ACADEMIC REGULATIONS
COURSE STRUCTURE AND
DETAILED SYLLABUS

CENTRE FOR ENERGY STUDIES

For

M. Tech. (Energy Systems)
(Two Year Full Time Programme)

JNTUH COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)
Kukatpally, Hyderabad – 500 085, Telangana, India.
2015
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JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.TECH. (Energy Systems) – FULL TIME W.E.F. 2015-16

Elective -1
ES 103 - Energy Audit and Management
ES 104 - Thermal Power Plants
ES 105 - Environmental pollution and control

Elective -2
ES 106 - Renewable Energy Technologies
ES 107 - Energy Management in Building
ES 108 - Materials for solar Photovoltaics

Elective -3
ES 109 - Industrial Instrumentation and Control Engineering
ES 110 - Energy Conversion Systems
ES 111 - Energy Storage Devices

Elective -4
ES 112 - Computational Methods
ES 113 - IC Engines and Alternative Fuels
ES 114 - Biomass Conversion and Technologies
ES 115 - Design of Experiments

Elective -5
ES 203 - Design and Optimisation of Energy Systems
ES 204 - Energy Scenario and Energy Policy
ES 205 - Cogeneration and Hybrid Vehicles

Elective -6
ES 206 - Nuclear Energy and its Applications
ES 207 - Solar Refrigeration and Air Conditioning
ES 208 - Hydrogen and Fuel Cells

Elective -7
ES 209 - Advanced Control Systems
ES 210 - Industrial Waste Management and Recycling
ES 211 - Integration of Renewable energy sources

Elective -8
ES 212 - Bio Conversion and Processing of waste
ES 213 - Pollution control in power plants
ES 214 - Computational Fluid Dynamics
ES 215 - Smart Grid Technologies
OBJECTIVES:
✓ To understand and apply the concept of availability and to calculate the behavior of real gases
✓ To predict the condition of systems and analyze them by the criteria of equilibrium
✓ To apply the concepts of advanced thermodynamics to combustion systems and refrigeration systems.

OUTCOMES:
✓ Students will able to calculate the availability of the systems and cycles
✓ Analyze the engineering systems to improve and optimize its performance
✓ Understand the working and the design principles of combustion systems and refrigeration systems.


4. 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.


Reference Books:
a. Thermodynamics – An Engineering Approach / Y.A.Cengel and Mc. A. Boles/
b. Basic and Applied Thermodynamics / P.K.Nag /TMH
c. Thermodynamics / Sontag & Van Wylen
d. Thermodynamics / YVC RAO.
e. Introduction to the Thermodynamics of Materials – David R. Gaskell
OBJECTIVES:
- To understand the laws of fluid flow and Heat transfer
- To develop the skills to correlate the Physics with applications

OUTCOME:
- Student will be able to use the concepts of Heat Transfer and fluid flow in the field of energy applications.


2. **Fins:** Types of fins – Analysis of fins (Longitudinal & annular) of uniform cross section, effectiveness - Efficiency of fin.

3. **Convection:** Boundary layer flow with heat transfer - Equations of momentum and energy – Forced convection over a flat plate (similarity solution) – Empirical relations for forced and free convection - Mechanism of free convection in enclosed spaces – Mixed convection.

4. **Two Phase Heat Transfer:** Regimes of pool boiling – Flow boiling – Correlations - Types of condensation – Film condensation on horizontal and vertical surfaces.

5. **Radiation:** Overview of Mechanism – laws of radiation- Radiant heat exchange in gray - non-gray bodies - with transmitting - reflecting and absorbing media - specular surfaces - gas radiation
   - **Heat Exchanger:** Definition and classification - 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 – compact heat exchangers.

**Reference Books:**
- b. Engineering heat and mass transfer by Mahesh M Rathore, Laxmi Publications
- c. Heat Transfer - A basic approach / Necati Ozisik/ Mc Graw Hill
- d. Heat transfer by Cengel and Ghajar, TMH
- e. Fundamentals of Heat and Mass transfer by Incropera and Dewit, Wiley
- f. Heat Transfer / Ghoshdastidar / Oxford University Press
- g. Convective Heat Transfer Analysis /Patrick H.Oosthuizen/David Naylor/ Mc Graw Hill
- h. Convective Heat and Mass Transfer / W.M.Kays & Craford/ TMH
OBJECTIVES:
✓ To understand the energy utilization pattern including wastage and its management.

OUTCOMES:
Student will be able to
✓ Carry out the energy audit in any type of building and suggest the relevant and appropriate conservation measures.
✓ Suggest the renewable energy systems for the buildings

1. Introduction: Basic elements and measurements - Mass and energy balances - Scope of energy auditing industries - Evaluation of energy conserving opportunities.

