Institution

Mission:

To develop NMAM Institute of Technology, Nitte as a Center of Excellence by imparting Quality Education to generate Competent, Skilled and Human Manpower to face emerging Scientific, Technological, Managerial and Social challenges with Credibility, Integrity, Ethics and Social concern

Vision:

Strive for Excellence, Empowering people, Partnering in Community Development

Department

Vision Statement: To produce Mechanical engineers of the highest quality who are professionally competent and highly qualified to suit the needs of industries and organizations by promoting excellence in teaching, learning and research.

Mission Statement: The Dept. of Mechanical Engineering is committed to –

- Provide high quality education to the students, to fulfill the requirements of a ‘Global Engineer’.
- Constantly strive to improve the teaching-learning methods, in order to deliver good academic programs.
- To respond to the fast evolving scientific and technological challenges in a highly competitive world.
- To inculcate, ethics, integrity, honesty, credibility, social and environmental consciousness.

Programme Educational Objectives

PEO1: The Programme is designed to produce teachers and researchers to work in the area of new and renewable energy which is a field having great impact on society.

PEO2: The programme is expected to produce man power who can become entrepreneurs in the area of energy system and renewable energy.

PEO3: The programme is designed to train students to take up employment in the area of solar energy, wind energy and conventional energy sectors.

Programme Outcomes

1. Able to Model and analyze energy systems
2. Able to Design solar thermal systems
3. To be able to carry out Auditing of energy equipments
4. To be able to carry out numerical methods for designing & analysis of an system
5. Able to determine performance of energy systems experimentally
6. Able to Communicate energy topics and prepare reports effectively
7. Able to design Biomass systems
8. Possess basic knowledge of combustion aspects & Environmental pollution control
9. Have knowledge of wind solar and other alternative energies.
NMAM INSTITUTE OF TECHNOLOGY, NITTE  
SCHEME OF TEACHING AND EXAMINATION FOR M. TECH. ENERGY SYSTEMS ENGINEERING (ESE)  
(AUTONOMY SCHEME)

Revised at the BOS meeting on 13.06.2015

I SEMESTER

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of the Subject</th>
<th>Contact hours/week</th>
<th>Duration of Sem. End Exam in hours</th>
<th>Marks for</th>
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**ELECTIVE –I**

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<td>Wind Energy Conversion Systems</td>
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<tr>
<td>15ESE 112</td>
<td>Steam and Gas Turbines</td>
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<td>15ESE 113</td>
<td>Direct Energy Conversion</td>
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<td>15ESE114</td>
<td>Power Electronics -I</td>
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**ELECTIVE-II**

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<th>Sub. Code</th>
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<tr>
<td>15ESE 121</td>
<td>Biomass Energy for IC Engines</td>
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<td>15ESE122</td>
<td>Energy from Wastes</td>
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<tr>
<td>15ESE 123</td>
<td>Advanced IC Engines</td>
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<td>15ESE124</td>
<td>Electric Drives</td>
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Laboratory work will be conduction of a minimum of 4 experiments in the Alternative Fuels/ Alternative Energy Research Laboratory
## M.TECH. ENERGY SYSTEMS ENGINEERING (ESE)
(AUTONOMY SCHEME)

### II SEMESTER

<table>
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### ELECTIVE –III

- 15ESE 211 Combustion Engine Design Principles
- 15ESE 212 Energy Storage
- 15ESE 213 Design of Heat Transfer Equipments
- 15ESE 214 Power Electronics II
- 15ESE 215 HVDC Transmission
- 15ESE 216 Design of Solar PV Systems

### ELECTIVE - IV

- 15ESE 221 Instrumentation and Control in energy systems
- 15ESE 222 Nuclear Engineering
- 15ESE 223 Pollution control from thermal power stations
- 15ESE 224 Power Generation & System Planning
- 15ESE225 Application of Power Electronics to Power Systems

Laboratory work will be conduction of a minimum of 4 experiments in the energy laboratory
M.TECH. ENERGY SYSTEMS ENGINEERING (ESE)  
(AUTONOMY SCHEME)

III SEMESTER

Revised at the BOS meeting on 13.06.2015

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of the Subject</th>
<th>Duration</th>
<th>Marks for Practical/Field Work/Assignment</th>
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<td>50 (report) 50(presentation)</td>
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<tr>
<td>15ESE 302</td>
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<tr>
<td>15ESE 303</td>
<td>Project-part I</td>
<td>Full time 8 weeks</td>
<td>100 (report) 100(presentation)</td>
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IV SEMESTER

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<th>Name of the Subject</th>
<th>Duration</th>
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<th>Total Credits</th>
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<tr>
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<td>Project -part II</td>
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GRAND TOTAL From 1st to 4th semester: 100 credits (2000 marks)

Note:
1. 15ESE 301: Industrial Training /mini-project: Practical training report and oral presentation are to be evaluated by the Department for 50 marks each. Alternatively, if mini-project is carried out, it is evaluated for 100 marks by the Department.
2. 15ESE 302: The Seminar Marks are to be awarded by the Department committee constituted for the purpose.
3. 15ESE 303: Progress of work to be assessed by the Department Committee including the guide for 100 + 100 marks.
4. 15ESE 401: The project report valuation will be carried out separately by the guide and the external examiner for 100 marks each. Viva-Voce will carry 200 marks and will be conducted by a committee consisting of the following:
   a. Chairman, BOE (PG) or his nominee and PG Coordinator
   b. Guide
   c. External examiner
DETAILED COURSE CONTENTS

ALTERNATIVE ENERGY SYSTEMS

Sub Code: 15ESE 101: (4+2+0)  CIE Marks: 50
Lecture Hrs/ Week: 04  Exam Hours: 03
Tutorials: 02  SEE Marks: 50
Total Lecture Hrs: 52

Course Outcomes

- To create awareness about sources of energy and able to estimate how long the available conventional fuel reserves will last.
- Able to estimate and measure solar radiations, know about the applications of solar energy.
- To design the storage of bio gas required for a particular engine and use of bio gas for water pumping and power generation.
- To design wind turbine blades and know about applications of wind energy for water pumping and electricity generation.
- To understand the working of OTEC system and different possible ways of extracting energy from ocean.
- To know about mini-micro hydro systems and geothermal and nuclear energy.

UNIT-I

Introduction: Introduction and overview, Sociological, political and economic aspects, review of basic thermodynamics and thermal sciences. (06 Hrs)

Solar Energy Systems:
Solar radiation geometry, and estimation and measurement of solar energy. Thermal systems: Water heating, Drying, Cooking, Desalination, Solar refrigeration, solar ponds. Photovoltaic systems: Types and characteristics of Photovoltaic cells, Solar cell arrays, Balance of system (BOS), PV powered pumps. (08 hrs)

UNIT-II

Biomass Energy Systems:

UNIT-III

Wind Energy Systems:
Orientation systems and Regulating devices, Design of blades: Aerodynamic configuration of rotor and Determination of the blade structure. Description and performance of vertical axis wind mills. Use of wind energy for water pumping and generation of electricity. (10 Hrs)

UNIT-IV

Ocean Energy systems:
OTEC-Principle of operation, Open & Closed OTEC cycles; Wave energy, Wave energy conversion machines and recent advances Tidal Energy, Single basin and double basin tidal systems. Hydrogen energy systems (08hours)

UNIT-V
Other energy sources:
Small-Mini-Micro hydro system, concepts, Types of turbines, hydrological analysis, Geothermal Energy Conversion. Elements of nuclear fission and fusion energy conversion (10 Hrs)

Environment, Energy and global climate change (self study)

