CENTER OF EXCELLENCE FOR ENERGY AND ENVIRONMENTAL STUDIES
DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE AND TECHNOLOGY
MURTHAL: 131 039(SONEPAT)

## SCHEME OF STUDIES & EXAMINATIONS

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

### 1st YEAR (I - SEMESTER)

| S. No. | Course No. | Course Title | Teaching Schedule | | | Marks | | | Credits | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P/D | Total | Class Work | Theory / Practical | Total | | |
| 1 | ESEM-101 | New and Renewable Energy Sources | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 2 | ESEM-103 | Direct Energy Conversion | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 3 | ESEM-105 | Environmental Science & Engineering | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 4 | ESEM-107 | Analytical Chemistry of Environment | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 5 | ESEM-109 | Heat Transfer and Process Integration | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 6 | ESEM-111 | Environmental Engineering Lab-I | 0 | 4 | 4 | 20 | 30 | 50 | 2 | 3 |
| 7 | ESEM-113 | Energy laboratory-I | 0 | 4 | 4 | 20 | 30 | 50 | 2 | 3 |
| 8 | ESEM-115 | Remedial Mathematics and Remedial Environmental Science | 4 | 0 | 4 | 25 | 75 | 100 | 0 | 3 |
| Grand Total | | | 24 | 8 | 32 | 190 | 510 | 700 | 24 | |

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## SCHEME OF STUDIES & EXAMINATIONS

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

**1st YEAR (II - SEMESTER)**

| S. No. | Course No. | Course Title | Teaching Schedule | | | Marks | | | Credits | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P/D | Total | Class Work | Theory / Practical | Total | | |
| 1 | ESEM-102 | Solar Energy: Fundamentals, Devices and Systems | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 2 | ESEM-104 | Energy, Ecology & Environment | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 3 | ESEM-106 | Materials and Devices for Energy Applications | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 4 | ESEM-108 | Fuel Technology | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 5 | ESEM-110 | Environmental Audit & Impact Assessment | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 6 | ESEM-112 | Environmental Engineering laboratory-II | 0 | 4 | 4 | 20 | 30 | 50 | 2 | 3 |
| 7 | ESEM-114 | Energy laboratory-II | 0 | 4 | 4 | 20 | 30 | 50 | 2 | 3 |
| Grand Total | | | 20 | 8 | 28 | 165 | 435 | 600 | 24 | |

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## SCHEME OF STUDIES & EXAMINATIONS

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

**2nd YEAR (III - SEMESTER)**

| S. No. | Course No. | Course Title | Teaching Schedule | | | Marks | | | Credits | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P/D | Total | Class Work | Theory / Practical | Total | | |
| 1 | ESEM | Elective-I | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 2 | ESEM | Elective-II | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 3 | ESEM | Elective –III | 4 | 0 | 4 | 25 | 75 | 100 | 4 | 3 |
| 4 | ESEM-201 | Seminar | 0 | 2 | 2 | 50 | -- | 50 | 2 | -- |
| 5 | ESEM-203 | Field Visit | 0 | 2 | 2 | 50 | -- | 50 | 2 | -- |
| 6 | ESEM-205 | Dissertation-I | 0 | 8 | 8 | 100 | -- | 100 | 8 | -- |
| Grand Total | | | 12 | 12 | 24 | 275 | 225 | 500 | 24 | -- |

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## SCHEME OF STUDIES & EXAMINATIONS

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

**2nd YEAR (IV - SEMESTER)**

| S. No. | Course No. | Course Title | Teaching Schedule | | | Marks | | | Credits | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P/D | Total | Class Work | Theory/ Practical | Total | | |
| 1 | ESEM-202 | Dissertation-II | 0 | 20 | 20 | 100 | 100 | 200 | 20 | -- |
| Grand Total | | | 0 | 20 | 20 | 100 | 100 | 200 | 20 | -- |

