. Experiment on Heat exchanger - Counter flow experiment
12. Experiment on Any other suitable experiment on critical insulation thickness.
13. Experiment on Conduction - Determination of thermal conductivity of fluids.
14. Experiment on Conduction - Thermal Contact Resistance Effect.

**Textbooks**

| | |
|---|---|
| 1. | Advances in Heat Transfer- James P Hartnett (Academic Press) |
| 2. | Principles of Heat Transfer- Kaviany M (Wiley-International) |
| 3. | Heat Transfer: Principles and Applications-B.K. Datta (Prentice Hall of India) |

**Reference books**

| | |
|---|---|
| 1. | Heat Transfer Calculations- Myer Kutz (McGraw-Hill) |
| 2. | Convective Heat Transfer- Burmeister Louis (Wiley-International) |

| **MME-204A** | | **CLEAN ENERGY SYSTEMS** |
|---|---|---|
| **Course Category** | : | Program Core (PC) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, and One Minor test and One Major Theory Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Ability to understand basics of solar energy, solar time calculations and production and utilization of biomass in different areas.
2. Student will be able to understand basics of wind energy, power calculations, site selection and wind power production plants.
3. Ability to understand the principle, construction and application of fuel cell and also about power production and distribution by hydel energy.
4. Ability to apply the concept of material and energy balance by various methods and flow charts.
5. Ability to understand the methods and tools of energy audit along with maximizing the energy efficiency.

| Topics Covered | |
|---|---|
| **UNIT-I** | |
| **Solar Energy:** Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy<br>**Bio-mass energy:** Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo-Chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc., Applications of Gasifiers to thermal power and Engines, Biomass as a decentralized power generation source for villages. | 9 |
| **UNIT-II** | |
| **Wind Energy:** Wind Energy: Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Principles of Aerodynamics of wind turbine blade, Various aspects of wind turbine design, Wind Turbine Generators: Induction, Synchronous machine, constant V & F and variable V & F generations, Reactive power compensation. Site Selection, Concept of wind form & project cycle, Cost economics | 9 |
| **UNIT-III** | |
| **Fuel Cell:** Fuel cell – Principle of working, construction and applications<br>**Material and Energy Balance:** Basic Principles; The Sankey Diagram and its Use; Material Balances; Energy Balances; Method for Preparing Process Flow Chart; Facility as an Energy System; How to Carryout Material and Energy (M & E) Balance. | 9 |
| **UNIT-IV** | |
| **Energy Audit:** Energy Audit: Types and Methodology; Energy Audit Reporting Format; Understanding Energy Costs; Benchmarking and Energy Performance; Matching Energy Usage to Requirement; Maximizing System Efficiency; Fuel and Energy Substitution; Energy Audit Instruments; Duties and responsibilities of energy auditors. | 9 |

| **Textbooks** | |
|---|---|
| 1. | Principles of Thermal Process: Duffie -Beckman. |
| 2. | Solar Energy Handbook: Kreith and Kreider (McGraw Hill) |
| 3. | Biomass Renegerable Energy – D.O.hall and R.P. Overeed |
| 4. | Energy Management: W.R.Murphy, G.Mckay (Butterworths) |
| **Reference books** | |
| 1. | Renewable Sources of Energy and Conversion Systems: N.K. Bansal and M.K. Kleeman |
| 2. | Wind energy Conversion Systems – Freris L.L. (Prentice Hall1990) |
| 3. | Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific) |

| **MME-220** | **MINOR PROJECT** | |
|---|---|---|
| **CourseCategory** | : | Program Core (PC) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 0, Tutorial: 0, Practical: 8 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course |

1. Understanding of importance of literature survey.
2. Develop ability to comprehend the research paper.
3. Understanding of steps involved in writing the research paper.
4. Develop the ability to write a research paper.

| | | |
|---|---|---|
| **MME-230** | **DISSERTATION PART-I** | |
| **Course Category** | : | Program Core (PC) |
| **Pre-requisite Subject** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 0, Tutorial: 0, Practical: 8 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course |
| 1. Analyze and apply prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints.<br>2. Analyze the selected topic, organize the content and communicate to audience in an effective manner<br>3. Application of various thermal engineering concepts and analyze Database.<br>4. Evaluate the various validation and verification methods | | |