2. Energy Audit Concepts: Need of Energy audit - Types of energy audit - Energy management (audit) approach - understanding energy costs - Bench marking - Energy performance - Matching energy use to requirement - Maximizing system efficiencies - Optimizing the input energy requirements - Duties and responsibilities of energy auditors - Energy audit instruments - Procedures and Techniques.


*Note: A case study involving audit may be taken up and a report suggesting improvements which can be considered as a part of assignment.

References Books:
a. Energy Management: W.R.Murphy, G.Mckay 109
c. Efficient Use of Energy : I.G.C.Dryden
d. Energy Economics A.V.Desai
OBJECTIVES:
✓ To obtain knowledge on power generation techniques
✓ To suggest suitable methods to improve the performance of thermal power plants

OUTCOMES:
Students get
✓ Exposure to different cycles and their working principle related to thermal power plants


4. **Gas Turbines (Illustrative problems only):** Gas Turbine cycle – Combined cycle analysis – 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


**Reference Books:**
a. A course in Power Plant Engineering, Arora and Domkundwar, Dhanpat Rai.
d. Power Plant Technology, Rajput.
OBJECTIVES:
✓ To understand the concepts of pollution/pollutants and how to protect it from the environment.

OUTCOMES:
Student will be able to
✓ Have knowledge of continual degradation of environment.
✓ Have an exposure to different types of pollution control methods.


2. 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 - Methods of monitoring and control of air pollutants SO₂, 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.


5. Marine pollution: Sources and nature of pollutants - Oil pollution - Metallic pollutants - Status of coastal and estuarine pollution in India - Chemicals and drugs from oceans - Sea level rise – Cause - effect.

Reference Books:
OBJECTIVES:
✓ To explain the concepts of Non-renewable and renewable energy systems
✓ To outline utilization of renewable energy sources for both domestic and industrial applications
✓ To analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.

OUTCOMES:
Student have
✓ An understanding of renewable energy sources
✓ A knowledge of working principle of various energy systems
✓ A capability to carry out basic design of renewable energy systems


4. Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

5. Ocean Energy: Ocean wave energy conversion - Principle of Ocean Thermal Energy Conversion (OTEC) - Ocean thermal power plants - Tidal energy conversion - Tidal and wave energy its scope and development - Scheme of development of tidal energy.
a. **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.
b. **Geothermal Energy:** Geothermal power plants - Various types - Hot springs and steam ejection.

**Reference Books:**
a. Power plant technology, J Wakhil
b. Non-Conventional Energy Sources  G.D Rai
c. Solar Energy - Principles of thermal collection and storage S. P. Sukhatme
d. Solar Engineering of Thermal Processes J. A. Duffie and W. A. Beckman
g. Renewable Energy Engineering and Technology, Kishore VVN, Teri Press, New Delhi, 2012
OBJECTIVES:
✓ To explain the concept of energy usage at indoor and at end use.
✓ To give a exposure to energy management techniques.

OUTCOMES:
Students get
✓ Exposure to Electrical Management in Building at indoor and at outdoor.

1. **Overview Of The Significance Of Energy Use And Energy Processes In Building:**
   Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications – Concepts of energy efficient building.

2. **Indoor Environmental Requirement And Management:**

3. **Climate:**

4. **End-Use:**

5. **Energy Management Options:**
   Energy audit and energy targeting – Technological options for energy management – Modifications for energy efficient buildings for Indian conditions.

**Reference Books:**


M.Tech. I Year I-Sem (Energy Systems)  

ES – 108 MATERIALS FOR SOLAR PHOTOVOLTAICS  
(Elective-2)

OBJECTIVES:
✓ To explain concept of various materials using for photovoltaic cells  
✓ To expose latest developments in PV technology.

OUTCOME:
Students have  
✓ Understanding of materials for solar energy.

1. Introduction: Different types of materials – Availability – Advantages – Disadvantages - applications.


Batteries - Carbon Nano Tube (CNT) - Fabrication of CNTs - CNTs for hydrogen storage - CNT polymer composites - Ultra capacitors etc - Polymer membranes for fuel cells - PEM fuel cell - Acid/Alkaline fuel cells.

References Books:
OBJECTIVES:
✓ To understand the principles and use of transducers for measurement of different thermal and electrical parameters.
✓ To understand the concepts of control systems, modes and design.

OUTCOMES:
Students obtain
✓ knowledge on measurement and control techniques applicable to energy systems


4. **Control Systems:** Open & Closed loop systems - Linear Time-invariant systems - Transfer Function Analysis - Mason’s Gain Formula - Transient response analysis - Concepts of P, PI and PID controllers (Descriptive treatment only) - Stability Analysis - RH Criterion - Relative stability.

