**Institute of Environmental Studies**

 **Kurukshetra University, Kurukshetra**

**Syllabus of**

M. Tech.

**(Energy & Environmental Management)**

**(I – IV Semester)**

**w. e. f. 2016-17**

**INSTITUTE OF ENVIRONMENTAL STUDIES**

**KURUSKHETRA UNIVERSITY, KURUKSHETRA**

**SCHEME OF COURSES& EXAMINATIONS**

**M.Tech. Energy and Environmental Management (EEM)**

**(w.e.f. 2016-17)**

**FIRST SEMESTER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Paper Code** | **Title of Paper** | **Type of Paper** | **Hours/Week** | **Credits** | **Marks** |
| **Internal Assessment** | **Final Examination** | **Total** |
| MEMT-101 | Ecology and Systems Analysis | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-102 | Energy Resources andManagement | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-103 | Energy and Climate Change | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-104 | Research Techniques andQuantitative Methods | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-105 | Practical - I | Core | 8 | 4 | 40 | 60 | 100 |
| MEMT-106 | Practical - II | Core | 8 | 4 | 40 | 60 | 100 |
| **Total** | 24 | 240 | 360 | 600 |

**Note:** Each Theory Final Examination will be of 3 hours and practical examination will be of 6 hours duration.

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**SCHEME OF COURSES& EXAMINATIONS**

**M.Tech. Energy and Environmental Management (EEM)**

**(w.e.f. 2016-17)**

**SECOND SEMESTER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Paper Code** | **Title of Paper** | **Type of Paper** | **Hours/Week** | **Credits** | **Marks** |
| **Internal Assessment** | **Final Examination** | **Total** |
| MEMT-201 | Environmental Assessmentand Management | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-202 | Renewable Energy andTechnology | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-203 | Environmental RemoteSensing & GIS | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-204 | Environmental Biotechnologyand Biofuels | Core | 4 | 4 | 40 | 60 | 100 |
| MEMT-205 | Seminar | Core | 1 | 1 | 25 | - | 25 |
| MEMT-206 | Practical - I | Core | 8 | 4 | 40 | 60 | 100 |
| MEMT-207 | Practical - II | Core | 8 | 4 | 40 | 60 | 100 |
| **Total** | 25 | 265 | 360 | 625 |

**Note:** Each Theory Final Examination will be of 3 hours and practical examination will be of 6 hours duration.

**INSTITUTE OF ENVIRONMENTAL STUDIES**

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**SCHEME OF COURSES& EXAMINATIONS**

**M.Tech. Energy and Environmental Management (EEM)**

**(w.e.f. 2016-17)**

**THIRD SEMESTER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Paper Code** | **Title of Paper** | **Type of Paper** | **Hours/****Week** | **Credits** | **Marks** |
| **Internal Assessment** | **Final Examination** | **Total** |
| MEMT-301 | EL-1A (Energy Conservation and Efficient Systems) | Elective | 4 | 4 | 40 | 60 | 100 |
| EL-1B (Environmental Bioremediation Technology) |
| EL-1C (Environmental Policies, Laws and Impact Assessment) |
| MEMT-302 | EL-2A (Industrial Energy) | Elective  | 4 | 4 | 40 | 60 | 100 |
| EL-2B (Energy from Waste) |
| EL-2C (Environmental Modelling) |
| MEMT-303 | Minor Project/Practical | Core | 8 | 4 | 40 | 60 | 100 |
| MEMT-304 | Summer training (Report and Seminar) | Core | - | 2 | 50 | - | 50 |
| MEMT-305 | Seminar  | Core | 1 | 1 | 25 | - | 25 |
| MEMT-306 | Practical | Elective | 8 | 4 | 40 | 60 | 100 |
| **Total** | 19 | 235 | 240 | 475 |

**Note:** The minor project in the form of summer training (8 weeks) report with some Industry/NGO/Research Institute/ organization will be submitted by the student in the 3rd Semester and the student will give a presentation on the training.