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|---|---|---|
| **MME-240** | **SEMINAR** | |
| **CourseCategory** | : | Program Core (PC) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 0, Tutorial: 0, Practical: 4 |
| **Number of Credits** | : | 2 |
| **Course Assessment Methods** | : | Continuous assessment through presentations and viva voce |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course |
| 1. Ability to understand the working in real environment and get acquainted with the organization structure, business operations and administrative functions.<br>2. They able to enhance the communications and presentation skills.<br>3. Ability to evaluate, credit, and synthesize sources.<br>5. Understanding to write technical documents and give oral presentations related to the work completed. | | |

| MME-250 | DISSERTATION PART-II | |
|---|---|---|
| **Course category** | : | Program Core (PC) |
| **Pre-requisite Subject** | : | Dissertation Part-I |
| **Contact hours/week** | : | Lecture : 0, Tutorial : 0, Practical: 28 |
| **Number of Credits** | : | 14 |
| **Course Assessment methods** | : | Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course |

1. Synthesizing and applying prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints.
2. Analyze the selected topic, organize the content and communicate to audience in an effective manner
5. Application of various thermal engineering concepts and analyze Database.
3. Evaluate the various validation and verification methods
4. Analyzing professional issues, including ethical, legal and security issues, related to computing projects

| MME-251 | ECONOMICS AND PLANNING OF ENERGY SYSTEMS | |
|---|---|---|
| **Course Category** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes,<br>and Three Minor tests and One Major Theory Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Ability to understand the evaluation of energy technology and economics of energy conservation.
2. Ability to understand Energy demand, Energy models and energy planning.
3. Ability to understand implications of energy, clean development mechanism, energy transfer with financing.
4. Ability to understand the carbon credits, trading opportunities and energy policy acts with regulations.

**Topics Covered**

| **UNIT-I** | |
|---|---|
| Relevance of financial and economic feasibility, Evaluation of energy technologies and systems, Basics ofengineering economics, Financial evaluation of energy technologies, Social cost benefit analysis, Case studies ontechno-economics of energy conservation and renewable energy technologies. | 9 |

| | |
|---|---|
| **UNIT-II** | |
| Energy demand analysis and forecasting, Energy supply assessment and evaluation, Energy demand – supplybalancing, Energy models, Software for energy planning, | 9 |
| **UNIT-III** | |
| Energy – economy interaction, Energy investment planning and project formulation. Energy pricing, Policy andplanning implications of energy – environment interaction, clean development mechanism, technology transferand its financing | 9 |
| **UNIT-IV** | |
| Carbon credits and trading opportunities, Financing of energy systems, Energy policy related acts and regulations | 9 |
| **Textbooks** | |
| 1. Economic Issues of Renewable Energy Systems Gerhard Oelert, Falk Aner& Klaus Pertz | |
| **Reference books** | |
| 1. Energy Policy: B. G. Desai | |

| **MME-254** | | **COMBUSTION ENGINEERING** |
|---|---|---|
| **CourseCategory** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Ability to understand the basics, importance and thermodynamics behind combustion.
2. Ability to understand kinetics of combustion and various aspects pertaining to propagation of flame.
3. Ability to understand advances of burning of fuel in spray form and also about the ignition.
4. Student will be able to tell combustion generated pollution and their controls.

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| **Topics Covered** | |
| **UNIT-I** | |
| **Introduction:** Importance of combustion; Combustion equipment's, Hostile fire problems, pollution problemsarising from combustion.<br>**Thermodynamics of Combustion:** Enthalpy of formation; Enthalpy of reaction; Heating values; First & second laws; Analysis of reaction system, Chemical equilibrium, Equilibrium composition; Adiabatic &equilibrium,Flame temperature. | 9 |
| **UNIT-II** | |