5. **Frequency response analysis:** Bode plots - Nyquist Stability Criterion - Gain Margin & Phase Margin (Simple problems only) - Introduction to State Space Analysis (Elementary treatment only – No numerical) - Concept of state - State variables & state models - State transition matrix

* Being a descriptive & inter disciplinary course NO NUMERICALS are envisaged in this course except for unit IV.
Reference Books:

a. Modern Electronic Instrumentation and Measurement Techniques; Albert D Helfrick and William D Cooper, 2004, PHI.
d. Transducers and Instrumentation; DVS Murthy, 2003, PHI
e. Instrumentation Devices and Systems; CS Rangan, GR Sarma, and VSV Mani; 2 ed, Tata McGraw-Hill
h. Principles of Industrial Instrumentation, Patranabis D. TMH – 1997
k. Instrument Technology – Vol.1m, Jones E.B., Butterworths – 1981
l. Control Systems Engineering, Nagrah & M.Gopal, Wiley Eastern
m. Automatic Control Systems, B.C.Kuo, John Wiley, 2009
n. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall
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M.Tech. I Year I-Sem (Energy Systems)  

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ES – 110 ENERGY CONVERSION SYSTEMS  
(Elective-3)

OBJECTIVES:
To analyze the working principle, pros and cons of
✓ Conventional energy conversion techniques
✓ Direct energy conversion systems
✓ Need and necessity of energy storage systems and their desirable characteristics & Fuel cells

OUTCOME:
Students have an
✓ Awareness on the existence of various mechanisms for conversion and storage of energy, their merits, constraints and drawbacks


References Books:
OBJECTIVES:
✓ To understand the concept of understand / analyse the various types of energy storage.
✓ To study the various applications of energy storage systems

OUTCOME:
Students will be
✓ Able to analyse various types of energy storage devices and perform the selection based on techno economic view point


2. Thermal Storage: Types - Modelling of thermal storage units - Simple water and rock bed storage

3. System Pressurized Water Storage System: Modelling of phase change storage system - Simple units - Packed bed storage units - Modelling using porous medium approach - Use of Transys.


References Books:
a. Solar Engg. Thermal Procession, Buffa & Buckman
b. Solar Energy, G.D. Rai
d. Solar Energy, Sukhatme
Corporation, Oklahoma (2005).
OBJECTIVES:
✓ To understand different analytical techniques including Finite Element Methods

OUTCOME:
Students will get an
✓ Exposure to different computational methods and their applications to engineering background

1. **Finite Differences**: Forward - Backward and Central difference approximations to derivatives – Croutes method - Jacobi’s Method – Gauss Siedel iterative method - Successive over-relaxation method.


3. **Introduction to FEM**: Basic concepts – Historical background – General Applications of FEM –Steps involved in F E M - Discretization of domain - Basic element shapes and types-Characteristics of finite elements - Location of nodes - Node numbering scheme - Degree of freedom - Interpolation models – Convergence requirements.


5. **Two Dimensional Problems**: Introduction to Plane stress and plane strain - 2-D modeling – Constant strain triangle – Boundary condition – Shape functions for a CST element - Element stiffness matrix - Isoparametric representation - Basic equations of heat transfer - Steady state heat transfer-heat conduction - Some typical problems in heat transfer.

**Reference Books:**
- a. Finite element Methods by Bathe PHI Publication
- b. Introduction to Numerical Methods/ S.S.Sastry
- c. Numerical Methods /B.S.Grawel
- d. Computational Fluid flow and Heat transfer / Edt.K.Muralidhar and T.Sundararajan / Narosa
- e. Finite Elements in Engineering / S.S.Rao
- f. Introduction to Finite Element Engineering/T.R.Chandrupatla and A.D. Belagundu
- g. Finite Element engineering -Jalaluddin
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M.Tech. I Year I-Sem (Energy Systems)  
ES – 113 IC ENGINES AND ALTERNATIVE FUELS  
(Elective-4)

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OBJECTIVE:  
To obtain the knowledge on automobile engines their working principles fuels used and their applications

OUTCOME:  
Students gets exposure for preparation of fuels for different engines


3. **Combustion Chambers in S.I & C.I Engines:** Design Principles – Types of combustion chambers – IDI Engines – Comparison of DI & IDI Engines.


5. **Modern Trends in IC Engines:** Lean Burning and Adiabatic concepts - Rotary Engines - Modification in IC Engines to suite Bio-Fuels - Fuel supply systems for SI and CI engines to use gaseous fuels like LPG, CNG, and Hydrogen – Common Rail Direct Injection (CRDI) - Homogenous Charge Compression Ignition (HCCI) & Gasoline Direct Injection (GDI).