TEXTS / REFERENCE BOOKS:
2. John A Duffie & William A Beckman "Solar energy Thermal Processes" Wiley Inter science publication, New York
3. G. D.Rai,-"Non Conventional Energy Sources", Khanna publisher, New Delhi
7. Srivatsava, Shukla and Ojha: "Technology and Application of Biogas", Jain Brothers, New Delhi, 1993

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

APPLIED NUMERICAL ANALYSIS

Sub code: 15ESE102 IA Marks: 50
Hours/Week: 4 Exam Hours: 03
No. of credits: 4 Exam Marks: 50
Total Hours: 52

Course Outcomes
• The student is able to understand the type of problems which can be solved by numerical methods. The student can also know the type of errors, its truncation error and round off error associated with numerical method and the method to minimize these.
• The student is able to locate an interval in which a real root lies and to determine the root approximately by regula-falsi method and Newton Raphson method. The student is also able to use Newton Raphson method for solving system of non-liner equations.
• The student able to appreciate the use of interpolating polynomials to approximate functions defined by table of values, which occurs in many of engineering problems. The student is able to get the derivatives and integrals of such functions.
• The student gains ability to obtain the solution of a system of linear of equation which occurs in all branches of engineering. Able to use methods like LU- decomposition method and iterative method like Gauss Seidal method.

• The student is able to solve a first order initial value problem both by single step method and multi-step method. The student is able to appreciate the advantages of these methods, since these methods are employed for both linear and nonlinear differential equations.

• The student is able to use numerical method to solve the partial differential equations which are of great importance in engineering mathematics. The student is able to solve the algebraic equations resulting from partial differential equations when the partial derivatives are replaced by their finite difference approach.

• The student is able to identify the different types of Boundary value problems and solve them by the finite difference method. The students also gets familiar with weighted residual methods like collocation method, Galerkin method etc. which lead the student the principle behind the finite element technique, a method of very great importance in the solution of boundary value problems.

UNIT-I

Concepts of errors and error propagation.

Solution of Algebraic and Transcendental Equations: Bisection method , iteration method, Method of false position, Newton-Raphson method(review), order of convergence of the above methods. (05 Hrs)


UNIT-II

Interpolation: Finite Differences – Forward, Backward , Newton’s formulae for interpolation(review) , Central differences, Gauss central difference interpolation formula, interpolation with unevenly spaced points – Lagrange’s interpolation formula, Hermite interpolation formula. (06 hrs)

UNIT-III

Numerical differentiation and numerical integration: Numerical differentiation- High accuracy differentiation formulae, Richardson extrapolation. (04 hrs)

Numerical integration: Newton-Cote’s integration formulae, Trapezoidal rule- a composite formula, Romberg integration , Simpson’s Rules- 1/3rd rule and 3/8th rule, Gaussian quadrature. (06 hrs)

Numerical solution of first order initial value problems: Taylor’s series method, Euler and Modified Euler method, Runge-Kutta Methods, Multi step methods: Milne;s and Adam.s Moulten method, R.K method for system of first order equations. (06 Hrs)

UNIT-IV
Numerical solutions of partial differential equations: General 2\textsuperscript{nd} order linear partial differential equations: Elliptic, Parabolic and hyperbolic. Finite difference approximation to derivatives. (4 hrs)

UNIT-V

Laplace equation: Jacobi method, Gauss-Seidel method, the ADI method Parabolic equations; Explicit method, Implicit method, Crank Nicolson method. (4hrs)

Numerical solution of first order boundary value problems (7 Hrs)

Introduction to Finite element method: Steps involved in FEM, Comparison between finite difference and finite element method, Application of finite element method. (6 hrs)

TEXT BOOKS/REFERENCES:


Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

COMBUSTION ENGINEERING

Sub Code : 15ESE 103 : (4+2+0) CIE Marks : 50
Lectures Hrs/ Week : 04
Tutorial: 02Hrs Exam Hours : 03
Total Lecture Hrs:52 SEE Marks : 50

Objective:

1. To make the student understand the concepts of thermochemistry of combustion.
2. To train the student in calculations of reaction kinetics, chemical equilibrium and heat release encountered in practical combustion systems.
3. To make the student understand principles of laminar and turbulent flames, flame propagation, flame stability, flame quenching and droplet combustion. To know the effect of physico-chemical parameters on the above as applicable to practical combustion systems such as reciprocating combustion engines, gas turbines and rocket motors.

At the end of the course, the student should be able to have a good comprehension of principles of reaction kinetics and combustion and be able to apply the same to practical combustion units and initiate projects on design and simulation of innovative systems.
Course Outcomes

- To learn about Stoichiometry of reactions, actual combustion processes, enthalpy of formation, thermo-chemical analysis of steady flow and constant volume systems, enthalpy of reaction and heating values, adiabatic combustion temperature
- To understand the criteria for equilibrium, equilibrium and chemical potential, Equilibrium constant Kp, Calculation of Kp and equilibrium compositions, first law analysis of equilibrium ideal gas mixtures, simultaneous reactions, relation between Kp and enthalpy of reaction (vant Hoff isobar equation)
- To know about Rate constant, order of reactions, calculation of order of simple reactions, half-life, activation energy and Arrhenius factor, determination of activation energy, concept of activated complex, measurement techniques for study of fast reactions.
- To understand the principles of laminar flame propagation- thermal and diffusion theories and their comparison, Temp-distance and Concentration-distance diagrams across the flame front, factors affecting laminar flame velocity, measurement of flame velocity, Turbulent flame propagation, factors affecting turbulent flame velocity, Damkoler and Shelkin’s models for turbulent combustion
- Study the Structure of diffusion flames, Roper’s correlations for length of laminar diffusion flames from circular, square and slot burners, turbulent diffusion flames, soot formation in diffusion flames.
- Understand the technique of Flame stabilization in open burners, stability diagram, flammability limits, flame quenching and quenching distance, factors affecting flammability and quenching, flame stabilization techniques in high speed flow. Ignition methods.
- To understand the principles of Evaporation and burning theories of liquid and solid fuel particles, transfer number, burning time of liquid and solid fuel particles
- To study overfeed and underfeed combustion principles, burners for pulverized coal, liquid fuels and gaseous fuels. Combustion process in the SI and CI engines, abnormal combustion in the SI engine and reasons for the same. Combustion chambers for gas turbines, Solid propellant rocket motors, methods of injection and ignition in rocket motors, rocket motor cooling, combustion instabilities in rocket motors - causes and remedies.

UNIT-I

Combustion and thermochemistry: Stoichiometry of reactions, actual combustion processes, enthalpy of formation, thermo-chemical analysis of steady flow and constant volume systems, enthalpy of reaction and heating values, adiabatic combustion temperature, second law analysis of chemical reactions, availability analysis of reactive systems. (8 Hrs)

UNIT-II

Chemical Equilibrium: Criteria for equilibrium, equilibrium and chemical potential, Equilibrium constant Kp, Calculation of Kp and equilibrium compositions, first law analysis of equilibrium ideal gas mixtures, simultaneous reactions, relation between Kp and enthalpy of reaction (vant Hoff isobar equation) (4Hrs)

Basic reaction kinetics: Rate constant, order of reactions, calculation of order of simple reactions, half-life, activation energy and Arrhenius factor, determination of activation energy, concept of activated complex, measurement techniques for study of fast reactions. (6 Hrs)
UNIT-III

**Combustion:** **Premixed flames:** laminar flame propagation- thermal and diffusion theories and their comparison, Temp-distance and Concentration-distance diagrams across the flame front, factors affecting laminar flame velocity, measurement of flame velocity. Turbulent flame propagation, factors affecting turbulent flame velocity, Damkoler and Shelkin’s models for turbulent combustion.  

**Diffusion flames:** Structure of diffusion flames, Roper’s correlations for length of laminar diffusion flames from circular, square and slot burners, turbulent diffusion flames, soot formation in diffusion flames.  