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|---|---|
| **Kinetics of Combustion:** Law of mass action; Reacting rate; Simple and complex reaction; Reaction order &molecularity, Arhenius laws; Activation Energy; Chain reaction; Steady rate & Partial equilibrium approximation;chain explosion; Explosion limit and oxidation characteristics of hydrogen, Carbon monoxide, Hydrocarbons.<br>**Flames:** Remixed flame structure & propagation of flames in homogeneous mixtures; Simplified RankineHugoniot relation, Properties of Hugoniot curve, analysis of Deflagration & detonation branches, Properties of Chapmen Jouguetwave, Laminar flame structure; Theories of flame propagation & calculation of flame speedmeasurements. Stability limits of laminar flames; Flammability limits & quenching distant, Burner design, Mechanism of flamestablization in laminar &turbulent flows, Flame quenching, Diffusion flames; Comparison of diffusion withpremixed flame, combustion of gaseous fuel, jets burke & Schumann development. | 9 |
| **UNIT-III** | |
| **Burning of Condensed Phase:** General mass burning considerations, Combustion of fuels droplet in a quiescent and convective environment, Introduction to combustion of fuel sprays<br>**Ignition:** Concept of ignition, Chain ignition, Thermal spontaneous ignition, Forced ignition. | 9 |
| **UNIT-IV** | |
| **Combustion Generated Pollution & its Control:** Introduction, Nitrogen oxide, Thermal fixation of atmosphericnitrogen prompts, NO, Thermal NOx & control in combustors. Fuel NOx & control, post combustion destructionof NOx, Nitrogen dioxide, carbon monoxide Oxidation-Quenching, Hydrocarbons, Sulphur oxide. | 9 |

| **Textbooks** | |
|---|---|
| 1. | Internal Combustion Engines: Applied Thermo sciences- Ferguson Colin R (John Wiley) |
| 2. | Engineering Fundamentals of the Internal Combustion Engine- Pulkrabek (Pearson Education) |
| **Reference books** | |
| 1. | Instrumentation for Combustion and Flow in Engines- Durao D F G (Kluwer Aca) |
| 2. | Energy from Biomass: A Review of Combustion and Gasification Technologies - Quaak Peter |

| **MME-253** | | **DESIGN OF HEAT TRANSFER EQUIPMENTS** |
|---|---|---|
| **CourseCategory** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, and One Minor tests and One Major Theory Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Student will be able to design co-current, counter current and cross flow heat exchangers.
2. Student will be able to design hair-pin heat exchangers and their calculations.
3. Student will be able to design shell and tube heat exchangers and boiling curve & condensation mechanisms.
4. Student will be able to design the cooling tower and evaporators in various applications.

| **Topics Covered** | |
|---|---|
| **UNIT-I** | |
| **Introduction to Heat exchangers:** Definition, TEMA classification of heat exchangers and their applications, concept of varying overall heat transfer coefficient.<br>**Analysis of heat exchangers:** LMTD analysis of single pass co-current, counter-current and cross flow heat | 9 |

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| exchangers, special operating conditions, influence of fouling factor, contrast between LMTD and AMTD, effectiveness-NTU method, charts solutions for heat exchangers, pressure drop calculation in heat exchanger. | |
| **UNIT-II** | |
| **Compact and plate heat exchangers:** Types, merits and demerits, design of compact heat exchangers, performance influencing parameters, limitations.<br>**Hair-pin Heat Exchangers**- Introduction to counter flow double pipe or hair-pin heat exchangers, Augmentation of hair-pin heat exchangers, film coefficient in tubes and annulus, pressure drop calculation, Algorithm for design and performance calculation of hair-pin heat exchangers. | 9 |
| **UNIT-III** | |
| **Shell and tube heat exchangers:** Classification and nomenclature pertaining to industrial version heat exchangers, baffles and tube-pitch arrangement**,** thermal design consideration of shell and tube heat exchanger for single and two-phase heat transfer, calculations.<br>**Boiling and condensation:** Pool boiling, forced convection boiling, physical mechanism of condensation, laminar film and turbulent film condensation, condensation in horizontal tube, drop wise condensation. | 9 |
| **UNIT-IV** | |
| **Cooling towers:** Basic principle of evaporative cooling, psychrometric processes, classification of cooling towers, performance characteristics of cooling tower.<br>**Evaporators:** Introduction and classifications of evaporator, temperature profile in evaporator, methods of feeding evaporator, performance of evaporator, thermal design considerations, mechanical design considerations, single effect and multiple effect evaporator. | 9 |