**INSTITUTE OF ENVIRONMENTAL STUDIES**

**KURUSKHETRA UNIVERSITY, KURUKSHETRA**

**SCHEME OF COURSES& EXAMINATIONS**

**M.Tech. Energy and Environmental Management (EEM)**

**(w.e.f. 2016-17)**

**FOURTH SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Paper Code** | **Title of Paper** | **Type of Paper** | **Credits** | **Marks** |
| **Internal Assessment** | **Final Examination** | **Total** |
| MEMT-401 | Dissertation | Core | 10 | - | 250 | 250 |
| MEMT-402 | Seminar on Dissertation | Core | 2 | 50 | - | 50 |
| MEMT-403 | Viva-voce on Dissertation | Core | 2 | - | 50 | 50 |
| MEMT-404 | Progressive Seminar/ Laboratory Development Work | Core | 2 | 50 | - | 50 |
| **Total** | 16 | 100 | 300 | 400 |

**Note:** M.Tech Dissertation will be evaluated by the Internal Supervisor/ Examiner and an External Examiner.

The Dissertation will be based on scientific data collection, analysis and fieldwork.

**ECOLOGY AND SYSTEMS ANALYSIS**

**(w.e.f. 2016-17)**

**MEMT-101**

**Max. Marks: 60 + 40**

**Total Credits- 4**

**Objectives and Outcomes of Course:**

The aim of this course is to make students understand the basic concept of ecology, ecosystem, biological diversity, biomes and biogeochemical cycles, ecosystem disturbances, Energy flow and population dynamics. The students will be able to apply concepts of ecology in better understanding of energy and environment and to understand different biotic interactions and ecological modelling.

**Unit-I**

Introduction : Aims and scope of ecology, biological levels of organization-genes to biosphere, Sustainable development, Ecological sustainability, Ecological footprint, Living planet Index, Human dimensions in ecology

Population ecology: Population and metapopulation, Population growth and regulation, Biotic interactions: Competition, mutualism, parasitism, predator-prey relations.

**Unit-II**

Community structure and organization: Nature of community and continuum, Ecological niche,

Keystone species, Biological diversity, Ecosystem disturbance and succession.

Biome and aquatic systems: Distribution, characteristics, climate and biota.

Natural and anthropogenic disturbances, Invasive species: Ecology, impacts and control.

**Unit-III**

Ecosystem components, Ecosystem processes-photosynthesis and decomposition,

Global C and N cycle, Man’s impact on nutrient cycles.

Energy in biological systems: Biological energy transformations, global distribution of primary productivity, human appropriation of productivity, energy flow models of terrestrial and aquatic systems.

**Unit-IV**

Concept of ecosystem modeling, Ecosystem stability, Cybernetics and ecosystem regulation.

Systems theory, Ecological models: Compartment model, matrix model, statistical model,

Mathematical model, Energy-Circuit Analog Model.

Analytical models in Ecology: logistic model of population growth, Lotka-Volterra model

Models of succession.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Reading:**

1. Begon, M., Harper, J.L. and Townsend, C.R. 1986. *Ecology: Individuals, Populationsand Communities*. Blackwell, Oxford.
2. Chapin, F.S., Matson, P.A. and Mooney, H.A. 2002. *Principles of Terrestrial EcosystemEcology*. Springer-Verlag, New York.
3. Odum, E.P. 1983. *Basic Ecology*, Sanders, Philadelphia.
4. Singh K.P. and. Singh J.S. 1992. Tropical Ecosystems: Ecology and Management. WileyEastern Limited, Lucknow, India.
5. Singh, J.S., Singh S.P. and Gupta S.R. 2015. *Ecology, Environmental Science andConservation,* S.Chand Publishers, New Delhi.

**ENERGY RESOURCES AND MANAGEMENT**

**w.e.f. 2016-17**

**MEMT- 102**

 **Max. Marks: 60+40**

**Total Credits- 04**

**Objectives & Outcomesof Course:**

The course provides students an overview of the basic concepts of energy, non-renewable and renewable energy resources and different management strategies. The students will be able to learn the need of management of energy resources and promotion of use of appropriate management technology in harnessing energy resources.

**Unit-I**

Basic concepts of energy: Theoretical treatment of energy, Laws of thermodynamics, CarnotEfficiency, Energy quality. Energy balance of earth: Sunlight electromagnetic spectrum, Major flows in global hydrological cycle, Ocean-Currents and heat flux, Atmospheric circulation, Earth’s energy budget

**Unit-II**

Energy resources: Non-renewable energy resources, Fossil fuels - origin and development of

coal, types of coal and it reserves, coal - fired power plants - cleaner coal combustion - origin

and reserves of petroleum and natural gas - composition and classification of petroleum -

petroleum refining, Natural Gas origin, composition and storage.

