# SCHEME OF STUDIES & EXAMINATIONS

**M. Tech Programme in Energy Studies and Environment Management (ESEM)**

## 1st YEAR (1 - SEMESTER)

<table>
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### 1st YEAR (II - SEMESTER)

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SCHEME OF STUDIES & EXAMINATIONS

M. Tech Programme in Energy Studies and Environment Management (ESEM)

2nd YEAR (III - SEMESTER)

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# M. Tech Programme in Energy Studies and Environment Management (ESEM)

## 2nd YEAR (IV - SEMESTER)

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<td>ESEM-301 Independent Study</td>
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<td>ESEM-303 Nuclear Energy</td>
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**NOTE:**

1. Since this is a very broad and multidisciplinary programme, preference shall be given to the setting of examination papers by internal examiners for all the sessional and semester examinations. If an external examiner is asked to set the paper, then the CEEES Center shall have the option of moderating the questions set in it.

2. The choice of students for any elective shall not be binding on the department to offer it.

In Theory examinations, students will have to answer only 5 out of 8 questions set in the semester exam.
UNIT - I
Origin of Biomass: Resources: Classification and characteristics; Techniques for biomass assessment; Application of remote sensing in forest assessment; Biomass estimation. Thermochemical Conversion Different processes: Direct combustion, incineration, pyrolysis, gasification and liquefaction; Economics of thermochemical conversion.

UNIT - II
Geothermal Energy

Unit-III
Ocean Energy

UNIT - IV
Hybrid systems
Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems) and Application areas, Hydrogen energy production, storage & application.

Recommended References:


Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-103: DIRECT ENERGY CONVERSION
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (I- Semester)

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Unit I
Survey of energy conversion problem. Basic science of energy conversion.
Physics of semiconductor junctions for photovoltaic.

Unit II
Fabrication and evaluation of various solar cells. Application of solar cells in photovoltaic power generation systems.

Unit III
Technology and physics of thermo-electric generators. Thermo-electric materials and optimization studies, Basic concepts and design consideration of MHD generators. Cycle analysis of MHD systems. Thermionic power conversion and plasma.

Unit IV
Thermodynamics and performance of fuel cells and their applications, recent developments and their applications.

References:
1. Direct Energy Conversion : W.R.Corliss
4. Energy conversion principles : Begamudre, Rakoshdas
13. Non-Conventional Sources of Energy- G D Rai
14. Energy Technology- S. Rao (Khanna Publications)

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
UNIT I
Water sources, Rain water harvesting, hydrological cycle, physical, chemical and biological parameters of water resources,

UNIT II
Fluid and its properties, fluid pressure, buoyancy and floatation, types of fluid flow, boundary layer theory, equation of continuity, Navier–Stockes equation for boundary layer,

UNIT III
Waste water treatment – primary, secondary, tertiary treatment, disinfection techniques, sludge treatment and disposal, Gaseous and particulate matter control measures, Air pollution meteorology – mixing height, wind rose, inversion condition, lapse rate, stability of atmosphere, plume behavior.

UNIT IV
Solid waste management, Sources and nature of solid waste their characteristic and classification, reduction, reuse and recovery, recycling of solid waste, Effluent and emission analysis,

Recommended Books :

1. Introduction to environmental science and engineering by Gilbert M. Masters.
2. Fluid Mechanics and Hydraulics by J. Lal
3. Air Pollution and Control by K.V.S.A. Murali Krishna
5. Waste Water Engineering Treatment, Disposal, Reuse by Metelf and Eddy.
6. Industrial Water Pollution Control by W. Wesley, Eckenfelder, Jr.
7. Environmental Hazards by Smith, Keith.
8. Water supply and Sanitary Engineering by G. S. Birde and J. S. Birde

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
UNIT I
Basic environmental chemistry
Chemical equilibria and kinetics fundamentals, Acids and base, titration, acidity, alkalinity, buffers and buffer intensity, chemical equilibrium calculation, PC-pH diagram, Solubility diagram, oxidation and reduction reactions.

UNIT II Atmospheric and Water chemistry
Atmospheric chemistry: Chemical composition and structure of atmosphere, the changing global atmosphere, green-house effect and global warming, chloro-flouro carbons with their nomenclature, sources, substituent and effects, photochemical smog, ozone layer depletion, residence time, acid rain, atmospheric brown cloud. Fundamentals definition classification and sources, water quality standards, BOD, COD, DO determinations, eutrophication.