**ELECTIVES**

| | | | | | |
|---|---|---|---|---|---|
| 1 | ESEM-301 | Independent Study | 7 | ESEM-307 | Hydrogen Technology |
| 2 | ESEM-302 | Hazardous Waste Management | 8 | ESEM -308 | Wind energy & hydro power energy |
| 3 | ESEM-303 | Nuclear Energy | 9 | ESEM-309 | Alternative Fuel for I.C. Engines |
| 4 | ESEM-304 | Water Resource Management | 10 | ESEM-310 | Energy Conservation (In Systems) |
| 5 | ESEM-305 | Power generation, distribution & transmission | 11 | ESEM-311 | Green Building Technology |
| 6 | ESEM-306 | Solar energy utilization | | | |

**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**

**ESEM-101: NEW AND RENEWABLE ENERGY SOURCES**

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)1st Year (I– Sem)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | **:** | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | **:** | **75 Marks** |
| | | | | **Total** | **:** | **100 Marks** |
| | | | | **Duration of Examination** | **:** | **3 Hours** |

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**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**

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.

**Unit-III**

**Ocean Energy**

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies. Tidal Energies.

**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:**


1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society *I* E& FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy;'Noyes DATA Corpor_tion, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.


**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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| | | | | **Class Work** | **:** | **25 Marks** |
| **4** | **--** | **--** | **4** | **Examination (Theory/Practical)** | **:** | **75 Marks** |
| | | | | **Total** | **:** | **100 Marks** |
| | | | | **Duration of Examination** | **:** | **3 Hours** |

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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 photo voltaic 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.

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**References:**


1. Direct Energy Conversion : W.R.Corliss
2. Aspects of Energy Conversion : I.M.Blair and B.O.Jones
3. Principles of Energy Conversion : A.W.Culp (McGraw-Hill International)
4. Energy conversion principles : Begamudre , Rakoshdas
5. Handbook : Batteries and Fuel cell – linden (Mc.Graw Hill)- 1984
6. Essentials of Solar Cells by R. K. Kotnala & N.P. Singh, Allied Publishers Pvt. Ltds, New Delhi, 1986.
7. Semiconductor Devices by Nauro Zamluto, Mc Graw Hill 1989 (Int. Ed.)
8. Solid State Electronic Devices. III ed. By B. G. Streetman, Prentice Hall India Pvt. Ltd., N.D, 1991.
9. Solar Cells by Martin Green, Pergamon press.
10. Solar Energy Thermal processes: Duffie & Buckman, Wiley & Sons, New York.
11.Solar Energy by S.P. Sukhatme, Tata Mc Graw Hill, New Delhi.
12.Solar Energy: H P Garg & J P Prakash.
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.**

## ESEM-105: ENVIRONMENTAL SCIENCE AND ENGINEERING

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)1st Year (I - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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**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
4. Air Pollution and Control Engineering by C S Rao.
5. Waste Water Engineering Treatment, Disposal, Reuse by Metclf 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.**

## ESEM-107: ANALYTICAL CHEMISTRY OF ENVIRONMENT

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)1st Year (I - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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**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
4. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication III rd Edition.1986
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.
9. Fundamentals of Analytical chemistry by Skoog, West & Holler
10. Environmental Chemistry by Colin Baird.


**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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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**Unit I**

**Basic Heat Transfer Concept and Terminology:**

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

**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:**

Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

**Unit III**

**Boiling and Condensation**

Condensation Heat-Transfer Phenomena, The Condensation Number Film Condensation Inside Horizontal Tubes, Boiling Heat Transfer, Simplified Relations for Boiling Heat Transfer with Water, The Heat Pipe.

**Heat Exchangers**

The Overall Heat-Transfer Coefficient, Fouling Factors, Types of Heat Exchangers, The Log Mean Temperature Difference, Effectiveness-NTU Method, Compact Heat Exchangers, Heat Exchangers Design Considerations.

**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**

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M.Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company

Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).