Environmental problems associated with petroleum.

**Unit-III**

Renewable energy resources: New developing renewable energy sources - nuclear fission reactors – fission and fusion power and the environment.

Energy management and its present scenario in India- solar, wind, tidal, geothermal and bioenergy.

**Unit-IV**

Importance of management of energy sources, management of fossil fuel sources, oil crisis and economic development, OPEC Market behaviour, management of oil and natural gas- extraction and processing. New energy polices in India.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Readings:**

1. Barrow, C. J. 2005. *Environmental Management and Development*. Taylor and FrancisGroup, London, New York.
2. Cleveland, C. J. 2008*. Encyclopedia of Energy*, Elsevier, New Delhi.
3. Kothari, D.P., Singal, K.C. and Ranjan, R. 2008. *Renewable energy sources and*

*Emerging technologies*, Prentice hall, New Delhi.

1. Miller, G.T. 1997. *Environmental Science: Working With the Earth*, Wadsworth

Publishing Company, Belmont, California.

1. Singh, J.S., Singh S.P. and Gupta S.R. 2015. *Ecology, Environmental Science andConservation,* S.Chand Publishers, New Delhi.

**ENERGY AND CLIMATE CHANGE**

**w.e.f. 2016-17**

**MEMT-103**

**Max. Marks: 60+40**

**Total Credits- 04**

**Objectives and Outcomes of Course:**

The aim of this course is to provide the knowledge of impacts of uses of different energy resources on environment, recent energy scenarios, global climate change, its impacts and mitigation strategies. The students will be able to understand the trends in energy related carbon emissions, carbon trading and climate change mitigation measures.

**Unit-I**

Energy and carbon emissions, World energy use and current energy scenario, Trends in energy use of oil, coal and gas, Energy use and air quality, Nuclear energy and environment, Fission and fusion, Clean Technology: Environmental Life Cycle Assessment.

**Unit–II**

Global climate change**:** Greenhouse effect, greenhouse gases: sources, trends, radiative forcing, warming potential of gases.

Photosynthetic mechanism and global climate change, Impacts of global warming: Polar ice

caps and melting of glaciers, sea level increase, weather extreme, ecosystems, human health,

coral reef bleaching, surface ocean chemistry, Biogenic calcification in oceans.

**Unit–III**

Tools to study climate change: Climate change modelling and general circulation models.Mitigation strategies for global warming; Biological Carbon Sequestration, Carbon Sequestration in geological formations, role of forests and dry lands in Carbon Sequestration, carbon capture and storage technologies. Geoengineering

Kyoto protocol, CDM and carbon trading.

**Unit-IV**

CO**2** challenge: Contribution by source; contribution by national and international sector;

Carbon intensity and emission scenarios; Global warming as an energy problem;

Energy efficiency; Energy transition and carbon content reduction; impact of climate change on energy demand; environmental impacts of energy consumption. Sustainable low carbon future; role of IPCC .

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Reading:**

1. Cleveland, C. J. 2008. *Encyclopedia of Energy*, Elsevier, New Delhi.
2. Goudie, A. S. and Cuff, D. J. 2002. *Encyclopedia of global change,* Oxford, New York.
3. IPCC (Intergovernmental Panel on Climate Change) 1990. *Climate Change: The IPCC*

*Assessment*. Cambridge University Press, Cambridge.

1. Sorokhtin, O.G.,Chilingar, G.V. and Khilyuk, L.F. 2007. *Global warming and global*

*cooling: Evolution of climate and earth,* Elsevier, Netherland.

1. Fouquet R. 2015, *Handbook on Energy and Climate Change,* Edward Elgar Publishing, UK.
2. Cherian A. 2015, *Energy and Global Climate Change: Bridging the Sustainable Development Divide,* Wiley Publisher, New York.