UNIT III Soil chemistry
Physio-chemical mineralogical and biological properties of soil, soil organic matter, microorganisms of soil, decomposition of organic matter in soil, soil formation and distribution, Mobility of nutrients, and trace elements during soil genesis, effects of modern agriculture on soil geochemistry

UNIT IV Analytical techniques
Particle size analysis, X-ray diffraction in minerals, chemical analysis by spectrometric and spectrophotometric methods, chromatographic techniques, Atomic absorption spectrophotometer, Atomic emission spectrophotometry.

Recommended Books
1. Environmental chemistry by Mannahan.
2. Environmental chemistry by A K De.
3. Introduction to environmental science and engineering by Gilbert M. Masters
5. Environmental chemistry by B K Sharma
6. Composition, chemistry and Climate of the Atmosphere by H. B. Singh.
7. Environmental Soil Chemistry by Donald L. Sparks.
8. Industrial Water Pollution Control by W. Wesley, Eckenfelder, Jr.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-109: HEAT TRANSFER AND PROCESS INTEGRATION
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (I - Semester)

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Unit I
Basic Heat Transfer Concept and Terminology:

Conduction:
Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance, Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction, Lumped Heat Capacity Analysis.

Unit II
Convection:

Unit III
Boiling and Condensation

Heat Exchangers

Unit IV
Radiation
Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Reference Books

**Note:** Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-111: ENVIRONMENTAL ENGINEERING LABORATORY-I
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (I - Semester)

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1. Determination of pH and Conductivity of given soil sample.
2. Determination of TOC of Soil
3. Determination of COD of waste water
4. Determination of BOD of Waste water.
5. Determination of heavy metal free fall dust.
7. Determination of ash content in coal.
8. Determination of available heavy metals in contaminated soil.
9. Determination of ferrous ion in waste water.
10. Determination of heavy metals in waste water.
1. To determine the heat transfer coefficient in natural convection.
2. To measure the heat transfer coefficient in forced convection.
3. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode.
4. To determine heat transfer coefficient for drop and film wise condensation.
5. To determine thermal conductivity of an insulating power.
6. Determining efficiency of lighting system/loads
7. Measurement of Intensity of solar radiation
8. Study of solar collector.
9. Study of solar hot water systems (FPC and ETC)
10. Study of heat pipe
11. Characteristics of SPV system.
12. Determination of efficiency of DC/AC inverter.
13. Study of Lead Acid Battery as a energy storage.
14. Wind power and annual energy estimation from wind data.
15. Pay back analysis, financial work sheet of a renewable energy project.

At least five (5) out of seven (16) experiments will be carried out in one semester
UNIT I
Earth & Sun Relationship:
Solar Collectors
Flat Plate Collectors, Air Flat Plate Air Collectors, Concentrating Collectors, Evacuated Tubular Collectors, Solar Cookers.

UNIT II
Thermal Energy Storage: Sensible Storage (Water, pebble bed and ground storage), Latent Heat Storage.
Thermal Energy Systems
Solar Water Heating System: Components, Natural Flow, Forced Flow and Load
Solar desalination system: Design and type, Solar still, performance analysis.

UNIT III
Solar Refrigeration and Desiccant

UNIT IV
Solar Power Generator

Recommended Books:
9. Markvart, Solar Electricity, John Wiley
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

**Note:** Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-104: ENERGY, ECOLOGY & ENVIRONMENT  
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (II - Semester)  

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UNIT I  
Origin of earth, Earth’s temperature and atmosphere, Sun as a source of energy, Solar spectrum, introduction to fossil fuel-petroleum, coal, natural gas and bio mass.

UNIT II  
Introduction to ecology, concept of biosphere, community characteristics, ecological succession. Forest resources – Forest and environment, World forest resources, National forest Policy, Deforestation and forest management.

UNIT III  
Energy flow in material cycle, Food chain, Food web, Photosynthesis, ecological pyramids, Autecology, Biogeochemical cycles, Concept of sustainable development, Responses of Ecosystems (Land, Water, Marine) to deforestation, fire, pollution, ecological invasions; Rural vs. Urban systems; Restoration of Degraded Ecosystems.