UNIT-IV

**Flame stability:** Flame stabilization in open burners, stability diagram, flammability limits, flame quenching and quenching distance, factors affecting flammability and quenching, flame stabilization techniques in high speed flow. Ignition methods.  

UNIT-V

**Droplet combustion:** Evaporation and burning theories of liquid and solid fuel particles, transfer number, burning time of liquid and solid fuel particles.  

**Combustion in practical systems:** Combustion of solid coal- Overfeed and underfeed combustion principles, burners for pulverized coal, liquid fuels and gaseous fuels. Combustion process in the SI and CI engines, theory of combustion knock, abnormal combustion in the SI engine and reasons for the same. Combustion in gas turbines, combustion chambers for gas turbines, Solid propellant rocket motors, schematic layout of a liquid bi-propellant system, propellant types, methods of injection and ignition in rocket motors, rocket motor cooling, combustion instabilities in rocket motors -causes and remedies.  

**TEXT/REFERENCE BOOKS**


**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.
WIND ENERGY CONVERSION SYSTEMS

Sub Code: 15ESE 111 : (4+0+0)  
CIE Marks: 50
No. of Lecture Hrs/week 04  
Exam Hours: 03
Total Lecture Hrs : 52  
SEE Marks: 50

Course Outcomes
- Should be able to use statistical methods to find wind parameters
- The student should be able to determine present worth for wind energy plant
- Should have the ability to determine capacity factor, energy production associated with wind energy.
- Should be aware of synchronous and asynchronous load on the wind turbines

UNIT-I
Introduction: Historical uses of wind, History of wind electric generations (06 Hrs)


UNIT-II
Wind Measurements: Eolian & Biological indicators, Wind speed & direction measurement, Rotational anemometers, other anemometers. (06 Hrs)

UNIT-III
Wind Turbine Power, Energy and Torque: Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds. (8 Hrs)

Wind Turbine Connected to the Electrical Network: Methods of generating synchronous power, AC circuits, The synchronous generator, Per unit calculations, The induction machine, Motor starting, Capacity credit features of electrical network. (06 Hrs)

UNIT-IV
Wind turbines with Asynchronous Electric Generators: Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self excitation of the induction generators, Single phase operation of the induction generator, Field modulated generators, Roesel generator. (06 Hrs)

Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells. (06 Hrs)

UNIT-V
Economics of Wind Systems: Capital costs, Economic Revenues requirements, Value of wind generated electricity (06 Hrs.)

TEXT REFERENCE BOOKS:

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.
STEAM AND GAS TURBINES

Sub Code: 15ESE 112 : (4+0+0)  
No. of Lecture Hrs/week: 04  
Total Lecture Hrs: 52  
CIE Marks: 50  
Exam Hours: 03  
SEE Marks: 50

UNIT-I
Steam turbines: power plant cycles. Cycle analysis and design.
Losses in steam turbine. Design of a stage.

UNIT-II
Design of multistage axial flow turbines. Vortex flow and lower pressure stage design.

UNIT-III
Performance at varying loads governing. Calculation of design point efficiency uses cascade data.

UNIT-IV

TEXT REFERENCE BOOKS:
W.J. Kearton, Steam Turbine Theory and Practice.
Jennings and Rogers, Gas turbine analysis and Practice, Mc Graw Hill.

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

DIRECT ENERGY CONVERSION

Sub Code: 15ESE 113 : (4+0+0)  
No. of Lecture Hrs/week: 04  
Total Lecture Hrs: 52  
CIE Marks: 50  
Exam Hours: 03  
SEE Marks: 50

UNIT-I
Basic science of energy conversion (06 Hrs)
Thermionic Converters (06 Hrs)

UNIT-II
Thermoelectric Engines (10 Hrs)

UNIT-III
Magneto hydrodynamic Engines (08 Hrs)

UNIT-IV
Photovoltaic Effect and Solar cells (06 Hrs)

UNIT-V
Free Energy and Fuel cells (08 Hrs)
Typical layout and constructions, Current developments (08 Hrs)

**TEXTS / REFERENCE BOOKS:**
3. S. L. Soo: "Direct Energy Conversion".

**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

**Power Electronics - I**

Sub Code: 15ESE114
Contact Hours : 4-0-0
Total Hours : 52
Exam Hours : 3
Credits : 4

**Course Outcomes**
1. List the different types of power semiconductor devices, converters and their characteristics.
2. Describe the principle of operation of phase controlled converters.
3. Describe the principle of operation of single phase and three phase inverter circuits.
4. Describe the principle of operation of single phase and three phase AC voltage regulators and cycloconverters.
5. Applications of Power electronic devices in UPS, HVDC, Static VAR compensators, SMPS and various circuits etc.

**Module I**
**Introduction:** History to power electronics development, power electronic systems, power electronics converters, power electronics, applications 04 Hrs
**Power Devices:** Phase controlled thyristors, Inverter grade thyristors, Inverter grade thyristors, RCT, DIAC, TRIAC, BJT, Power MOSFETs, IGBTs, GTOs, MCT operating characteristics and gate drive requirements and circuits. 08 Hrs

**Module II**
**Phase Controlled Converters:**
Introduction, Control Techniques, 1-φ half wave / full wave controlled rectifier, 1-φ half controlled bridge rectifier, performance facors of line commutated converters, performance measures of tw0 pulse converters, 3-φ controlled converter, 3-pulse/ 6-pulse converter, 3-φ fully controlled bridge converter, external performance measures, effect of input source impedance, performance of converter with battery load, selection of converter circuit, power factor improvement 10 Hrs

**Module III**
**Inverters:**
Introduction, classification, 1-φ half bridge, full bridge VSI, performance parameters, voltage control of 1-φ inverter, charge controllers applicable to solar PV: shunt type charge controller, series type charge
controller, MPPT charge controller and DC to DC converter type charge controller. 3-φ Inverters, voltage control of 3-φ Inverter, Series / parallel inverter, self commutated inverters, 1-φ SCR bridge inverter, CSI, performance comparison, Harmonic reduction, filters. 10 Hrs

Module –IV
AC voltage Regulators
Introduction, 1-φ AC Regulators, sequence control, 3-φ AC regulators, AC regulator to feed transformers. 04 Hrs

Cycloconverters
Introduction, basic principle, 1-φ to 1-φ cycloconverters, 3-φ half-wave cycloconverters, cycloconverters circuit for 3-φ output, output voltage equation, control circuit, comparison between cycloconverters and DC link converter, load commutated cycloconverters. 06 Hrs

Module -V
Power Electronic Applications:
UPS, SMPS (bridge configuration), HVDC, Static VAR compensators, RF Heating, Switched Mode Welding, Electronic Lamp Ballast, Battery Charger, Emergency Lighting System, Static circuit breaker, time delay circuit, flasher circuit, integral cycle triggering. 10 Hrs

Reference Books :

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

Power System Dynamics and Control

Sub Code: 15ESE115  Credits : 4
Contact Hours : 4-0-0  Total Hours : 52  CIE : 50 Marks
Exam Hours : 3  SEE : 50 Marks

Objectives : To get acquainted with the modelling of components and system for carrying out transient and dynamic stability analysis of large scale power system.
Prerequisite: Electrical machines, Control engineering, Basics of Power system.
**Outcome/ Expectation:** i) power stability problems and the basic concepts of modeling and analysis of dynamical system ii) Modeling of power system components - generators, transmission lines, excitation and prime mover controllers iii) Stability analysis of single machine and multi-machine systems iv) Methods for Enhancing system stability.