* Note: This being a descriptive course, numerical problems are not envisaged.

**Reference Books:**  
b. I.C. Engines, Ferguson  
c. I.C. Engines, Maleev  
d. I.C Engines, V Ganesan  
f. I.C. Engines, Obert, Int.Text Book Co.  
g. Combustion Engine Processes, Lichty  
OBJECTIVES:
✓ To have an exposure on the types of biomass, its surplus availability and characteristics.
✓ Analyze the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.

OUTCOME:
Student gets
✓ A practical understanding on the various biomass energy conversion technologies and its relevance towards solving the present energy crisis.


4. Chemical Conversion: Hydrolysis & hydrogenation - Solvent extraction of hydrocarbons - Solvolysis of wood - Biocrude and biodiesel - Chemicals from biomass


References Books:
a. Biotechnology and Alternative Technologies for Utilization of Biomass, Chakraverthy A
c. Biomass Energy Systems, Venkata Ramana P and Srinivas S.N
k. Thermochemical Characterization of Biomass, Iyer PVR, M N E S
OBJECTIVES:
✓ To get a feel of developing different mathematical models for designing.
✓ To obtain an optimization solution after designing a product.

OUTCOME:
Students get
✓ An exposure to design and optimize a product or a process.


* Simple treatment only

Reference Books:
c. Quality Engineering using robust design, Phadke, M S, Prentice Hall, 1989
f. Optimization for engineering design, Deb, K., Prentice Hall of India, 2005
WRITING PROGRAMS AND DEMONSTRATION

1. Declination of earth, hour angle, day length, local apparent time.
3. Power generation from a wind turbine, Variation of wind velocity and power with altitude.
5. Solution of one-dimensional steady state heat conduction equation.
6. Solution of two-dimensional steady state PDE.
7. Solution of one-dimensional transient PDE.

FINITE ELEMENT ANALYSIS

8. Two dimensional heat conduction.
10. Transient analysis of a casting process.

CFD ANALYSIS

11. Flow through a pipe bend.
12. Flow through a nozzle.
Course Objectives
- To improve the fluency of students in English
- To facilitate learning through interaction
- To illustrate the role of skills in real-life situations with case studies, role plays etc.
- To train students in group dynamics, body language and various other activities which boost their confidence levels and help in their overall personality development
- To encourage students develop behavioral skills and personal management skills
- To impart training for empowerment, thereby preparing students to become successful professionals

Learning Outcomes
- Developed critical acumen and creative ability besides making them industry-ready.
- Appropriate use of English language while clearly articulating ideas.
- Developing insights into Language and enrich the professional competence of the students.
- Enable students to meet challenges in job and career advancement.

INTRODUCTION
Definition and Introduction to Soft Skills – Hard Skills vs Soft Skills – Significance of Soft/Life/Self Skills – Self and SWOT Analysis and
1. Exercises on Productivity Development
   - Effective/Assertive Communication Skills (Activity based)
   - Time Management (Case Study)
   - Creativity & Critical Thinking (Case Study)
   - Decision Making and Problem Solving (Case Study)
   - Stress Management (Case Study)

2. Exercises on Personality Development Skills
   - Self-esteem (Case Study)
   - Positive Thinking (Case Study)
   - Emotional Intelligence (Case Study)
   - Team building and Leadership Skills (Case Study)
   - Conflict Management (Case Study)

3. Exercises on Presentation Skills
   - Netiquette
   - Importance of Oral Presentation – Defining Purpose- Analyzing the audience- Planning Outline and Preparing the Presentation- Individual & Group Presentation- Graphical Organizers- Tools and Multi-media Visuals
   - One Minute Presentations (Warming up)
   - PPT on Project Work- Understanding the Nuances of Delivery- Body Language – Closing and Handling Questions – Rubrics for Individual Evaluation (Practice Sessions)

4. Exercises on Professional Etiquette and Communication
   - Role-Play and Simulation- Introducing oneself and others, Greetings, Apologies, Requests, Agreement & Disagreement….etc.
• Telephone Etiquette
• Active Listening
• Group Discussions (Case study)- Group Discussion as a part of Selection Procedure- Checklist of GDs
• Analysis of Selected Interviews (Objectives of Interview)
• Mock-Interviews (Practice Sessions)
• Job Application and Preparing Resume
• Process Writing (Technical Vocabulary) – Writing a Project Report- Assignments

5. Exercises on Ethics and Values
Introduction — Types of Values - Personal, Social and Cultural Values - Importance of Values in Various Contexts
• Significance of Modern and Professional Etiquette – Etiquette (Formal and Informal Situations with Examples)
• Attitude, Good Manners and Work Culture (Live Examples)
• Social Skills - Dealing with the Challenged (Live Examples)
• Professional Responsibility – Adaptability (Live Examples)
• Corporate Expectations

Note: Hand-outs are to be prepared and given to students.
Training plan will be integrated in the syllabus.
Topics mentioned in the syllabus are activity-based.