| **Textbooks** | |
|---|---|
| 1. | Heat Exchangers Selection Rating and Thermal Design (2nd Edition): SadikkakacHongtan Liu, **CRC** Press Boca Rattan Londan New York, Washington, D.C. |
| 2. | Heat Exchanger Design: Ramesh K. Shah and Dusan P. Sekulic, John Wiley & Sons, Inc. |
| 3. | Incropera, F. P. and De Witt, D. P., Fundamentals of Heat and Mass Transfer, 4th Edition, John Wiley and Sons, New York. |
| **Reference books** | |
| 1. | Donald Q. Kern: Process Heat Transfer, **McGraw – Hill,** New York. |
| 2. | Kays, W. M. and London, A. L., Compact Heat Exchangers, 2nd Edition, **McGraw – Hill**, New York. |
| 3. | Process Heat Transfer principles and Applications, R.W. Serth, **Academic Press is an imprint of Elsevier** |

| **MME-256** | **ENERGY STORAGE SYSTEMS** | |
|---|---|---|
| **CourseCategory** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination. |

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| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Understand need and potential of energy storage system.
2. 4Understand the concept electrochemical energy storage and sensible heat storage system.
3. Understand the concept of phase change material and numerical analysis of heat transfer mechanism of PCM during melting and freezing process.
4. Understanding about the application of energy storage system in the field of solar energy, waste heat, drawing and heating for process industries.

**Topics Covered**

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| **UNIT-I** | |
| **Need of energy storage;**<br>Different modes of Energy Storage Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels, Hydrogen for energy storage. Solar Ponds for energy storage | 9 |
| **UNIT-II** | |
| **Electrochemical Energy Storage Systems:**<br>Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon nano-tubes in electrodes Sensible Heat Storage SHS mediums; Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; Earth storage; Energy storage in aquifers; Heat storage in SHS systems; Aquifers storage. | 9 |
| **UNIT-III** | |
| **Latent Heat Thermal Energy Storage:**<br>Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems; Enthalpy formulation; Numerical heat transfer in melting and freezing process | 9 |
| **UNIT-IV** | |
| **Some Areas of Application of Energy Storage:**<br>Food preservation; Waste heat recovery; Solar energy storage; Greenhouse heating; Power plant applications; Drying and heating for process industries. | 9 |

**Textbooks**

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|---|---|
| 1. | Energy storage Robert Huggins Springer |

**Reference books**

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|---|---|
| 1. | Solar Energy Handbook: Kreith and Kreider (McGraw Hill) |

| **MME-255** | **HYDROGEN ENERGY** | |
|---|---|---|
| **CourseCategory** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |

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|---|---|---|
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Ability to understand the basics of hydrogen energy such as- requirements, storage, utilization etc. and various methods of hydrogen generation.
2. Ability to understand the physical & chemical properties of hydrogen and various methods of storage of hydrogen.
3. Ability to apply the concept of hydrogen utilization in various applications such as- IC engines, gas turbines, power plants etc. and its various characteristics related to performance and emission in SI engines.
4. Ability to understand the various safety issues for using hydrogen energy and risk analysis along with simulation of crash tests.

**Topics Covered**

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|---|---|
| **UNIT-I** | |
| Hydrogen pathways introduction – current uses, General introduction to infrastructure requirement for hydrogen production, storage, dispensing and utilization, and hydrogen product ion power plants.<br>Thermal-Steam Reformation – Thermo Chemical Water Splitting – Gasification – Pyrolysis, Nuclear thermo catalytic and partial oxidation methods. Electrochemical – Electrolysis – Photo electro chemical, Biological – Photo Biological – Anaerobic Digestion Fermentative Micro- organisms | 9 |
| **UNIT-II** | |
| Physics and chemical properties – General storage methods, compressed storage – composites cylinders – Glass micro sphere storage – Zeolities, Metal hydride storage, chemical hydride storage and cryogenic storage. | 9 |
| **UNIT-III** | |
| Overview of hydrogen utilization: I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic and marine applications. Hydrogen fuel quality, performance, COV, emission and combustion characteristics of Spark Ignition engines for hydrogen, back firing, knocking, volumetric efficiency, hydrogen manifold and direct injection, fumigation, NOx controlling techniques, dual fuel engine, durability studies, field trials, emission and climate change. | 9 |
| **UNIT-IV** | |
| Safety barrier diagram, risk analysis, safety in handling and refueling station, safety in vehicular and stationary applications, fire detecting system, safety management, and simulation of crash tests. | 9 |