**UNIT I**

**UNIT II**
Modeling of a Synchronous Machine: Synchronous machine(Flux Linkage equations, Voltage equations, Torque equations), Park’s transformation, Analysis of Steady State Performance, Transient Analysis of a Synchronous Machine, Model with Standard parameters  

**UNIT III**

**UNIT IV**

**UNIT V**

**Text Books:**

**Reference Books :**

**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.
BIOMASS ENERGY FOR IC ENGINES

Sub Code: 15ESE 121 : (4+0+0) CIE Marks : 50
No. of Lecture Hrs/week : 04 Exam Hours : 03
Total Lecture Hrs : 52 SEE Marks : 50

Course Outcomes

- The student should be able to understand the parameters associated with setting up of energy plantation.
- The student should be able to design a community biogas plant and gasifier.
- The student should be able to understand combustion in CI and SI engine.
- The student should be aware of problem associated with the use of production gas in the IC engine.
- Should have the ability to understand the intricacies of water pumping biogas engine combination.

UNIT-I

Introduction: Relevance of biomass as an energy source. Biomass Resources, Cultivated biomass resources, Water-to-biomass resources, Advantages associated with biomass resources, Availability of biomass for energy generation. Energy plantation: Concept, Objectives and advantages (08 Hrs)


UNIT-II

Types of gasifiers, design of a down draft gasifiers, cooling, cleaning systems, performance evaluation of a downdraft gasifier. Production of alcohols from biomass. (05 hrs)

Bio-conversion Process: The process, Types of biogas plants, Design of biogas plants, Factors affecting gas generation rate. (06 Hrs)

UNIT-III

Combustion in Compression Ignition Engines:

Stages of combustion in CI Engines, factors affecting the different stages, Delay period and knock, factors controlling diesel knock. Direct injection systems and indirect injection systems. Fuel spray characteristics, Fuel injection, overall spray structure, atomization, spray penetration, droplet size distribution and spray evaporation, knock rating of diesel fuels, method of Cetane rating, anti-knock agents. (08 Hrs)

UNIT-IV

Combustion in Spark Ignition Engines:

Stages of Combustion in the SI engine, factors affecting these stages, flame propagation relations, misfire and engine stability, lean bum techniques, abnormal Combustion, Knock and surface ignition, factors controlling knock, knock rating of SI fuels, methods of Octane rating, anti-knock additives,
combustion chamber design. (08 Hrs)

**UNIT-V**


**TEXT / REFERENCE BOOKS:**

**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

**ENERGY FORM WASTES**

<table>
<thead>
<tr>
<th>Sub Code: 15ESE 122</th>
<th>CIE Marks : 50</th>
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<tbody>
<tr>
<td>No. of Lecture Hrs/week : 04</td>
<td>Exam Hours : 03</td>
</tr>
<tr>
<td>Total Lecture Hrs : 52</td>
<td>SEE Marks : 50</td>
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</table>

**UNIT-I**
Sources & types of wastes (Industrial, Municipal, agro, domestic). Generation of wastes, Pollution standards, Wastes characterization. Functional elements of waste management, technological aspects related to waste generation, on site handling, storage, collection, transfer, and transport. (04 Hrs) Processing techniques and equipment (volume reduction, size reduction, component separation, dewatering, drying). (04 Hrs)

**UNIT-II**
Recovery of value added components: Recycling, conversion products and energy. (06 Hrs)
Conversion technologies: Incineration, Thermo-chemical conversions. (06 Hrs)

**UNIT-III**
Biochemical conversion: Biogas & ethanol (06 Hrs)
Conventional Chemical & biological treatment (04 Hrs)

**UNIT-IV**
Waste disposal, Environmental impact (toxic & non-toxic) (06 Hrs)
Utilization of energy generated, power generation (04 Hrs)

**UNIT-V**
Waste management issues: Planning, organization & control Hazardous & toxic wastes, hazard & its
management, classification, generation, handling, processing and disposal. (04 Hrs)
Industrial safety (04 Hrs)

TEXTS / REFERENCE BOOKS:
7. Baum & Parker: "Solid waste disposal_ Incineration and Landfi

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

ADVANCED I.C ENGINES

Sub Code: 15ESE 123 :(4+0+0) CIE Marks : 50
No. of Lecture Hrs/week : 04 Exam Hours : 03
Total Lecture Hrs : 52 SEE Marks : 50

UNIT-I

Thermodynamic cycles:

UNIT-II

Combustion in Spark Ignition Engines:
Stages of Combustion in the SI engine, factors affecting these stages, flame propagation relations, Cyclic variations in combustion, causes and remedies of cycle-by-cycle and cylinder to cylinder variations, misfire and engine stability, lean bum techniques, abnormal Combustion, Knock and surface ignition, factors controlling knock, knock rating of SI fuels, methods of Octane rating, anti-knock additives, combustion chamber design. (10 Hrs)

UNIT-III

Combustion in Compression Ignition Engines:
Stages of combustion in CI Engines, factors affecting the different stages, Delay period and knock, factors controlling diesel knock, methods of generating swirls, their relative merits and demerits, combustion chamber designs for the CI engines, Direct injection systems, Indirect injection systems, Comparison of combustion chambers, heat release rate diagrams, Fuel spray characteristics, Fuel
Injection, overall spray structure, atomization, pray penetration, droplet size distribution and spray evaporation, knock rating of diesel fuels, method of Cetane rating, anti-knock agents.  (10 Hrs)

**Alternative combustion engine designs:**
Dual fuel engines, multi-fuel engines, stratified charge engines, VCR engine, Rotary combustion engine, Homogeneous charge compression ignition (HCCI) engine.  (08 Hrs)

**Pollutant Formation and Control:**
Nature and extent of problem, types of pollutants, their ill effects, evaporation loss and its control UBHC, CO and NOx emissions from SI engines, mechanism of formation of UBHC, CO and NO in engine combustion, factors affecting their formation and emission, control methods, comparison of methods, total emission control packages, alternative fuels for low emissions, driving cycles and emission standards. Particulate Emission, Characteristics of Diesel exhaust particulates, causes and methods of control, soot formation fundamentals, soot oxidation, adsorption and condensation, Exhaust Gas Treatment, Available options, Catalytic converters, thermal reactors, particulate traps, odour control in I.C. Engine exhaust.  (08 Hrs)

**Alternative Fuels for Combustion Engines:**
Use of Biogas, LPG, CNG, H₂, Biodiesels, Alcohol and producer gas in SI and CI engines. Reasons for derating, problems associated with gasifier engine system and its efficiency. Biodiesel and dual fuel engine: Power capacity, thermal efficiency, Diesel substitution, Smoothness of operation, Load following capability, Maintenance and durability, Exhaust emissions.  (08 Hrs)

**TEXTS / REFERENCE BOOKS:**
4. Klaus Von Mitzlaff "Engine for biogas", Published by Friedr Vielveg and Sohraunschweig, Germany – 1988

**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.
Electric Drives

Sub Code: 15ESE124  
Contact Hours : 4-0-0  
Total Hours : 52  
Exam Hours : 3  
Credits : 4  
CIE : 50 Marks  
SEE : 50 Marks

Course Outcome:
After finishing the course successfully, the student shall understand the
1. Different components of Electric Drives and their applications.
2. Dynamics of the Electric Drives and classifications of the load torque with different modes of operation of Electric Drives.
3. Understand concepts of Starting and Braking.
4. To study the concepts of controlled rectifier fed dc Drives
6. Analysis of IM operation with unbalanced source voltages, single phasing and also from non-sinusoidal voltage supply along with braking and various control methods.
7. Various control methods for Synchronous machines

Unit - I

Unit - II

Unit-III
converter ratings and closed loop control – transfer function of self, separately excited DC motors – linear transfer function model of power converters – sensing and feeds back elements – current and speed loops, P, PI and PID controllers – response comparison – simulation of converter and chopper fed DC drive