UNIT IV  
Thermal pollution, radioactive pollution, noise pollution (Sources, classification and effects), micro climatic effects of pollution, environmental degradation, sources and classification of pollutants, Pollution abatement methods, resources of energy and energy use pattern in different regions of the world.

Recommended Books  
1. Introduction to Ecology by P D Sharma.  
2. Fundamentals of Ecology by E.P. Odum  
3. Living in the environment by T.J.Miller.  
4. Environmental Pollution Control Engineering by C.S.Rao.  

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
Unit I
Device fabrication technologies: diffusion, oxidation, photolithography, sputtering, physical vapor deposition, chemical vapor deposition (CVD), plasma enhanced CVD (PECVD), hot wire CVD (HWCVD), etc.

Unit II
Introduction to material characterization: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X-ray diffraction (XRD), Raman spectroscopy, Atomic force microscopy (AFM), Spectral response of solar cells, quantum efficiency analysis, dark conductivity, I-V characterization.

Unit III
Basics of Semiconductors Physics: Intrinsic and Extrinsic Semiconductor, Direct and indirect transition, inter-relation between absorption coefficients and band gap recombination of carriers
Basics of Photovoltaic Technology: Types of Solar cells, crystalline silicon deposition techniques, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells.

Unit IV
Materials and devices for energy storage; Batteries, Carbon Nano-Tubes (CNT), fabrication of CNTs, CNTs for hydrogen storage, CNT-polymer composites etc. Polymer membranes for fuel cells, PEM fuel cell, Acid/alkaline fuel cells.

Texts/References

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-108: FUEL TECHNOLOGY
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (II - Semester)

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Class Work: 25 Marks
Examination (Theory/Practical): 75 Marks
Total: 100 Marks
Duration of Examination: 3 Hours

Unit I: Introduction to nuclear fuels, Resources, Nuclear reactors, Nuclear fuel cycle, Enrichment of Uranium.

Unit II: Solid Fuels – Coal, Orgin, classification, washing, pulverization, briquetting of solid fuels, Coal Pyrolysis, carbonization, gasification, liquefaction.

Unit III: Liquid fuels - origin, cracking, reforming, purification, Polymerisation, alkylation. Isomerization, properties (knocking and antiknocking).

Unit IV: Gaseous fuel – Natural gas, LPG, producer gas, water gas, coal gas, Oil gas, Combustion – Principles of soild, liquid and gaseous fuels,

Recommended References:
- Combined books’ list attached at the end

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM 110: ENVIRONMENTAL AUDITING AND IMPACT ASSESSMENT
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (II - Semester)

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UNIT I

UNIT II

UNIT III

UNIT IV
National environmental policy, Case studies: EIA of Power plants, cement industry, iron and steel, chemical and refinery.

Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
8. Environmental Impact Assessment Glassan T.
9. Environmental Laws: K C Aggarwal

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
List of experiments to be conducted:

1. To determine the pH value, conductivity and turbidity of water sample.
2. To determine the amount of alkalinity of the water sample.
3. To determine the acidity of the given water sample.
4. To determine the total hardness of the water sample.
5. To remove both types of hardness from the given water sample.
6. To determine the Calcium and Magnesium ions from the given water sample.
7. To determine the Total, Suspended, Dissolved and Volatile solids of the water sample.
8. To determine optimum alum dose for coagulation of water sample.
9. To determine chlorine demand of water.
10. To determine oil and grease in provided sample.
11. To determine chloride concentration in given water sample.

At least seven experiments will be carried out in the course of one semester.
List of experiments to be conducted:

1. Determine the I-V and P-V characteristics of PV module with varying radiation and temperature level.
2. Determine the I-V and P-V characteristics of series and parallel combination of PV modules.
3. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
4. Determine the efficacy of the given Incandescent v/s compact florescent lamp
5. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.
7. Study of Performance of Solar Lamp.
10. Performance evaluation of box type and concentrating type solar cooker.
11. Charging and discharging characteristics of battery.
12. The working of diode as bypass diode and blocking diode.