**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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| -- | -- | 4 | 2 | **Class Work** | : | **20 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **30 Marks** |
| | | | | **Total** | : | **50 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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.
6. Determination of Kdejeldal Nitrogen.
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.

**ESEM-113: ENERGY LABORATORY-I**

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT) 1st Year (I - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| -- | -- | 4 | 2 | Class Work | : | 20 Marks |
| | | | | Examination (Theory/Practical) | : | 30 Marks |
| | | | | Total | : | 50 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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

**ESEM-102: Solar Energy: Fundamentals, Devices and systems**

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)1st Year (II - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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**UNIT I**

**Earth & Sun Relationship:**

Earth & Sun Relation: Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram. Available Solar Radiation: Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface. Solar Radiations Characteristics

**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 Air Heating Systems : Space Heating, Solar Drying, Load Estimation.
Solar desalination system : Design and type, Solar still, performance analysis.

**UNIT III**

**Solar Refrigeration and Desiccant**

Cooling : Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling .

**UNIT IV**

**Solar Power Generator**

Solar Thermal Power Generation : Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.

**Recommended Books:**

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen “Solar Cells – Operating Principles, Technology, and System Applications”, 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.

11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P agrarwal - Solar Energy
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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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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.
5. Renewable Energy by N. K. Bansal.
6. Environmental Chemistry by b. K. Sharma.


**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-106: MATERIALS AND DEVICES FOR ENERGY APPLICATIONS**

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)1st Year (II - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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**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 electro 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**


1. Solar cells: Operating principles, technology and system applications, by Martin A. Green, Prentice-Hall Inc, Englewood Cliffs, NJ, USA, 1981.
2. Seminconductors for solar cells, H. J. Moller, Artech House Inc, MA, USA, 1993.
   Solid State electronic devices, Ben G. Streetman, , Prentice-Hall of India Pvt. Ltd., New delhi 1995.
3. Carbon nanotubes and related structures: New material for twenty-first century, P. J. F. Harris, Cambridge University Press, 1999.
4. Thin-film crystalline silicon solar cells: Physics and technology, R. Brendel, Wiley-VCH, Weinheim, 2003.
5. Clean electricity from photovoltaics, M. D. Archer, R. Hill, Imperial college press, 2001.
6. Organic photovoltaics: Concepts and realization, C. Barbec, V. Dyakonov, J. Parisi, N. S. Saricifttci, Springer-Verlag 2003.
7. Fuel cell and their applications, K. Kordesch, G. Simader, VCH, Weinheim, Germany, 1996.
8. Battery technology handbook, edited by H.A. Kiehne, Marcel Dekker, New York, 1989
9.


**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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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**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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | **:** | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | **:** | **75 Marks** |
| | | | | **Total** | **:** | **100 Marks** |
| | | | | **Duration of Examination** | **:** | **3 Hours** |

**UNIT I**

Elements of Environmental Impact Assessment: Introduction Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening, Baseline study, Impact Identification, Impact prediction.

**UNIT II**

Evaluation alternatives, Evaluation and Mitigation. Methodology- Checklist, matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA, Public participation and environmental decision making.

**UNIT III**

Socio economic environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries. Concepts of the Environmental Audit, Need for Environmental Audit, Guidelines for Environmental Audit.

**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.
3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter (II nd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Ltd. Publications.
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.**

**ESEM-112: ENVIRONMENTAL ENGINEERING LABORATORY-II**

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)1st Year (II - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 0 | -- | 3 | 3 | Class Work | : | 20 Marks |
| | | | | Examination (Theory/Practical) | : | 30 Marks |
| | | | | Total | : | 50 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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.