Unit-IV
Induction motor drives – stator voltage control of induction motor – torque-slip characteristics – operation with different types of loads – operation with unbalanced source voltages and single phasing – analysis of induction motor fed from non-sinusoidal voltage supply


Unit - V


Reference Books:
7. Murphy and Turnbull, Power Electronic Control of AC motors, Pergamon Press

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

ALTERNATIVE FUELS / ENERGY LABORATORY

Sub Code: 15ESE 104 :(4+0+0) CIE Marks : 50
No. of Lecture Hrs/week : 04 Exam Hours : 03
Total Lecture Hrs : 52 SEE Marks : 50

(Minimum of EIGHT experiments to be performed from the following list)
1. Performance characteristics of a diesel engine at various compression ratios
2. Performance characteristics of dual-fuel engine
3. Determination of properties of various alternative fuels
4. Study of P-θ and injection pressures curves for CI engine using computerized CI engine test rig with blended fuels
5. Study of P-θ and injection pressures curves for computerized VCR CI engine test rig with blended fuels
6. Study of P- θ curves for SI engine using computerized SI engine test rig with blended fuels
7. Testing of solar water heater
8. Experiments on solar Photo Voltaic System
9. Performance of wind rotor
10. Determination of Flash point and Fire point of lubricating oil using Cleveland open cup apparatus.
11. Determination of Viscosity of lubricating oil using Saybolt/ Cannon-Fenske Viscometer
12. Determination of Calorific value of fuel using Bomb Calorimeter
13. Study of Biodiesel pant and Preparation of Biodiesels.
II SEMESTER

UTILIZATION OF SOLAR ENERGY

Sub Code: 15ESE 201 : ( 4+2+0)  CIE Marks: 50
No. of Lecture Hrs/week: 04  Exam Hours: 03
Tutorials: 02 Hrs  SEE Marks: 50
Total Lecture Hrs: 52

Course Outcomes

To estimate or measure solar radiation at any location.
To understand radiation characteristics of opaque material and partially transparent media
To estimate the thermal losses and efficiency of a flat plate collector and understand its applications.
To know about the different orientation systems and types of concentrating collectors, can determine the thermal performance of focusing collector.
To understand use of solar energy for different applications like cooking, desalination, space heating etc.
To know about different designs of green house, solar refrigeration and high temperature application
To know about different PV panel configurations and its characteristics
To know the importance of storage systems, types of thermal storage and alternate methods

UNIT-I

Solar Radiation Analysis: Solar constant, Basic earth sun angles, Beam and diffused radiations, Radiation on titled surfaces (estimation), Measurement of solar radiation, Numerical problems (08 Hrs)

UNIT-II

Heat Transfer for Solar Energy Utilization: Basic models of heat transfer, Radiation characteristics of opaque materials and partially transparent media, Heat transfer analysis for flat plate collectors, Numerical problems (08 Hrs)

UNIT-III

Flat Plate Collectors: Physical principles of conversion of solar radiation into heat, Thermal Losses and efficiency of FPC, Practical considerations for flat plate collectors, Applications of FPC - Water heating and Drying (08 Hrs)

UNIT-IV

Focusing Type Collectors: Orientation and sun tracking systems, Types of concentrating collectors - Cylindrical parabolic collector, Compound parabolic collector, Thermal performance of focusing collectors, Testing of solar collectors.
Solar cooking, Solar desalination, Solar ponds and Solar space heating Solar Industrial process heating and Solar power generation. (08 Hrs)

UNIT-V

Solar Green Houses, Solar thermo mechanical power, Solar refrigeration & air conditioning and Solar High Temperature Applications (04 Hrs)

TEXTS / REFERENCE BOOKS:
1. John A Duffie & William A Beckman: "Solar Energy Thermal processes" — Wiley Inter science publication

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

ENERGY CONSERVATION AND MANAGEMENT

<table>
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<td>Lecture Hrs/week</td>
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<td>Tutorials: 02 Hrs</td>
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<tr>
<td>Exam Hours</td>
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<td>SEE Marks: 50</td>
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<td>Total Lecture Hrs</td>
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Course Outcomes

1. The importance of Energy conservation, the need for arising for awareness of energy can be recognized in any energy application.
2. Initiating and Managing an energy management program, learning types of energy audits & the systematic procedure for technical audit can be thoroughly learnt.
3. Students will be able to know basics of Cash flows, Payback period, ROI, depreciation and plant value calculations also time value of money etc and therefore learn the concepts of economics and its importance in energy engineering.
4. Energy conservation in steam and condensate systems will bring knowledge of
5. Concepts, Types of cogeneration systems, Performance evaluation of a cogeneration system Efficiently use of steam in various engineering application & also mathematical concepts along with it.
6. Potential, benefits, waste heat recovery equipments knowledge will be imparted.
7. Basic concepts involved in transfer of heat, Space heating methods, Ventilation and air conditioning will be learnt.
8. Need of Insulation materials, Insulation selection, Critical thickness and Economical thickness of insulation will help design better insulation and therefore contribute in energy savings.
9. The options available for heating applications in Industries such as Indirect resistance heating, Direct resistance heating (salt bath furnace), Heat treatment by induction heating in the electric arc furnace industry etc can be understood.

10. Energy conservation in utility by improving load factor, Power factor improvement methods, Energy conservation possibilities in many other industries will provide the student complete basic knowledge of the Energy Conservation in Electric Utility and Industrial sectors.

UNIT-I

Introduction: General energy problem, global and national energy use patterns. Scope of energy conservation in domestic, transportation, agriculture and industrial sectors, Electrical energy sector (generation, transmission and distribution) (04Hrs)


UNIT-II


UNIT-III

Economic Analysis: Cash flows, Payback period, ROI, depreciation and plant value calculations. Time value of money, Formulae relating present and future cash flows, NPV, IRR, B/C ratio, Life cycle costs. (08Hrs)

UNIT-IV

Efficient use of steam: Energy conservation in steam and condensate systems. (04 Hrs)
Cogeneration: Concepts, Types of cogeneration systems, Performance evaluation of a cogeneration system. (04 Hrs)

UNIT-V

Waste Heat Recovery: Potential, benefits, waste heat recovery equipments. (04 Hrs)

Space Heating, Ventilation, Air Conditioning (HVAC) and water heating: Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, cooling loads, Electric water heating systems, energy conservation methods in the above devices. (06 Hrs)

Industrial Insulation: Insulation materials, Insulation selection, Critical thickness and Economical thickness of insulation. (04 Hrs)

Industrial Heating: Indirect resistance heating, direct resistance heating (salt bath furnace), Heat treatment by induction heating in the electric arc furnace industry. (04 Hrs)

TEXT/REFERENCE BOOKS


**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

**ENERGY SYSTEM MODELING AND ANALYSIS**

Sub Code: 15ESE 203 :(4+2+0)  
No. of Lecture Hrs/week : 04 Tuto :02 Hrs  
Exam Hours : 03

**Course Outcomes**
1. Should have the ability to model a given set of data by various methods.
2. Should be able to carry out simulation of simple energy systems.
3. Should be able to formulate a problem and carry out optimization of simple thermal system by various methods.
4. Should be aware of methods available for testing the fidelity of representation

**UNIT-I**
Designing a Workable System: Workable and optimum systems, Steps in arriving at a workable system, Creativity in concept selection, Workable Vs Optimum system, Designing of a food freezing plant.  
(04Hrs)

Equation Fitting: Mathematical modeling, Polynomial representation, Functions of two variables, Exponential forms, Best fit Method of least squares  
(06 Hrs)