**Textbooks**

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|---|---|
| 1. | Fuel Cells and Hydrogen Energy Bansal, Narottam P. |

**Reference books**

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|---|---|
| 1. | Industrial Hydrogen Hugh S. Taylor D.Sc |
| 2. | Hydrogen Generator Gas for Vehicles and Engines John D Cash; Martain Cash |

| MME-161 | FINITE ELEMENT METHOD | |
|---|---|---|
| **Course category** | : | Program Electives (PE) |
| **Pre-requisite Subject** | : | NIL |
| **Contact hours/week** | : | Lecture: 3, Tutorial : 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voice , one major test and one major examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course |

1. To develop the ability to generate the governing finite element equations for systems governed by partial differential equations.
2. To understand the use of the basic finite elements for structural applications using truss, beam, frame and plane elements;
3. To understand the application and use of the finite element method for heat transfer problems.
4. To demonstrate the ability to evaluate and interpret Finite Element Method analysis results for design and evaluation purposes.
5. To develop a basic understanding of the limitations of the Finite Element Method and understand the possible error sources in its use.

**Topics Covered**

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| **UNIT-I** | |
| **Introduction:** Historical background,basic concepts of FEM**,** Comparison with Finite Difference Method, Advantages and limitations, Different approaches in Finite Element Method-Discrete, Variational approach, Weighted Residual methods. | 9 |
| **UNIT-II** | |
| **Direct Problems-** Spring, Hydraulic Network; Resistance Network and Truss Systems<br>**Finite element analysis of 1-D problems:** formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its postprocessing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame. | 9 |
| **UNIT-III** | |
| **Finite element analysis of 2-D problems:**Finite Element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics; | 9 |
| **UNIT-IV** | |
| **Numerical considerations:** numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about preprocessors, postprocessors and finite element packages. | 9 |

**Books & References**


1. An Introduction to Finite Element Method – J. N. Reddy (Tata McGraw Hill).
2. Finite Element Procedure in Engineering Analysis - K.J. Bathe (Tata McGraw Hill). (New Central book Agency)
3. Concepts and Application of Finite Element Analysis- R.D. Cook, D.S. Malcus and M.E. Plesha (John Wiley)
4. Introduction to Finite Elements in Engineering- T.R Chandrupatla and A.D. Belegundu (Prentice Hall India)
5. Numerical Methods– E. Balagurswamy (Tata Mc Graw Hill)

| MME-261 | ENERGY MODELLING AND PROJECT MANAGEMENT | |
|---|---|---|
| **CourseCategory** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Understand the importance of energy management and application of energy management in boiler, turbine and heat exchanger etc.
2. Understand the concept of energy audit and responsibility of energy auditor.
3. Knowledge of material and energy balance of energy converting devices
4. Understand the purpose energy policies, managerial function, strategies, marketing, training and planning of any organization