**ESEM-114: ENERGY LABORATORY-II**

**M. Tech. - ESEM (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)1st Year (II - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 0 | -- | 3 | 3 | **Class Work** | : | **20 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **30 Marks** |
| | | | | **Total** | : | **50 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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.
6. Workout power flow calculations of stand-alone PV system of AC load with battery.
7. Study of Performance of Solar Lamp.
8. Flue gas analysis of petrol, diesel and LPG Engines.
9. Study of solar hot air collector/ solar dryer.
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 (I - Semester)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 0 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

**(Non Credit, compulsory course)**

Elementary numerical analysis: roots of equations, systems of linear algebraic equations, solution of ordinary differential equations. Differentiation of simple mathematical functions- product rule, quotient rule and chain rule. Integration- by parts, substitution and by partial fractions. Linear differential equations and their solution. Introduction to Matrices and Determinants. Introduction to Vectors- addition, subtraction, multiplication of vectors. Equation of Straight Line and Solving Linear System of Equations.

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**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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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.**

**ESEM-303: NUCLEAR ENERGY**

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

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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**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.
**Unit IV:** Nuclear radiation detector. Current status.
.

**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**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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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:**


1. Handbook of Applied Hydrology: A Compendium of Water Resources Technology. Chow, V. T. (ed.) (1954): McGraw Hill, New York.
2. Water Resource Planning and Development, Rai, V.K. (1993): Deep and Deep Publication, New Delhi
3. Rural Water Resource Utilization and Planning. Bilas, R. (1988): Concept Publishing Company, New Delhi.
4. Water Harvesting and Sustainable Supply in India. Athavale, R. N. (2003): Rawat Publications., Jaipur.
5. Sustainable Management of Water Resources, Prasad, H. et al.(eds.) (2005): Tara Book Agency,Varanasi
6. A Textbook of Hydrology. Reddy, J. P. (1988): Laxmi Publication., New Delhi. 4th edition
7. Principles of Hydrology. Ward, R.C. and Robinson, M. (2000): McGraw Hill, New York
8. Karanth: Development, Assessment and Management of Water Resources
9. Tolman, C.F. (1937): Groundwater, McGraw Hill , New York and London.
10. Todd, D.K. (1995): Groundwater Hydrology, John Wiley and Sons.
11. Raghunath, H.M. (1990): Groundwater, Wiley Eastern Ltd.
12. Nagabhushaniah, H.S. (2001): Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ.
13. Karanth, K. R. (1989): Hydrogeology, Tata McGraw Hill Publ..


**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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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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:**


1.Power Generation, Operation, and Control by Allen J. Wood and Bruce F. Wollenberg, John Wiley & Sons, 2003.

2. Power System Control and Stability by P. M. Anderson and A. A. Fouad, Wiley-IEEE Press, 2002.

3. Electric Energy Systems Theory: An Introduction by Olle I Elgerad, T M H Edition, 1982.

4. HVDC Transmission: Power Conversions Applications in Power Systems by Chan-Ki Kim, Vijay K. Sood, Gil-Soo Jang, Seong-Joo Lim, Seok-Jin Lee, Wiley – IEEE Press, 2009.

5. Electric Power Transmission System Engineering Analysis and Design by Turan Gonen, CRC Press, 2009.

6. Power system stability and control by P. Kundur. McGraw-Hill, 1994.


**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**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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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**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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**Unit I**

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

Hydrogen Production: Photo-electrolysis, Fossil, Biological Process & Bio Fuels, Benefits and barriers of different production methods.

**Unit II**

Hydrogen Storage technologies: Compressed gas storage, Liquid Storage, Underground storage, Line Packing, Solid State Storage, Advantages and disadvantage of different storage methods.

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**

Hydrogen Fuel Cells: Principle and workings systems, Applications, Safety & Standards.

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

Comparative future viability analysis, Hydrogen economics, Public acceptability of hydrogen, Policy impllications and Current status.