 **RESEARCH TECHNIQUES AND QUANTITATIVE METHODS**

**w.e.f. 2016-17**

**MEMT-104**

**Max. Marks: 60+40**

 **Total Credits: 04**

**Objectives and Outcomes of Course:**

The course provides the students, knowledge on principles of spectroscopic and chromatographic techniques and their applications in environmental analysis, knowledge on different statistical techniques, sampling and analytical methods for environmental components. The students will acquire skills in handling of instruments, statistical tools, techniques and models.

**Unit - I**

Principles and applications of spectroscopy: UV-Vis, Spectrophotometry, Flame Photometry, Atomic Absorption Spectrophotometry (AAS), Colorimetry, Fluorometry, Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP – AES), Inductively Coupled Plasma – Mass Spectroscopy (ICP – MS).

**Unit - II**

Chromatography: Principles and applications of chromatographic techniques: (a) Paper (b) Thin Layer Chromatography (TLC)(c) Column (d) Gel (e) Gas Chromatography (GC) and (f) High Performance/Pressure Liquid Chromatography (HPLC) Microscopy: Optical, Phase Contrast, Automation method of analysis.

**Unit - III**

Types of data and measurement level; Statistical applications in environmental data analysis, , Measures of Central Location and Dispersion, Probability, Correlation and Regression, Standard error of estimate, Test of significance-t test for mean, difference between two means, variance and correlation coefficients, Chi-square test; Analysis of variance (ANOVA).

**Unit - IV**

Principles of experimental design randomization, replication and local control, Types of experimental design- CRD, RBD, LSD, Simple factorial design; Analysis of experimental designs. Sampling methods for water, air and soil analysis; Methods of vegetation analysis, Methods of estimating plant biomass and productivity, Isolation and enumeration of soil microorganisms, Methods of analysis of soil microbial diversity, Soil enzymes, Soil carbon.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Readings:**

1. Gomez, K.A. and Gomes, A.A. 1984. Statistical Procedures for Agricultural Research, John Wiley and Sons, New York.
2. Hoshmand,A.R. 1998. Statistical Methods for Environmental and Agricultural Sciences, CRP Press, New York.
3. John, W. & Mark, M. (eds). 2004. Environmental Modeling: Finding Simplicity in
Complexity, John Wiley and Sons Inc., New York.
4. Zhang, C. 2007. Fundamentals of Environmental Sampling and Analysis, John Wiley and Sons, New Jersey.
5. Hobart H. Willard, Lynne L. Merritt Jr., John A. Dean, Frank A. Settle Jr. 1988, Instrumental Methods of Analysis (Chemistry), Wadsworth Publishing Company, California.

**ENVIRONMENTAL ASSESSMENT AND MANAGEMENT**

**w.e.f. 2016-17**

**MEMT-201**

**Max. Marks: 60+40**

 **Total Credits: 04**

**Objectives and Outcomes of Course:**

The aim of this course is to impart knowledge on Environmental Impact Assessment process and methodology, impacts of different industries on environment, Environmental Auditing and role of judiciary in environmental protection in Indian context. The students will be able to identify impacts of different industries on environment and understand Environmental Management systems (EMS) and strategies of sustainable development.

**UNIT-I**

National environmental polices-2006, Approaches, objectives, principles and frameworks. Purposes and aims of environmental impact assessment, EIA methodology, EIA processes: Project screening, scoping, base-line data, impact identification: prediction, evaluation, valuation of environmental impacts, mitigation, public participation, presentation, review and decision making, monitoring and auditing.

**UNIT -II**

Environmental Management Plan, Environmental components of EIA.

Environmental procedures in India; Impact, identification and methods, Case studies of EIA of hydroelectric dam and river valley project, Thermal power plants and petroleum exploration,; Types of environmental audits ; Environmental audit and EIA

**UNIT-III**

Energy audits-energy conservations; Provision of energy conservation Act, 2001, List of energy Intensive industries and other establishments, Physical and operational data for the facility, Energy audit procedure, safety considerations, safety checklist, conducting the audit visit in industries .

Primary identification of energy conservation opportunities: Post-audit analysis, energy audit report, energy audit report format, energy action plan. Institutional designs for renewable energy resources.

**UNIT-IV**

Environmental management systems in India, ISO-14001.

Environmental sustainability – dimension and sustainability models. Environmental sustainability indicators, sustainability index, strategies for sustainable development, Traditional knowledge systems for sustainable development.