**Topics Covered**

| **UNIT-I** | |
|---|---|
| **Models and modeling approaches:**<br>Input output analysis, energy demand analysis and forecasting, project management. Multiplier Analysis – Energy and Environmental Input / Output Analysis-Energy Aggregation-Econometric Energy Demand Modeling-Overview of Econometric Methods. Methodology for Energy Demand Analysis – Methodology for Energy Technology Forecasting-Methodology for Energy Forecasting Sectoral Energy Demand Forecasting. Solar Energy-Biomass Energy-Wind Energy and other Renewable Sources of Energy. | 9 |
| **UNIT-II** | |
| **Basic concept of econometrics and statistical analysis:**<br>The 2-variable regression model; The multiple regression model; Tests of regression coefficients and regression equation; Econometric techniques used for energy analysis and forecasting with case studies from India; Operation of computer package Input – Output Analysis, Basic concept of Input-output analysis; concept of energy multiplier and implication of energy multiplier for analysis of regional and national energy policy; Energy and environmental Input – Output analyses using I-O model. | 9 |
| **UNIT-III** | |
| **Energy Modeling:**<br>**Interdependence of energy-economy- environment;**<br>Modeling concept, and application, Methodology of energy demand analysis; Methodology for energy forecasting; Sectoral energy demand forecasting; Interfuel substitution models; SIMA model, and I-O model for energy policy analysis; Simulation and forecasting of future energy demand consistent with macroeconomic parameters in India; Energy Economics and Policies: National and Sectoral energy planning; Integrated resources planning; Energy pricing. | 9 |
| **UNIT-IV** | |

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|---|---|
| **Project Evaluation & Management: Financial analysis:**<br>Project cash flows, time value of money, life cycle approach & analysis, conception, definition, planning, feasibility and analysis; Project appraisal criteria; Risk analysis; Project planning matrix; Aims oriented project planning; Social cost benefit analysis. Network analysis for project management; Time estimation; Critical path determination; PERT, CPM and CERT: Fuzzy logic analysis; Stochastic based formulations; Project evaluation techniques; Funds planning; Project material management, evaluation & analysis; Implementation and monitoring; Performance indices; Case studies. Autonomous Fossil Fuel and renewable energy (RE) - based Power Systems. | 9 |

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|---|---|
| **Textbooks** | |
| | Energy Policy Analysis and Modeling M. Munasinghe and P. Meier Cambridge University Press, |
| | The Economics of Energy Demand: A Survey of Applications, W.A Donnelly |
| | Econometrics Models and Economic Forecasts S. Pindyck and Daniel L Rubinfeld, McGraw Hill, New York 1991 |
| **Reference books** | |
| | Forecasting Methods and Applications S.Makridakis Wiley, 1983 |
| | Sectoral Energy Demand Studies: Application of the END-USE Approach to Asian Countries, - UN-ESCAP, New York 1991 |

| **MME-162** | **ADVANCES IN MATERIAL SCIENCE AND APPLICATIONS** | |
|---|---|---|
| **Course Category** | : | Program Electives(PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course |

1. Ability to understand the role of computer in the areas of automation, planning and manufacturing for improving their effectiveness.
2. Ability to develop manual part program and computer assisted part program to produce components.
3. Ability to design and develop various system such as feedback, interpolator, material handling and implementation of adaptive control.
4. Ability to apply the concept of group technology and computer assisted process planning.

| **Topics Covered** | |
|---|---|
| **UNIT-I** | |
| **Materials and Classification:** Introduction, Demand of advanced materials,Classification of different materials and alloys. Macro and micro analysis of materials, Segregation and bonding, Strengthening mechanisms. | 9 |
| **UNIT-II** | |
| **Properties of Materials:** Flexural Test,Toughness tests, Creep characteristics, Hardness tests, Fracture test, Griffith's crack theory, Strain hardening, Single crystal growth.<br>**Wear:** Modes of adhesive, abrasive, erosive, fretting, sliding. | 9 |
| **UNIT-III** | |
| **Techniques of Materials Characterization:** Definition; importance and application of X-ray diffraction technique for phase identification,Scanning Electron Microscope; Principles of image formation in SEM, Energy dispersive X-ray analysis, Thermo-mechanical behavior of composites materials, DSC, AFM. | 9 |

| UNIT-IV | |
|---|---|
| **Modern Materials and Alloys:** Super alloys-refractory materials, Shape memory alloys, Advanced Composites-Particulate and dispersion composites, Metal matrix and Ceramic matrix composites, Nano materials, Polymers and polymerization, Engineering applications of different materials. | 9 |