**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-308: WIND ENERGY & HYDRO POWER ENERGY**

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

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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**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 I.C. ENGINES**

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

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | **Class Work** | : | **25 Marks** |
| | | | | **Examination (Theory/Practical)** | : | **75 Marks** |
| | | | | **Total** | : | **100 Marks** |
| | | | | **Duration of Examination** | : | **3 Hours** |

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**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 III:** Alternative liquid fuels: Alcohol fuels-Ethanol & Methanol. Fuel composition, fuel induction techniques, fumigation, emission of oxygenates applications to engines and automotive conversions.

**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)**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | Class Work | : | 25 Marks |
| | | | | Examination (Theory/Practical) | : | 75 Marks |
| | | | | Total | : | 100 Marks |
| | | | | Duration of Examination | : | 3 Hours |

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**UNIT I**

Fuel Analysis:Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

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.

Boilers: Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.FBC Boilers: Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

Steam System: Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration: Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

**UNIT III**

Waste Heat Recovery: Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

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

**UNIT IV**

Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air Types and Performance Evaluation, Efficient System Operation, Cooling Towers Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

**Text books/References**

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P gm Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta , Element Of Fuel Furnaces And Refractories, Edition-Second
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**

| L | T | P/D | Credits | | | |
|---|---|---|---|---|---|---|
| 4 | -- | -- | 4 | 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:**

Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

**Unit II**

**Thermal Comfort:**

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

**Passive heating concepts:** Direct gain, indirect gain, isolated gains and suspense **Passive cooling concepts:** Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;

**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**

**Modeling of Building:** Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application. ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments, Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems. **Evaluation methods:** LEED methodology, BEE star rating, GERRHA Methodology **Case Studies**

**Recommended Books**

1. M.S.Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive:
Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood
Cliffs, New Jersey ( 1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-,

London U.K. ( 1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
1. Instructions to Energy Auditors, Vol. - I & Vol. - II –
National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
5. BEE Volume I –Second Edition 2005
6. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

**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.

**LIST OF BOOKS**

FOR

**M.TECH. (ENERGY STUDIES AND ENVIRONMENT MANAGEMENT)**

**CENTER OF EXCELLENCE IN ENERGY AND ENVIRONMENTAL STUDIES**

| S. NO. | TITLE | EDS / AUTHORS | PUBLISHER |
|---|---|---|---|
| 1. | WEALTH FROM WASTE | BANWARI LAL, MRVP REDDY | TERI |
| 2. | RENEWABLE ENERGY RESOURCES, BASIC PRINCIPLES AND APPLICATIONS | GN TIWARI, MK GHOSAL | NAROSA PUBLISHING HOUSE, DARYAGANJ |
| 3. | FINANCIAL EVALUATION OF RENEWABLE ENERGY TECHNOLOGIES | TC KHANDPAL, HP GARG | MCMILLAN INDIA LTD |
| 4. | ESSENTIALS OF ENVIRONMENT STUDIES | KURIAN JOSEPH, R NAGENDRAN | ISBN 81-297-0498-6<br>PEARSON EDUCATION |
| 5. | SOLID WASTE ENGG | P AARNE VESILIND, WILLIAM WORELL, REINHART | THOMSON BROOKS / COLE |
| 6. | ENVIRONMENT ENGG SCI | WILLIAM W NAZAROFF, LISA ALVAREZ COHEN | J WILEY AND SONS, INC |
| 7. | SOLAR ENERGY – PRINCIPLES OF THERMAL COLLECTION AND STORAGE | SP SUKHATAME, JK NAYAK | TATA-MCGRAW HILL PUBLISHERS |
| 8. | FUELS AND COMBUSTION | SAMIR SARKAR | ORIENT LONGMAN |
| 9. | SUSTAINABLE ENERGY | TESTER, DRAKE, GODAY, PETERS, DRISCOLL | PRENTICE HALL OF INDIA |
| 10. | POWER PLANT TECHNOLOGIES | MM ELWAKIL | MCGRAW HILL |
| 11. | INTERNAL COMBUSTION ENGINE FUNDAMENTALS | JOHN B HEYWOOD | MCGRAW HILL BOOK CO |
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