Introduction to environmental law and environmental protection act in India.

Role of Judiciary in environmental conservation in India.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Readings:**

1. Canter, L.W. 1996. Environmental Impact Assessment. 2nd edition, McGraw–Hill, New York.
2. Glasson, J., Therivel R. and Chadwick A. 1994. Introduction to Environmental Impact

Assessment. UCL Press. London.

1. Morgan, R.K. 2002. Environmental Impact Assessment: A Methodological Perspective,

Kluwer Academic Publishers, London.

1. Morris, P. and Thesivel, R. (Eds.) 2001. Methods in Environmental Impact Assessment.

UCL Press, London.

1. Treweek, J. 1999. Ecological Impact Assessment. Blackwell Science, UK.
2. Christopher S. and Mark Y.2002. Installing Environmental Management Systems.

EarthScan London.

1. Barrow, C. J. 2005. Environmental Management and Development, Taylor and Francis

Group, London and New York.

**RENEWABLE ENERGY AND TECHNOLOGY**

**w.e.f. 2016-17**

**MEMT-202**

**Max.Marks: 60 + 40**

**Total Credits: 4**

**Objectives and Outcomes of Course:**

The aim of this course is to provide the details regarding solar energy, solar photovoltaic conversion, design and analysis of PV cells, and other energy options i.e. wind, nuclear, tidal, geo-thermal, wave and tar and oil shale, biomass energy, biogas, biodiesel and hydrogen. The students will be able to understand energy options and techniques of harnessing and methods of generating energy from organic wastes.

**Unit-I**

Energy alternatives, the solar option, the nuclear option, tar sands and oil shale, tidal energy,

geo-thermal energy.

Solar energy: Solar radiations, solar thermal conversion devices and storage, applications

Solar photovoltaic conversion, Wave energy and Ocean thermal energy conversion, Hydroelectric energy

**Unit-II**

Indirect and direct solar energy conversion

Photovoltaic conversion: Optical effect of pn-junction, design and analysis of PV cell, PV cell fabrication, system design, Solar power heaters

Wind energy: Conversation to wind flow, wind energy converters, commercial wind power development, wind energy storage and transfer.

**Unit-III**

Solar energy collection and storage, Solar energy for industrial process heat.

Industrial process heat- temperature requirement, consumption pattern.

Designing thermal storage, transport of energy, concentrating solar collector system, industrial applications of concentrating collector.

Designs of energy collecters, tracking systems, absorbers and energy concentrators.

**Unit-IV**

Biomass energy: Sources of biomass energy, Petroleum plants, Energy plantations, Production of biogas from organic wastes, biogas plant designing.

Recent trends in biodiesel production. Bio- ethanol production: Lessons from national and international experience.

Energy from organic wastes; recent techniques in bio gas, biodiesel, bio-ethanol, bio-hydrogen fuel.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Reading:**

1. Chaudhuri, S. P. G. 2007. *Renewable Energy in the Sundarbans*, TERI.

2. Holechek, J.L., Cole, R. A., ans Fisher, V. 2000. *Natural resources*, Prentice Hall, New

 Jersey, USA.

3. Kothari, D.P., Singal, K.C. and Ranjan, R. 2008. *Renewable energy sources and
 emerging technologies*, Prentice hall, New Delhi.

4. Podobnik, B. 2006. *Global energy shifts*. TERI press.

5. Sorensen, B. 2006. *Renewable energy*, Elsevier Publication, New Delhi.

 **ENVIRONMENTAL REMOTE SENSING AND GIS**

**w.e.f. 2016-17**

**MEMT- 203**

**Max. Marks: 60+40**

 **Total Credits: 04**

**Objectives and outcomes of Course:**

The course provides students with an introduction to the principles and techniques of remote sensing and geographic information systems (GIS) and the application of these techniques to the various aspects of environment including the earth observation and analysis. The students will be able to understand the information embedded in remotely sensed data, its retrieval and geospatial analysis.

**Unit-I**

Principle, basics and components of Remote Sensing,Electromagnetic spectrum, Atmospheric windows, scattering, Spectral reflectance and emission, Energy-matter interaction. Basic principles of global positioning system, GIS- basic concept.