**UNIT-II**
Modeling of Thermal Equipment: Modeling of counter flow heat exchanger, Evaporators and Condensers, Heat exchanger effectiveness, Effectiveness of a counter flow heat exchanger, NTU, Pressure drop and pumping power  
(05Hrs)

(05 Hrs)
UNIT-III


Geometric Programming: One independent variable unconstrained, Multivariable optimization, constrained optimization with zero degree of difficulty. (04 Hrs)

UNIT-IV
Dynamic Programming: Characteristic of the Dynamic programming solution, apparently constrained problem, Application of Dynamic programming to energy system problems. (08 Hrs)

UNIT-V
Linear Programming: Simplex method, Big-M method, Application of LP to thermal systems (04 Hrs)

Search Methods : Basic Considerations, Importance of Search Methods, Types of Approaches Application to Thermal Systems. Single-Variable Problem, Uniform Exhaustive Search, Dichotomous Search, Fibonacci Search, Golden Section and Other Search Methods, Comparison of Different Elimination Methods. Unconstrained Search with Multiple Variables, Lattice Search, Univariate Search, Steepest Ascent/Descent Method. (04 Hrs)

Mathematical Modeling: Thermodynamic properties-Need for mathematical modeling, Criteria for fidelity of representation, Linear regression analysis, Internal energy and enthalpy, Pressure temperature relationship at saturated conditions, Specific heat, P-V-T equations. (04 Hrs)

Overview of various technologies and conventional methods of energy conversion, Power cycles.

TEXTS / REFERENCE BOOKS:
COMBUSTION ENGINE DESIGN PRINCIPLES

Sub Code: 15ESE 211 : (4+0+0)  
CIE Marks : 50  
No. of Lecture Hrs/week: 04  
Exam Hours: 03  
Total Lecture Hrs : 52  
SEE Marks: 50

UNIT-I
Prerequisites & selection of main parameters, application of principle of similitude, choice of
Materials for various engine components.  
(6 Hrs)

UNIT-II
Cylinder block, Cylinder liner, Cylinder heads, crankcase, gaskets, hold down studs  
Piston, piston rings, piston pin  
(8 Hrs)
(6 Hrs)

UNIT-III
Connecting rods, polar diagrams, flywheels, crank shaft, main bearings, crank pin, Methods to
improve fatigue strength of crank shaft  
(14 Hrs)

UNIT-IV
Valves & valve gears, valve springs, cams  
(8 Hrs)

UNIT-V
Combustion chamber shapes for SI & CI Engines, lubrication systems, cooling systems, cooling fans,
dynamics of piston- connecting rod- crank systems, engine balancing  
(10 Hrs)

TEXTS / REFERENCE BOOKS:
2. I.C. Engines by LC. Lichty, McGraw Hill, 1951
4. R.C. Engines by Taylor - Vo\, 2, MIT Press, 1985
5. High Speed IC Engines by Heldt P.M., Oxford & IBH, 1989

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least
ONE question from each unit.
ENERGY STORAGE

Sub Code: 15ESE 212 : (4+0+0)  CIE Marks : 50
No. of Lecture Hrs/week: 04  Exam Hours: 03
Total Lecture Hrs : 52  SEE Marks: 50

Course Outcomes

1. The importance of Energy transfer its basic functioning in different applications and the modes energy can be transferred can be recognized in any energy application
2. Learn the applications of thermal energy storage system also specifically study basic thermal energy storage system at medium and high temperatures using sensible and latent heat.
3. Understand concept of mechanical Energy Storage such as Pumped hydro storage, Elastic energy storage, Energy storage in advanced Flywheels etc
4. Study the basics of Electromagnetic energy storage systems such as Superconducting Magnetic Energy Storage.
5. Learn the concepts of Electro-chemical energy conversion and storage such as electrochemical cell, batteries, hydrogen oxygen cells etc.
6. Impart the knowledge of Supercapacitor and its basic components of supercapacitors, The disadvantages and advantages of supercapacitors over battery systems and their applications in public transport vehicles, private vehicles etc.
7. Learn how Energy storage in hydrogen can be of good help in energy needs of the society its production related issues.
8. Understand how high temperature storage through reversible reactions can be applicable in energy storage systems.

UNIT-I
Importance and modes of energy transport and storage, energy shift, Ragone plot. Importance of energy density and power density. (04Hrs)
Testing of storage systems (02 Hrs)
Thermal modeling of energy storage systems (04 Hrs)
Total energy systems (02 Hrs)

UNIT-II
Thermal energy storage at medium and high temperatures using sensible and latent heat (06 Hrs)
Energy storage in hydrogen – production of hydrogen (02 Hrs)
High temperature storage through reversible reactions (04 Hrs)

UNIT-III
Mechanical Energy Storage: Pumped hydro storage, Elastic energy storage, Energy storage in Advanced Flywheels (04Hrs)
Compressed air energy storage (04 Hrs)
UNIT-IV

Electro-chemical energy conversion and storage: Introduction to batteries, elements and operation of electrochemical cells, theoretical cell voltage and capacity, losses in cells. Battery classification, factors effecting battery performance, batteries for PV system.

Introduction to fuel cells, hydrogen oxygen cells, hydrogen air cell, hydrocarbon air cell, alkaline fuel cell, phosphoric and fuel cell with detailed analysis of the advantage and drawback of each type. (08 Hrs)

UNIT-V

Electromagnetic energy storage: Superconducting Magnetic Energy Storage. (04 Hrs)

Super capacitor: Basic components of supercapacitors like types of electrodes like high surface area activated carbons, metal oxide and conducting polymers, aqueous and organic electrolytes. The disadvantages and advantages of supercapacitors over battery systems and their applications in aspects of energy density, power density, price and market. (08 Hrs)

TEXTS / REFERENCE BOOKS:


Scheme of Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

DESIGN OF HEAT TRANSFER EQUIPMENT

Sub Code: 15ESE 213 :(4+0+0)  CIE Marks : 50
No. of Lecture Hrs/week : 04  Exam Hours : 03
Total Lecture Hrs : 52  SEE Marks : 50

UNIT-I
Study of different methods used for design of heat exchangers, classification, design methodology, LMTD and NTU methods. (10 Hrs)

UNIT-II
Design of double pipe heat exchanger. (06 Hrs)
Design of shell and tube heat exchanger. (06 Hrs)

UNIT-III
Cross flow heat exchangers (06 Hrs)

UNIT-IV
Extended surfaces, fin design, longitudinal and transverse fins. (06 Hrs)
Regenerator (06 Hrs)
UNIT-V

Plate Type Heat Exchangers (06 Hrs)
Compact Heat Exchangers (06 Hrs)

TEXTS / REFERENCE BOOKS:
2. D. G. Kern & A. D. Kraus: "Extended surface heat transfer".
5. Indian Standards, 4503-1967, UDC - 66045.1

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

Power Electronics - II

Sub Code: 15ESE214
Contact Hours : 4-0-0
Total Hours : 50
Exam Hours : 3
Credits : 4
CIE : 50 Marks
SEE : 50 Marks.