SUGGESTED SOFTWARE:
The following software from ‘train2success.com’
- Preparing for being Interviewed
- Positive Thinking
- Interviewing Skills
- Telephone Skills
- Time Management
- Team Building
- Decision making

SUGGESTED READING:
12. The Hindu Speaks on Education by the Hindu Newspaper
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year II-Sem (Energy Systems)                          L   T    P   C
ES – 201 ENERGY MANAGEMENT AND CONSERVATION

OBJECTIVE:
✓ To get exposure to energy management of thermal and electrical systems and to understand the various conservation techniques.

OUTCOME:
Students get
• An exposure to Energy Consumption pattern resulting in energy savings and conservation.

Part A: Energy Management of Thermal Systems


Part B: Energy Management of Electrical Systems


5. Economics of Generation and Distribution:
References Books:

b. Energy Management And Conservation, K V Sharma and P Venkataseshaiah
e. Electrical Machines, Bimbra, Khanna Publishers
g. Electrical Machines, S.K.Bhattacharya
h. Electrical Machines, I.J.Nagarath and D.P.Kothari, TMH
i. Energy Efficient Electrical motors, John C. Andreas, Marcel Dekker Inc.
OBJECTIVES:
- To have a knowledge of solar power generation from PV panels and thermal systems.
- To get an exposure to different cell technologies.

OUTCOME:
Students get
✓ An exposure to advanced cell technology and usage of different materials.


2. **Photovoltaic Fundamentals:** Place of PV in energy supply – PV Cells - Modules and arrays & costs - Review of semiconductor physics and Operating principle - Introduction to P-N and P-I-N junctions - Equilibrium and non equilibrium conditions - Design of solar cells - Cell parameters limits-Losses in solar cells-Solar cell design for high Isc,, Voc and FF.


4. **PV Module And PV System Applications:** Solar PV modules-Mismatch in series and parallel connection-design & structure of PV modules - PV module power output-Batteries for PV systems -DC to DC and DC to AC converters-charge controllers-MPPT - Stand alone PV systems - Design methodology of PV off grid and grid connected systems - Load estimation and System Sizing - Wire sizing in PV systems - Grid connected and hybrid PV systems - Design of roof top solar PV power plants (typically 100 kWp) - Use of PVSystem software for design of solar PV power plants.

Reference Books:

a. Generating Electricity from the Sun/Edited by Fred C. Treble/Pergamon Press
b. Solar photovoltaics-Fundamentals ,technologies and Applications/Chetan Singh Solanki/PHI Learning private Ltd. New Delhi
c. Terrestrial Solar photovoltaics, Tapan Bhattacharya, Narosa Publishing House
d. Solar Electricity, Tomas Markvart, John Wiley and Sons
e. Solar Cells – Operating Principles, Technology and System Applications, Martin A. Green, Prentice Hall Inc
f. Modelling Photovoltaic Systems using P Spice, Luis Castaner and Santiago Silvestre, John Wiley and Sons
h. Amorphous Silicon Solar Cells, K.Takahashi and M.Konagai, North Oxford Academic
i. Photovoltaic Systems Engineering, Roger Messenger, CRC Press
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M.Tech. I Year II-Sem (Energy Systems)

ES – 202 DESIGN AND OPTIMIZATION OF ENERGY SYSTEMS
(Elective-5)

OBJECTIVES:
- To have a knowledge of Optimization of Design Parameters.
- To have an exposure to different Design Methodologies and simulation processes.

OUTCOME:
Students have an exposure to
- Numerical Calculations
- Role of design parameters.
- Exposure to AI techniques like fuzzy logic & neural Network.


2. **Linear programming models**: Formulation - Simplex method – Artificial variable technique – Big M method - Concept of Sensitive analysis.


4. **Geometric programming**: Polynomial – Arithmetic and Geometric inequalities – Unconstrained GP - Constrained GP with constraints of type less than or equal- Application to thermal and electrical systems- Dynamic Programming- Bellman’s principle of optimality- Shortest route problems

5. **Simulation**: Types of Simulation models - Steps involved in simulation models - Application of simulation - Advantages and disadvantages – Introduction to Genetic algorithm – Similarities and dissimilarities with traditional methods - Genetic operators.