| **Textbooks** | |
|---|---|
| 1. | Engineering Materials and Applications, P. Flinn and P.K. Trojan, MIR Publications |
| 2. | Engineering Materials: Polymers, Ceramics and Composites, A.K Bhargava, Prentice Hall of India |
| 3. | Manufacturing processes for Engineering Materials, SeropeKalpakjian, Wesley Publishing Co. |
| 4. | An introduction to Physical Metallurgy, S.H. Avner, McGraw Hill |
| 5. | Advances in Materials and Their Applications, P. Rama Rao, Wiley Eastern |
| 6. | Mechanical Metallurgy, Dieter, McGraw Hill |
| 7. | Material Science & Engineering, W.D. Callister, Jr, Wesley Publishing Co. |
| **Reference books** | |
| 1. | Mechanical Metallurgy, Dieter, McGraw Hill |
| 2. | Material Science & Engineering, W.D. Callister, Jr, Wesley Publishing Co. |

| **MME-262** | **ALTERNATIVE FUELS FOR TRANSPORTATION** | |
|---|---|---|
| **Course Category** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Ability to understand the basics and need of alternate fuels in current scenario.
2. Ability to utilize the alcoholic fuels and their blends in place of conventional fuels and their performance.
3. Ability to utilize Natural Gas, LPG, Hydrogen and Biogas in SI and CI engines and their performance and emission characteristics.
4. Ability to have knowledge of vegetable oils and their performance and basics of Electric, Hybrid, Fuel Cell and Solar Cars.

**Topics Covered**

| **UNIT-I** | |
|---|---|
| **Need for alternate fuel**<br>Availability and properties of alternate fuels, general use of alcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternate energy sources like EV, hybrid, fuel cell and solar cars. | 9 |
| **UNIT-II** | |
| **Alcohols**<br>Properties as engine fuel, alcohols and gasoline blends, performance in SI engine, methanol and gasoline blends, combustion characteristics in CI engines, emission characteristics, DME, DEE properties performance analysis, | 9 |

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| performance in SI & CI Engines. | |
| **UNIT-III** | |
| **Natural Gas, LPG, Hydrogen and Biogas**<br>Availability of CNG, properties, modification required to use in engines, performance and emission characteristics of CNG using LPG in SI & CI engines, performance and emission of LPG. hydrogen; storage and handling, performance and safety aspects hydrogen combustion characteristics, flashback control techniques, safety aspects and system development, NOx emission control, natural gas components, mixtures and kits, fuel supply system and emission studies and control. | 9 |
| **UNIT-IV** | |
| **Vegetable Oils**<br>Various vegetable oils for engines, esterification, performance in engines, performance and emission characteristics, bio diesel and its characteristics.<br>**Electric, Hybrid, Fuel Cell and Solar Cars**<br>Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, fuel cell vehicles, solar powered vehicles. | 9 |

| **Textbooks** | |
|---|---|
| 1. | Alternate Fuels: Emissions, Economics, and performance by Maxwell, Timothy. T, and JessecoJones,Publisher: Society of Automotive Engineers, 1995 |
| 2. | Hydrogen fuel for surface transportation by Norbeck, Joseph M., Publisher: Society of AutomotiveEngineers, 1996 3. History of the Electric Automobiles |
| 3. | Alternate Fuels Guide Book by Richard L. Bechhold P.E. Publisher: Society of Automotive Engineers, 1997 |
| **Reference books** | |
| 1. | History of the Electric Automobiles: Hybrid Electric Vehicles by Wakefield, Earnest Henry |
| 2. | Engine Emissions: Pollutant formation and advances in control Technology by NorbePundir B.R. Publisher:Narosa Publishing House |

| **MME-263** | | **NUCLEAR SCIENCE AND ENGINEERING** |
|---|---|---|
| **CourseCategory** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course |

1. Ability to understand the concept of nuclear physics, Laws of radioactive decay and nuclear models
2. Ability to develop and design blade and understand the performance of horizontal and vertical axis wind machines.
3. Ability to understand Nuclear reactions, nuclear fission and liquid drop model.
4. Ability to control and understand the working of different nuclear reactor.