Course Outcomes
1. Ability to analyze and design DC- DC switch mode Converters
2. Ability to analyze and design Resonant Converters and filter design
3. Ability to analyze and design Resonant Switch Converters and filter design
4. Ability to analyze and design Switch mode dc-ac Inverters
5. Ability to analyze and learn the disturbances of the power lines, remedy on power conditioner sources and design of transformers and inductors

Unit -I
DC- DC switch mode Converters - principle of operation of buck, boost, buck-boost, Cuk, fly back, forward, push-pull, half bridge, full bridge & isolated Cuk Converters 12 Hrs

Unit - II
Input & output filter design, multi-output operation of isolated converters, dc-dc converter comparison 5 Hrs

Resonant Converters: Classification of resonant converters, basic resonant circuit concepts, load resonant converters 5 Hrs

Unit - III
Resonant switch converters, zero voltage switching, clamped-voltage topologies, resonant dc linked inverters with zero voltage switching 8 hrs

Unit - IV
Switch mode dc-ac Inverters: Basic concepts of switch mode inverters, PWM switching scheme, Single phase half-bridge inverter, push-pull inverter, PWM in three phase voltage source inverter 10 hrs
Unit - V

**Power conditioners and UPS:** Power line disturbances, power conditioners, uninterruptable power supplies  
4 hrs

**Design of transformers and inductors:** Analysis of specific inductor design, inductor design procedure, Analysis of specific transformer design, Transformer design procedure, eddy currents  
8 hrs

Reference Books :

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

**HVDC Transmission**

**Sub Code: 15ESE215**
Contact Hours : 4-0-0  
Total Hours : 50  
Exam Hours : 3  
Credits : 4

**CIE : 50 Marks**  
**SEE : 50 Marks**

UNIT-I
**08 hrs**

UNIT-II
Converter circuits: Graetz bridge Circuit, Analysis of Graetz bridge neglecting overlap, choice of converter configuration. Analysis of Line Commutated Converter(LCC) with grid control and overlap less than 60 degree and greater than 60 degree, Capacitor commutated Converter, Analysis of a Voltage Source Converter.  
**14 hrs**

UNIT-III
Principles of DC Link Control, Converter Control Characteristics, System Control Hierarchy, Firing Angle Control, Current and Extinction Angle Control, Power control, Higher level Controllers.  
**06 Hrs**
Converter Faults, Protection against Over currents, Over voltages in a Converter Station, Surge Arrestors, Protection against Overvoltage, Smoothing Reactors, DC Breakers.  
**06 Hrs**

UNIT-IV
Reactive Power Requirements in Steady State, Sources of Reactive Power, SVC and STATCOM, Reactive Power Control during Transients  
**05 Hrs**
Generation of Harmonics, Design of AC Filters, Passive AC Filters, DC Filters  
UNIT-V  

TEXT BOOKS:  

REFERENCES:  
1. E W Kimbark, “Direct current Transimission  

Scheme of Examination:  
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.  

INSTRUMENT A TION AND CONTROL IN ENERGY SYSTEMS  
Sub Code:15ESE 221 :(4+0+0)  
No. of Lecture Hrs/week : 04  
Total Lecture Hrs : 52  
CIE Marks : 50  
Exam Hours : 03  
SEE Marks : 50  

UNIT-I  
Transducer classification. Generalized performance characteristics of instruments, Static and dynamic characteristics of transducers, Transient analysis of a control system.  

UNIT-II  
**Temperature Measurement**: Use of bi-materials, Pressure thermometers, Thermocouples, RTD, Thermisters, and Pyrometry, pyrometers.  

UNIT-III  
**Flow Measurement**: Flow measurement methods, variable head flow meters for incompressible Fluids. Rota meters, Electromagnetic flow meters, Hot wire anemometers, hot film transducers, Ultrasonic flow meters.  

UNIT-IV  
**Air pollution and Measurement**: Introduction, Gas sampling techniques, particulate sampling techniques, Sulphur dioxide measurements, Combustion Products Measurements, Opacity and odor measurements  
**Miscellaneous measurements**: Measurement of liquid level, Measurement of Humidity moisture, measurement of O2, CO2 in flue gases. pH measurement
UNIT-V

**Instruments for monitoring electrical parameters:** Moving Iron/coil, Energy measurement, power factor meter. (04 Hrs)

Analog signal conditioning, Amplifiers, Instrumentation amplifier, A/D and 0/ A Converters, Digital data processing and display, Data acquisition system. (06 Hrs)

**TEXTS / REFERENCE BOOKS:**

**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

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**NUCLEAR ENGINEERING**

Sub Code: 15ESE 222 :(4+0+0) CIE Marks : 50
No. of Lecture Hrs/week: 04 Exam Hours: 03
Total Lecture Hrs : 52 SEE Marks: 50

UNIT-I
Scope of Nuclear Power- Review of Nuclear Physics- Reactor Theory (06)
Elements of Reaction Physics. Thermodynamic aspects of Nuclear Power,

UNIT-II
Fission and Fusion Processes. Thermal Reactor Types: PWR, CANDU, HTGCR (10)

UNIT-III
Fast breeder: Fluid fuelled, Organic Cooled Reactor and Economics. (08)

UNIT-IV
Steady and Unsteady State- Calculation of critical Size of Homogeneous and Heterogeneous Reactors. (08)
Elementary Idea of Reactor Instrumentation and control. (08)

UNIT-V
Reactor Materials, Shielding, Thermal Aspects of Nuclear Systems. (08)
Types and processing of nuclear fuels (04)

**TEXTS / REFERENCE BOOKS:**
Richards Stephenson, Introduction to Nuclear Engineering, McGraw Hill.
K.S.Ram, Basic Nuclear Engineering, Wiely Eastern.
M N El Vakil, Nuclear power engineering, McGraw Hill
Samuel Glasstone, Nuclear reactor engineering. Chapman & Hall, Fourth Edition Om Prakash Gupta,
Fundamentals of nuclear power reactors, Khanna publishers

**Scheme of Examination:**
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

**POLLUTION CONTROL FROM THERMAL POWER STATIONS**

Sub Code: 15ESE 223: (4+0+0)
CIE Marks: 50
No. of Lecture Hrs/week 04
Exam Hours: 03
Total Lecture Hrs : 52
SEE Marks: 50

**Course Outcomes**

1. The student should be able to know various type of pollution.
2. The student should be able to determine the pollutant concentration and plume height for the pollutant emission from a plant.
3. The student should be aware of mode of formation and control of various pollutants. The student should have the knowledge of water, noise, plastic and odor pollution and their control.
4. The student should be knowledgeable about some pollution control acts and legal aspects associated with pollution control.

**Unit -I**

**Impact of Man on the environment:** Biosphere; Hydrologic cycle; Nutrient cycle, Carbon cycle, Nitrogen cycle, Sulphur cycle; Pollution of Air water and Soil, Impact of Coal Mining, Fossil Fuel Related Pollutants in the Environment, Carbon Emissions and Global Warming, Reduction in Carbon Emissions, Impact of Urban Areas, Environmental Impacts of Hydro-electric & Nuclear Energy, Chemical Pollution, Marine Pollution, Ozone Depletion, Solid Wastes (04 Hrs)

**Air Pollution : Sources & Effects:** Definition and Scales of Concentration; Classification & Properties of Air Pollutants, Classification, Properties of Air Pollutants; Emission Sources, Classification according to Source Types, Other Methods of Grouping Air Pollution Services, Major Emissions from Global Sources, Emission Sources in India; Behaviour & Fate of Air Pollutants, Wet Precipitation, Interaction at the Earth’s Surface, Chemical Reactions in the Atmosphere, Photochemical Smog; Effects of Air pollution; Human Health, Vegetation, Materials, Damage to Health, Vegetation & Materials in India, Standards. (06 Hrs)

**Unit -II**

**Meteorological Aspects of Air pollutant:** Temperature Lapse Rates & Stability; Adiabatic Lapse rate, Atmospheric Stability, Inversions; Wind Velocity & Turbulence, Topographical Effects; Plume Behaviour, Aerodynamic Effects of Structures & Terrain; Dispersion of Air Pollutants, Solutions to the Atmospheric Dispersion Equation , The Gaussian Plume Model, Estimation of Plume Rise; Buoyant Plumes, Plume Rise under Stable & Calm Conditions, Non-buoyant Plumes (10 Hrs)