**Reference Books:**
- b. Optimization theory and applications / S.S.Rao / New Age Publication
- d. Operation Research / Panner Selvam / Prentice Hall
- e. Optimization Research / M.C.Joshi
- f. Simulation Modeling & Analysis / Law & Kelto
- g. Operation Research / S Prinsc Valle Kasur
ES – 204 ENERGY SCENARIO AND ENERGY POLICY  
(Elective-5)

OBJECTIVE:
• To get an awareness of present energy pattern and to understand the energy policy.

OUTCOME:
Students have
• An exposure to Evaluation / utilization of energy usage and finding alternate energy resources and policy implications.

1. Global Energy Scenario: Role of energy in economic development and social transformation - Energy and GDP - GNP and its dynamics - Energy sources and overall Energy demand and availability - Energy consumption in various sectors and its changing pattern - Depletion of energy sources and impact exponential rise in energy consumption on economies of countries


Reference Books:
b. Energy Policy, B.V. Desai (Wiley Eastern)
c. Modeling approach to long term demand and energy implication, J.K.Parikh
d. Energy Policy and Planning, B.Bukhoothsow
f. BEE Reference book: no. 1/2/3/4
OBJECTIVES:
• To impart knowledge on Energy savings by studying.
• To have an exposure about Hybrid Electric Vehicles.

OUTCOME:
Students get
• The knowledge on generation of energy with different methods.

1. **Concept of Cogeneration:** Review on Thermodynamics of conventional power producing plants - Selecting cogeneration technologies.

2. **Thermodynamics of Cogeneration Power Plants:** Performance criteria and effect of irreversibility - Comparative thermodynamic performance of cogeneration plants – Numerical examples – Calculations of typical heat to power ratios and performance parameters.

3. **Design of CHP:** Design of Cogeneration plant for varying plant heat to power ratio – Fuel savings from installation of cogeneration plant - Applications of cogeneration technology to various process plants.

4. **Introduction to Hybrid Electric Vehicles:** History of hybrid and electric vehicles - Social and environmental importance of hybrid and electric vehicles - Impact of modern drive-trains on energy supplies.

5. **Hybrid Electric Drive-trains:** Basic concept of hybrid traction - Introduction to various hybrid drive-train topologies - Power flow control in hybrid drive-train topologies - Fuel efficiency analysis.

**Reference books:**
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year II-Sem (Energy Systems)  

ES – 206 NUCLEAR ENERGY AND ITS APPLICATIONS  
( Elective-6)

OBJECTIVE:
• To understand the concept and different technologies in energy generation, their advantages.

OUTCOME:
• Support to convention energy sources in energy crisis and its utilization extent and particularly nuclear energy risk management


Reference Books:
e. A Course in Power Plant Technology, Domkundwar, Dhanpat Rai Sons
OBJECTIVE:
- To have awareness of Solar applications to Solar refrigeration and air-conditioning.

OUTCOMES:
Students get
- To make, design modifications and cost reduction methods.
- An exposure on Solar refrigeration or A/C.


2 **Solar operation of vapor absorption and vapor compression**: A refrigeration cycles and their thermodynamic assessment - Rankine cycle - Sterling cycle based on solar cooling systems - Fuel assisted solar cooling systems.

3 **Solar desiccant cooling systems**: Open cycle absorption – Desorption of solar cooling alternatives - Advanced solar cooling systems.

4 **Thermal modeling**: Computer simulation for continuous and intermittent - Solar refrigeration and air-conditioning systems - Refrigerant storage for solar absorption cooling systems.

5 **Solar thermoelectric refrigeration and air-conditioning**: Solar thermo acoustic cooling and hybrid air-conditioning - Solar economics of cooling systems.

**Reference Books:**
a. A course in Refrigeration and Air-conditioning, S. Domakundwar and S.C Arora,
b. Principles of Solar Engineering, F.Kreith and J.F Kreider,
c. Solar cooling and Heating Volumes, T. Nejat Vezirogulu, I, II & III.
d. Solar air conditioning and refrigeration, A. A. M. Sayigh, J. C. McVeigh
OBJECTIVE:
- To introduce to emerging technologies like production and storage of Hydrogen

OUTCOME:
- Exposure to different fuel cells in particularly Hydrogen fuel cells


Reference Books:
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year II-Sem (Energy Systems) ES – 209 ADVANCED CONTROL SYSTEMS (Elective-7)

OBJECTIVES:
- To design a linear system and obtain controllability and observability.
- To study about non linear systems and also to obtain stability analysis.
- To get an exposure to optimization techniques.