**Topics Covered**

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|---|---|
| **UNIT-I** | |
| Nuclear constituents – charge, mass, shape, and size of nucleus, Binding energy, packing fraction, nuclear magnetic moment, saturation and short range nuclear forces, Radioactivity – Laws of radioactive decay, half-life, mean life, specific activity, Nuclear models – single particle shell model, evidence and limitations of shell model, liquid drop model: Introduction, assumptions, semi-empirical mass formula | 9 |
| **UNIT-II** | |
| **Mechanisms of Nuclear Decay**<br>Law of radioactive decay, half-life, mean life, specific activity, partial radioactive decay, successive disintegration, α decay: Barrier penetration, β decay: Fermi theory, selection rules, parity non-conservation, γ decay of excited states.<br>**Nuclear Detectors and Accelerators**<br>Types of detectors, Geiger-Mueller counter, Scintillation counter, classification of accelerators, Cyclotron, Betatron. | 9 |
| **UNIT-III** | |
| **Introduction to Nuclear Engineering**<br>Theories of Nuclear reactions, Conservation laws, Q-value equation, Nuclear fission, explanation on the basis of liquid drop model, energy available from fission, Nuclear chain reaction, Nuclear fusion. | 9 |
| **UNIT-IV** | |
| **Nuclear Reactors**<br>Nuclear Reactor – Basic principle, classification, constituent parts, Heterogeneous reactor, Swimming pool reactor, Breeder reactor, Heavy water cooled and moderated CANDU type reactors, Gas cooled reactors | 9 |

**Books & References:**

**Textbooks**


| | |
|---|---|
| 1. | D.C. Tayal, Nuclear Physics, Himalayan Publication house, Bombay, 1980. |
| 2. | Irving Kaplan, "Nuclear Physics", Narosa Book Distributors, 2002. |


**Reference books**


| | |
|---|---|
| 1. | Wind Energy -Sathyajith& Mathew |
| 2. | J.H.Horlock ,"Combined Power Plants", Pergamon Press, 1992. |
| 3. | R.D. Evans, "The Atomic Nucleus", McGraw-Hill, 1955. |


| **MME-265** | **ENVIRONMENTAL IMPACT OF ENERGY SYSTEMS** | |
|---|---|---|
| **CourseCategory** | : | Program Elective (PE) |
| **Pre-requisites** | : | NIL |
| **Contact Hours/Week** | : | Lecture: 3, Tutorial: 1, , Practical: 0 |
| **Number of Credits** | : | 4 |
| **Course Assessment Methods** | : | Continuous assessment through tutorials, attendance, home assignments, quizzes, record, viva voce and Three Minor tests and One Major Theory. |
| **Course Outcomes** | : | The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. |

1. Understand need and potential of energy storage system.
2. Understand the concept electrochemical energy storage and sensible heat storage system.
3. Understand the concept of phase change material and numerical analysis of heat transfer mechanism of PCM during melting and freezing process.

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|---|---|
| 4. Understanding about the application of energy storage system in the field of solar energy, waste heat, drawing and heating for process industries. | |
| | |
| **Topics Covered** | |
| **UNIT-I** | |
| **Impact of Energy Systems on Environment**<br>Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants, Methods of Environmental Impact Assessment, Pollution due to Vehicles and Utilities, Methods to control emission from vehicle, Boilers, Furnaces etc., International Standards for quality of air and norms for exhaust gases, Effect of Hydroelectric power stations on ecology and environment | 9 |
| **UNIT-II** | |
| **Pollution due toThermal, Hydel and Nuclear Power Plants**<br>Potential sources of pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipment such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation. Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution, Limitations and advantages of pollution control systems. Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant | 9 |
| **UNIT-III** | |
| **Pollution due to Nuclear power plants**<br>Nuclear power plants and environmental pollution, pollution control measures<br>**Industrial and Urban Waste & Waste Energy Recovery**<br>(C-1.0, L-10) Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control. | 9 |
| **UNIT-IV** | |
| **Environmental and Pollution Control Laws**<br>United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP)19 Clean Development Mechanism (CDM), Prototype Carbon Funds(PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project.<br>**Global Environmental Concern**<br>Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission | 9 |
| **Textbooks** | |
| 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). |
| **Reference books** | |
| 1. | Environmental Impact Analysis Handbook -J.G. Rau, D.C. Wood (McGraw Hill). |
| 2. | Energy & Environment – J.M. Fowler, (McGraw Hill) |