**Unit-III**

**Air Pollution Sampling and Measurement:** Types of Pollutant Sampling and Measurement; Ambient Air Sampling, Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Analysis of Air Pollutants; Sulphur Dioxide, Nitrogen Oxides, Carbon Monoxide, Oxidants & Ozone, Hydrocarbons’, Particulate Matter:Stack(10 Hrs)
Unit-IV

**Air Pollution Control Methods & Equipment:** Control Methods; Source Correction Methods, Raw Material Changes, Process Changes, Equipment Modification or Replacement, Cleaning of Gaseous Effluents; Particulate Emission Control; Collection Efficiency, Particulate Control Equipment, Gravitational Settling Chambers, Cyclone Separators, Filters, Electrostatic Precipitators, Wet Scrubbers, Selection of a Particulate Collector; Control of Gaseous Emissions; Absorption by Liquids, Adsorption by Solids, Combustion (05 Hrs)

**Control of Specific Gaseous Pollutants:** Control of Sulphur Dioxide Emission; Extraction of Sulphur from Fuels, Sulphur Reduction During Combustion, Desulphurization of Flue Gases, Processes Using Metal Oxides, Processes Using Activates Carbon, Wet Scrubbing Methods, Metal Smelting Operations, Chemical & Petroleum Industries, Control of Nitrogen Oxides; Modification of Operating Conditions, Modification of Design Conditions, Effluent Gas Treatment Methods, Carbon Monoxide Control; Control of Hydrocarbons; Biological oxidation, Mobile Sources (07 Hrs)

Unit- V

**Sources and Classification of Water Pollutants:** Water Resources; Utilization of Water, Origin of Wastewater; Wastewater Composition, Types of Pollutants & Their Effects; Oxygen Demanding Wastes, Disease Causing Agents, Synthetic Organic Compounds, Plant Nutrients, Inorganic Chemicals & Minerals, Sediments, Radioactive Substances, Thermal Discharges, Oil, Water Pollution Laws & Standards (03 Hrs)

**Wastewater Treatment:** Basic Processes of Water Treatment; Primary Treatment; Pre-treatment, Sedimentation, Flotation, Secondary (Biological) Treatment; Role of Microorganisms, Decomposition of Organic Waste, Bacterial Pollution Dynamics, Growth Kinetics: The Monod Equation, Aerobic Biological Treatment, Activated Sludge Process, Evaluation of Biokinetic Parameters, Trickling Filters, Sludge Treatment & Disposal, Advanced Wastewater Treatment; Removal of Suspended Solids, Removal of Dissolved Solids, Nitrogen Removal, Advanced Biological Systems, Chemical Oxidation, Recovery of Materials from Process Effluents (04 Hrs)

**Other Types of Pollution:** Noise, plastic and odour pollution, their control methods. Soil pollution, their control methods (02 Hrs)

Pollution control Acts, legal aspects of pollution control (01 Hrs)

**References:**
2. W.L. Faith, Air Pollution Control, John Wiley
Power Generation and System Planning

Sub Code: 15ESE224
Contact Hours : 4-0-0 Credits : 4
Total Hours : 50 CIE : 50 Marks
Exam Hours : 3 SEE : 50 Marks

Unit-I
**Load forecasting** – characteristics of loads –methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting. 8 hrs

Unit-II
**System Planning** : Introduction, Objectives & Factors affecting to System Planning, Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning 8 hrs

Unit-III
**Generation system:** Reliability analysis-Reliability Concepts- Exponential Distribution mean time to failure-Series and Parallel system – Markov Process- Recursive technique- Generator System reliability analysis-Probability Models for generator unit and loads-Reliability Analysis of isolated and interconnected system – Generator system cost analysis 12 hrs

Unit-IV
**Transmission system reliability analysis:** Transmission system reliability model analysis – Capacity state classification- Average – Interruption rate method – LOLP method 6 hrs

**EXPANSION PLANNING:** Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system. 8 hrs

Unit-V
**DISTRIBUTION SYSTEM PLANNING OVERVIEW** : Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices 8 hrs

**Text Books:**
5. Endreni.J., Reliability modeling in electric power system, John Wiley 1980

**Reference Books :**
Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

Application of Power Electronics to Power Systems

Sub Code: 15ESE225
Contact Hours : 4-0-0
Total Hours : 50
Exam Hours : 3
Credits : 4
CIE : 50 Marks
SEE : 50 Marks

Course Outcomes:
1. Use of VSI for reactive power support and as active filter, and also understand the concept of load balancing.
2. Understand the concept of multi-level inverters.
3. Different methods of VAR generation and Analysis of different shunt FACTS controllers.
4. To study the concepts of series FACTS controllers and multi-functional FACTS controllers.
5. Understand the concept of HVDC system.

Unit-I
Load Balancing: Introduction- Transmission line theory, use of Voltage source inverter (VSI) for reactive power support, mid-point series and shunt compensation and HVDC.
Discussion on voltage profile at the point of common coupling (PCC), need for load compensation, load balancing using passive elements. Limitations of load balancing using passive elements, Use of VSI as a Var generator.
Bi-directional power flow in VSI, Use of VSI as active filter cum Var generator, Current controlled SLCVC, Strategy-1: Sensing the compensator current, Strategy-2: Sensing the source current, Use of two VSIs, one as var generator and another as active filter. 8 Hrs

Unit-II
Introduction to multi-level inverters. Principle of operation of 3-level and 4-level diode clamped multi-level inverters. Space vector representation of 3-level VSI, voltage control of 3-level inverter.
Instantaneous reactive power theory, expression for active and reactive powers in terms of d-q components.
Reactive power compensator, stationary to rotating frame transformation. harmonic oscillator, Phase locked loop (PLL) 8 hrs

Unit-III
Shunt Compensation: Introduction, methods of Var generation: Thyristor controlled reactor (TCR), Thyristor switched capacitor (TSC), Fixed capacitor-Thyristor controlled reactor (FC-TCR), STATCOM. 8 hrs

Unit-IV
Series Compensation: Introduction, comparison between series and shunt, GTO Controlled Series Capacitor (GCSC), Comparison of TCR and GCSC, Thyristor Switched Series Capacitor (TSSC),

Unit-V

HVDC: Introduction, various possible HVDC configurations, unipolar and bipolar links, Converter, transformer, smoothing reactor, harmonic filter. Reactive power support, operation of 6-pulse controlled rectifier in inverting mode of operation. Effect of source inductance, 6-pulse converter-source inductance. Operation of 12-pulse converter. Control of HVDC system, Rectifier and inverter characteristics, combined rectifier-inverter characteristics, limitations, HVDC system using line commutated converters, modern HVDC system

Reference Books:

Scheme of Examination:
Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

ENERGY SYSTEMS MODELING LABORATORY

Sub Code: 15ESE 204 :(0+0+4) CIE Marks : 50
No. of Lecture Hrs/week: 04 Exam Hours: 03
Total Lecture Hrs : 52 SEE Marks: 50

Course Outcomes
- To conduct an experiment on air compressor and develop equations relating pressure and input to the motor using the method of least squares.
- To conduct an experiment on a counter flow heat exchanger, and to determine the values of outlet temperature of a stream using physical model and compare with that of measured value.
- To conduct an experiment on centrifugal blower and develop equations relating discharge and efficiency using Lagrange method.
- To conduct an experiment on reciprocating pump and develop equations relating pressure and input to the motor using linear programming.

Experiments
1. Developing a model for characteristics of single stage reciprocating air compressor
2. Developing a model for characteristics of a centrifugal pump
3. Determining optimum system design for blower-motor system using successive simulation
4. Determining optimum system design for centrifugal pump-motor system using simultaneous simulation
5. Study of characteristics of a heat-pump.