At least seven experiments will be carried out in the course of one semester.
ESEM-115: REMEDIAL MATHEMATICS AND REMEDIAL ENVIRONMENTAL SCIENCE
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (1st Semester)

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Class Work : 25 Marks
Examination (Theory/Practical) : 75 Marks
Total : 100 Marks
Duration of Examination : 3 Hours

(Non Credit, compulsory course)


Evolution of biosphere, Diversity of life forms. Biological communities, species interaction, Communities properties, succession. Plant diversity and nomenclature with major classes of plants; Phytogeographical regions; Rare and threatened plants and exploration of plant wealth. Animal diversity and categories of animals; Rare and threatened species of mammals, aves, reptiles, pisces etc.; Exploration and conservation of faunal wealth. Microbial diversity, bacteria, fungi, actinomycetes; Microbial diversity in man-made ecosystems and natural ecosystems. Importance of flora and fauna in nutrient cycling, its effect, degradation and metabolism.

**Note:** Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-302: HAZARDOUS WASTE MANAGEMENT  
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) ELECTIVE

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Unit I: Sources and classification of hazardous wastes, Industries responsible for production of hazardous waste, assessment of exposure potential

Unit II: Transport processes of hazardous wastes. Handling and management of Biomedical, Agriculture and E-waste.

Unit III: Overview of waste management problem, Energy form organic wastes, Chemical waste treatment processes, Physical waste treatment processes, Biological, Thermal Waste treatment processes

Unit IV: Waste elimination options, Hazardous waste management options, Remediation of hazardous waste contaminated soils. Hydrocarbon remediation, heavy metal remediation, radioactive waste remediation etc.

Recommended References:
- Combined books’ list attached at the end

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
Unit I: Fission and fusion, laws on criterion, confinement problem. Laser-driven fusion, magnetic confinement, equilibrium and stability, cross-field transport.
Unit II: Tokamak and magnetic mirror, reactor concepts.
Unit III: Nuclear fission reactor and nuclear fusion reactor.

Recommended References:
- Combined books’ list attached at the end

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
**ESEM 304: WATER RESOURCE MANAGEMENT**

M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) ELECTIVE

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**Unit I**
Global distribution of water resources, water need and consumption; Threats to surface and ground water resources; Principles and approaches to surface and ground water management.

**Unit II**
Watershed management: Catchment infiltration, rain water harvesting and storage, recharging of ground water; Role of dams. Management of degraded surface and ground water resources.

**Unit III**
Properties of sewage and industrial effluents; Effluent standards; Treatment of industrial effluents, sewage treatment (primary, secondary and tertiary treatment), advanced treatments (nitrate and phosphate removal);

**Unit IV**
Sludge treatment and disposal; Waste water use. Drinking water quality and water treatment (desalination, ion-exchange, reverse osmosis and disinfection of water). People's participation and mass awareness programmes for water resource management.

**Text/References:**


**Note:** Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-305: POWER GENERATION, DISTRIBUTION & TRANSMISSION
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (II - Semester)

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**Unit I:** Generation: Synchronous generator operation, Power angle characteristics and the infinite bus concept, Dynamic analysis and modeling of synchronous machines, Excitation systems, Prime mover governing systems, and Automatic generation control, Auxiliaries.

**Unit II:** AC Transmission: Overhead and cables, Transmission line equations, Regulation and transmission line losses, Reactive power compensation, and Flexible AC transmission.

**Unit III:** HVDC Transmission: HVDC converters, Advantages and economic considerations, Converter control characteristics, Analysis of HVDC link performance, Multi-terminal DC System.

**Unit IV:** Distribution: Distribution systems, Conductors size, Kelvin’s law performance calculations and analysis, Distribution inside industrial and commercial buildings entrance terminology, Substation and feeder circuit design considerations, Distribution automation.

**Recommended References:**

**Note:** Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
### ESEM-306: SOLAR ENERGY UTILIZATION

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) ELECTIVE**

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**Unit I:** Solar radiation, its measurement and prediction.

**Unit II:** Flat plate collectors: liquid and air type. Theory of flat plate collectors, advanced collectors, Solar water heating, solar dryers, solar stills, solar cooling and refrigeration.

**Unit III:** Optical design of concentrators, selective coatings.

**Unit IV:** Thermal storage. Conversion of heat into mechanical energy. Active and passive heating of buildings.

**Recommended References:**
- Combined books’ list attached at the end

**Note:** Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-307  HYDROGEN TECHNOLOGY  
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) ELECTIVE

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**Unit I**
Hydrogen Energy: Need and Relevance in relation to depletion of fossil fuels and environmental considerations.