OUTCOMES:
Students gets
✓ An exposure to advanced control techniques both for linear as well as non linear systems.
✓ An exposure to optimization techniques applicable to control systems.

1. **Classical Design Techniques For Linear Control Systems:** Lag - Lead & Lag-Lead Compensation - State Space Analysis - State Space Representation - State Models - Solution of State Equation - State Transition Matrix - Canonical Forms - Controllable Canonical Form - Observable Canonical Form - Jordan Canonical Form.

2. **Controllability and Observability:** Tests for Controllability and Observability for Continuous Time Systems - Time Varying Case - Minimum Energy Control - Time Invariant Case - Principle of Duality - Controllability and Observability for Jordan Canonical Form and other Canonical Forms.

3. **Describing Function Analysis:** Introduction to nonlinear systems - Types of nonlinearities - describing functions - Describing function analysis of nonlinear control systems - Phase-Plane Analysis - Introduction to phase-plane analysis - Method of Isoclines for Constructing Trajectories - Singular points.


**Reference Books:**
- f. Modern control System - By Dorf, Pearson
ES – 210 INDUSTRIAL WASTE MANAGEMENT AND RECYCLING
(Elective-7)

Objectives:
✓ To make the students realize the importance of treatment, Disposal and energy recovery of waste from various industries including agriculture through the knowledge of processes, Equipment and Materials used in industrial waste – Characteristics & Composition of industrial waste and the pollution control techniques.

Outcomes:
✓ Students shall be able to Categorize the waste from various industries & recycle for energy extraction.

Unit-I: Integrated Solid Waste Management:

Unit-II: Landfills:

Unit-III: Sources of Effluent from the Process of Industries:

Unit-IV: Waste Water Treatment Methods:

Unit-V: Environmental Issues in Agriculture:
Reference Books:

Objectives:
Upon successful completion of the course the students will be familiar with:
✓ To introduce the characteristics of various types of renewable energy sources and converters.
✓ To explain the importance of storage and sizing of hybrid systems.
✓ To introduce the control issues of isolated systems.
✓ To explain the harmonics, power quality, voltage imperfections, power injection issues on the grid by integrating renewable energy sources.

Outcomes:
At the end of the course, the student should be able to:
✓ Identify the characteristics of renewable energy sources and converters.
✓ Analyze the importance of storage and sizing of hybrid systems.
✓ Realize the problems related to isolated systems.
✓ Analyze the challenges faced by the grid by integrating renewable energy sources.

1. Review Of Characteristics Of Power Sources: Basic review of power generation from wind - Solar PV - Thermal - Small hydro - Biomass power strategies in each of these energy conversion systems - Review of maximum power point tracking techniques in solar PV and wind (perturb & observe, hill climbs, incremental conductance).

2. Converter Topologies: DC/DC converter (buck, boost, buck boost) - DC/AC inverters (sine, triangular, PWM techniques) - Phase locked loop for inverters.

3. Hybrid Systems: Advantages of hybrid power systems - Importance of storage in hybrid power systems - Design of hybrid power system based on load curve - Sizing of hybrid power systems.

4. Isolated Systems: Control issues in isolated systems for voltage and frequency - Small signal stability in isolated power systems - Importance of storage and dump load in isolated systems.

5. Issues In Integration Of Renewable Energy Sources: Overview of challenges in integrating renewable sources to the grid - Impact of harmonics on power quality - Need to maintain voltage within a band and fluctuations in voltage because of renewable integration - Power inverter and converter technologies - Mechanism to synchronize power from renewable sources to the grid - Overview of challenges faced in designing power injection from offshore generation sources - Challenges in modeling intermittent nature of renewable power in a power system.

References Books:
b. Renewable Energy IntegrationChallenges and SolutionsSeries: Green Energy and TechnologyHossain, Jahangir, Mahmud Apel (Eds.)
OBJECTIVE:
✓ To inculcate knowledge on bio technologies and processing of wastes.

OUTCOME:
✓ Energy Conservation opportunities on recovery systems and to develop new technologies.


2. **Biomass Pyrolysis:** Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.


4. **Biomass Combustion:** Biomass stoves – Improved chullahs, types, some exotic designs – Fixed bed combustors – Types, inclined grate combustors – Fluidized bed combustors – Design, construction and operation - Operation of all the above biomass combustors.

5. **Introduction to Energy from Waste:** Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

**Reference books:**
OBJECTIVE:
✓ To make aware and understand of the subject and its impact on power plants.

OUTCOME:
Students are exposed to
✓ Minimization / elimination/ introduction of new technologies, identify optimum energy utilization techniques.