**Unit II**
Metal Hydrides: Benefits, PC isotherms, Hydrogen storage methods.

**Unit III**
Fundamentals of Hydrogen storage in different materials: Carbon nanostructures, Magnesium hydrides, Intermetallics and other materials.

**Unit V**
Application of Hydrogen/Hydrides as fuel in Engines, Socio-Economic Aspects.

**Recommended References:**
- Combined books’ list attached at the end

**Note:** Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
UNIT I
Introduction: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics.

WECS Design: Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt’s tip loss correction.

UNIT II
Design of Wind Turbine
Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods.

Wind Energy Application
Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies, Environmental Impacts of Wind Farms.

UNIT III
Small Hydropower Systems
Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works; Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in North East India.

UNIT IV
Wind and hydro based stand-alone hybrid power systems. Case Studies

Recommended References:
- Combined books’ list attached at the end

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-309: ALTERNATIVE FUELS FOR L.C. ENGINES
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) ELECTIVE

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(Theory/Practical)

Total: 100 Marks

Duration of Examination: 3 Hours

Unit I: An introduction to hydrocarbon fuels their availability and effect on Environment. Gasoline and Diesel self ignition characteristics of the fuel, Octane Number, Cetane number.

Unit II: Alternative fuels e.g. Biodiesel, Synthesis gas, BioGas, DME, LPG, LNG, Hydrogen, Physico-chemical characteristics, performance and Emissions.


Unit IV: Biodiesel formulation techniques, transesterification, Blending and application in diesel engines. DME (Di-methyl ether), properties Fuel injection consideration.

Unit V: General introduction to LPG and LNG. Compressed Natural Gas components, mixtures and kits, fuel supply system and emission studies and control.

Unit VI: Hydrogen combustion characteristics, flashback control techniques, safety aspects and system development, NOx emission control, Biogas, Producer gas and their characteristics. System development for engine application.

Recommended References:
- Combined books’ list attached at the end

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
## ESEM-310: ENERGY CONSERVATION (IN SYSTEM)

M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 2nd Year (III - Semester)

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### UNIT I
Furnaces: Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

### UNIT II
Insulation and Refractories: Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractories, Case Studies.

### UNIT III
HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.

### UNIT IV

### Text books/References
3. F. W. Pyne, Pgm Energy Conservation Manual, Fairmont Proem, INC. P.O. Box 14227 Atlanta, GA 30224
7. Gunnar, Anderlind, A Theoretical Analysis Of Thermal Insulation
Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
ESEM-311: Green Building Technology
M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) ELECTIVE

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Class Work : 25 Marks
Examination (Theory/Practical) : 75 Marks
Total : 100 Marks
Duration of Examination : 3 Hours

Unit I
Green Building Design Strategies and Building Codes:

Unit II
Thermal Comfort:
Criteria and various Parameters, Psychrometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.
Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit III
Heat Transmission in Buildings:
Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit IV

Recommended Books
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-,

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.
SEMINAR (ON ANY CONTEMPORARY TOPIC)

In this course, the traffic engineering, pavement engineering or transportation systems concepts on specific contemporary topic will be studied and tools for preparing reports will be used by students to prepare report. Reporting, writing and presentation skill development in engineering and technology is the main objective.
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<th>S. NO.</th>
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<td>1.</td>
<td>WEALTH FROM WASTE</td>
<td>BANWARI LAL, MRVP REDDY</td>
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<td>RENEWABLE ENERGY RESOURCES, BASIC PRINCIPLES AND APPLICATIONS</td>
<td>GN TIWARI, MK GHOSAL</td>
<td>NAROSA PUBLISHING HOUSE, DARYAGANJ</td>
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<td>3.</td>
<td>FINANCIAL EVALUATION OF RENEWABLE ENERGY TECHNOLOGIES</td>
<td>TC KHANDEL, HP GARG</td>
<td>MCMILLAN INDIA LTD</td>
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<td>4.</td>
<td>ESSENTIALS OF ENVIRONMENT STUDIES</td>
<td>KURIAN JOSEPH, R NAGENDRAN</td>
<td>ISBN 81-297-0498-6</td>
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<td>SOLID WASTE ENGG</td>
<td>P AARNE VESILIND, WILLIAM WORELL, REINHART</td>
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<td>6.</td>
<td>ENVIRONMENT ENGG SCI</td>
<td>WILLIAM W NAZAROFF, LISA ALVAREZ COHEN</td>
<td>J WILEY AND SONS, INC</td>
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<td>SOLAR ENERGY – PRINCIPLES OF THERMAL COLLECTION AND STORAGE</td>
<td>SP SUKHATAME, JK NAYAK</td>
<td>TATA-MCGRAW HILL PUBLISHERS</td>
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<td>FUELS AND COMBUSTION</td>
<td>SAMIR SARKAR</td>
<td>ORIENT LONGMAN</td>
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<td>INTERNAL COMBUSTION ENGINE FUNDAMENTALS</td>
<td>JOHN B HEYWOOD</td>
<td>MCGRAW HILL BOOK CO</td>
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<td>INTRODUCTION TO HYDROGEN TECH</td>
<td>ROMAN J PRESS, KSV SANTHANAM, MASOOD J MIRI, ALLA V BERILEY, GERALD A TAKAES</td>
<td>J WILEY AND SONS</td>
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<td>FUELS AND FUEL TECH</td>
<td>FRANCIS WILFRED</td>
<td>OXFORD, PERGAMON PRESS</td>
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<td>ENVIRONMENTAL POLLUTION CONTROL ENGG</td>
<td>CS RAO</td>
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<td>HP GARG, J PRAKASH</td>
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<td>D YOGI GOSWAMI, FRANK KEITH, JAN F KREIDER</td>
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<td>GILBERT M MASTERS</td>
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<td>ECOLOGY PRINCIPLES AND APPLICATIONS</td>
<td>JL CHAPMAN, MJ REINS</td>
<td>CAMBRIDGE UNIV PRESS</td>
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<td>SOLAR ENERGY – FUNDAMENTALS, DESIGN MODELLING AND APPLICATIONS</td>
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<td>SOLAR ENERGY – PROBLEMS SOLUTIONS AND EXPERIMENTS</td>
<td>GN TIWARI, P BARNWAL, SC SOLANKI, MK GAUR</td>
<td>ANAMAYA PUBLISHERS, N DELHI</td>
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<td>HANDBOOK OF PHOTOVOLTAIC SCIENCE AND ENGINEERING</td>
<td>ANTONIO LUQUE AND STEVEN HEGEDUS, EDS</td>
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<td>ENVIRONMENT, ENERGY, AND ECONOMY</td>
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<td>UNITED NATIONS UNIVERSITY</td>
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<td>ADVANCES IN SOLAR ENERGY V. 17</td>
<td>D.YOGI GOSWAMI, CHIEF ED.</td>
<td>EARTHSCAN</td>
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<td>27.</td>
<td>MAKING TECHNOLOGY WORK: APPLICATIONS IN ENERGY AND ENVIRONMENT</td>
<td>JOHN M. DEUTCH, RICHARD K. LESTER</td>
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<td>28.</td>
<td>APPLIED PHOTOVOLTAICS</td>
<td>S.R. WENHAM, M.A. GREEN, M.E. WATT, R. CORKISH</td>
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<td>29.</td>
<td>BIOFUELS, SOLAR AND WIND AS RENEWABLE ENERGY SYSTEMS</td>
<td>DAVID PIMENTEL ED.</td>
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<td>30.</td>
<td>ENERGY MANAGEMENT HANDBOOK</td>
<td>WAYNE C. TURNER, STEVE DOTY</td>
<td>THE FAIRMONT PRESS</td>
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<td>ENERGY, SOCIETY AND ENVIRONMENT</td>
<td>DAVIT ELLIOTT</td>
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<td>W SHEPHERD, DW SHEPHERD</td>
<td>IMPERIAL COLLEGE PRESS</td>
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<td>33.</td>
<td>ENERGY USE WORLDWIDE</td>
<td>JAINA L. MOAN AND ZACHARY A. SMITH</td>
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<td>ENERGY AND THE ENVIRONMENT</td>
<td>JAMES A. FAY DAN S. GOLOMB</td>
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<td>Ed. EVAN K. NYER</td>
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