4. Pollution Control Methods: Pre-combustion controls - Combustion controls Low NOx burners, Clean Development Mechanism (CDM).

5. Gaseous pollutants controls: flue gas desulfurization (FGD) systems, CSR reduction applications of electron beam and non thermal plasmas for SOx and NOx treatments, Thermal pollution and its impact on aquatic life.

Reference Books:
i. Power Plant Technology, El Wakil, McGraw Hill
OBJECTIVE:

The course is intended to
- Impart the advances knowledge of heat transfer
- Get analytical solutions for 2-D steady and transient heat conduction problems.
- Deep understanding on the governing equations for convection heat transfer; knowing the dimensionless parameters (influencing the convection performance).
- Aware of turbulence concept and modeling.
- Apply the concept of natural convection for electronic cooling, HVAC etc.
- Understand the boiling and condensation mechanism.
- Understand the concept of mass transfer.

OUTCOME:

At the end of the course, the student will be able to:
- Understand both the physics and the mathematical treatment of the advanced topics pertaining to the modes of heat transfer.
- Apply principles of heat transfer to develop mathematical models for uniform and Non-uniform fins.
- Employ mathematical functions and heat conduction charts in tackling two dimensional and three-dimensional heat conduction problems.
- Analyze free and forced convection problems involving complex geometries with proper boundary conditions.
- Apply the concepts of radiation heat transfer for enclosure analysis.
- Understand physical and mathematical aspects of mass transfer.


3. FVM to Convection and Diffusion: Concept of Elliptic, Parabolic and Hyperbolic Equations applied to fluid flow – Governing Equations of Flow and Heat transfer – Steady 1DConvexion Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions

5. **Grid generation**: Algebraic methods, differential equation methods.

**Reference Books:**

c. Computational Fluid Flow and Heat Transfer – Muralidharan & Sundarajan (Narosa Pub)
d. Computational Fluid Dynamics – Hoffman and Chiang, Engg Education System
e. Computational Fluid Dynamics – Anderson (TMH)
f. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)
g. Computational Fluid Dynamics, T.J. Chung, Cambridge University
h. Computational Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier)
i. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers
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M.Tech. I Year II-Sem (Energy Systems)  

ES – 215 SMART GRID TECHNOLOGIES 

OBJECTIVE:  
- To understand concept of smart grid and developments on smart grid.  
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.  
- To have Knowledge on smart substations, feeder automation and application for monitoring and protection.  
- To have knowledge on micro grids and distributed energy systems.  
- To know power quality aspects in smart grid.

Outcomes:  
After completion of the course, students are able to:  
- Understand smart grids and analyze grid policies and development in smart grids.  
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.  
- Understand smart substation, feeder automation, GIS etc.  
- Analyze micro grids and distributed generation systems.  
- Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.


Unit-II : Smart Grid Technologies: Introduction to smart meters- Real time prizing – Smart appliances- Automatic meter reading (AMR)- Outage management systems(OMS)- plug in hybrid electric vehicles(PHEV)-Vehicle to grid- Smart sensors- Home & building automation.

Unit – III: Smart Grid Technologies : Smart Substations – Substation automation – Feeder automation – Intelligent electronic devices(IED) & their application for monitoring 7 protection – Smart storage like battery – SMES- Pumped hydro – Compressed air energy storage – Wide area measurement system(WAMS)-Phasor measurement unit(PMU).


Unit – V: Information and Communication Technology for Smart Grid: Advanced metering infrastructure (AMI)- Home area network (HAN)- Neighborhood area network(NAN)-Wide area network(WAN).
Reference Books:
ES – 207 ENERGY SYSTEM LABAROTARY

Study of
a. Operational experience on i) Pyranometer, ii) Sunshine recorder
b. Measurement of speed using Tachometer, Stroboscope and anemometers
c. Measurement of temperature using Infrared Thermometers
d. Measurement of illumination using Lux meter
e. Exhaust gas analysis using gas analyzer

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 Concentrating water heating system
4. Determination of conversion efficiency of a solar air heating system
5. Study and analysis of a solar still / distillation plant
6. Performance estimation of photovoltaic water pumping system
7. Investigation on a solar dryer
8. Operational characteristics of P.V. Indoor lighting system
9. Determination of characteristics of a wind generator
10. Performance evaluation of solar cooker
11. P.V. System sizing exercise
12. Data acquisition system for continuous monitoring of P.V system parameters using LABVIEW software
13. Performance estimation of Solar fuel cell
Outcomes:
At the end of the course the student will be able to

- Identify the problem of a research project through literature survey.
- Analyze the technical feasibility of the project.
- Propose the solution for the research problem.
- Analyze and design the proposed solution using Simulation Tools