**Unit – II**

Remote Sensing process, Platforms and sensors used in Remote Sensing; Systems for data collection-Passive and Active Remote Sensing; Microwave Remote Sensing, Multispectral Remote Sensing, concept of Lidar Remote sensing and its applications.

**Unit-III**

Elements of visual image interpretation, Digital image Classifications, Procedures and Map accuracy, , Ground truthing, Geo-referencing, image rectification and Digital image processing. Photogrammetry: Basic concepts, Types of aerial photographs, Application of Remote Sensing in Energy, Natural Resources Management, environmental management, Disaster management and urban planning etc.

**Unit-IV**

Data structure: Raster and Grid data, Analytical modeling in GIS- A general account. GIS project design and management, problem identification, implementation, evaluation. GIS application in natural resource management, biodiversity and gap analysis, Environmental impact assessment, solid waste management and disaster management.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Readings:**

1. James B. Campbell and Randolph H. *Introduction to remote sensing*, Wynne, Guilford Press (5th ed., 2011), New York.
2. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman. *Remote Sensing And Image Interpretation,* 7th Ed., 2015, John Wiley & Sons, USA.
3. An Introduction to Geographical Information Systems, Heywood Ian, Pearson Education India, 2010, New Delhi.
4. Harvey F.*A Primer of GIS: Fundamental Geographic and Cartographic Concepts*, TheRawat Publication; 2009 edition (2009).

**ENVIRONMENTAL BIOTECHNOLOGY AND BIOFUELS**

**w.e.f. 2016-17**

**MEMT-204**

**Max. Marks: 60+40**

 **Total Credits: 04**

**Objectives and Outcomes:**

The proposed course is designed to teach students, the microbiological and biotechnological principles of treatment technologies forclean-upof contaminated environments and to recover the valuable resources for the welfare of human society. The students will able to understand theapplications of environmental biotechnology in the different areas of bioremediation, biofuel production and biorefineries.

**Unit-I**

Microbes and environmental management

Biodegradation of macromolecules and xenobiotics,

Bioremediation techniques: aerobic and anaerobic, Bioremediation of metal contaminated sites and spilled oil, Biosorption, Bioaccumulation, Bioleaching and Biomining for recovery of resources,Phytotechnology

**Unit-II**

Biosensors in detection of Environmental Pollution – BOD sensor, Methane biosensor, Ammonia and nitrate biosensor.Bioreactors designs, types and environmental applications.

Micropropagation and cloning of plants – application in forestry; Biotechnology in preservation of bio-diversity; Cryopreservation and Gene banks.

**Unit-III**

Wastewater treatment technologies; Biological Processing of waste water, Biotechnology for solid, hazardous and radioactive waste management, Biodegradable plastics

Biotechnology for wasteland management; Biofertilizers and Biopesticides and IPM.GMO’s and Biosafety guidelines. IPR and environment

**Unit-IV**

Biofuels: Biodiesel fuels, their origin, chemical and physical properties; Biodiesel production; Advantages and disadvantages of biodiesel; Storage and use of biodiesel; Bioethanol production, properties and its limitations.

Biorefinery concept – biomass derived chemical products.

Biomass gasification; Policy issues in biofuels, Indian Biofuel Programme.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Readings:**

1. Armstrong, F. and Blundell, B. K. 2007. *Energy……beyond oil*, Oxford, New York.
2. Bhojvaid, P.P. 2007. *Biofuels Towards a Greener and Secure Energy Future* Teri Press, New Delhi.
3. Buchanan, G. and Jones 2004. *Biochemistry and Molecular Biology of Plants,* IK International Pvt. Ltd., New Delhi.
4. Kaushik, N. 2004. *Biopesticides for Sustainable Agriculture, Prospects and Constraints* TERI Press, New Delhi.
5. Nelson, G.C. 2001. *Genetically Modified Organisms in Agriculture: Economics and Politics*. Academic Press.
6. Spiros, N.A. and Reineke, W. 2002. *Biotechnology for the Environment: Soi Remediation*, Kluwer Academic Publishers, Springer-Verlag , New York.

**ENERGY CONSERVATION AND EFFICIENT SYSTEMS**

**w.e.f. 2016-17**

**MEMT- 301 (EL-IA)**

**Max.Marks: 60+40**

**Total Credits: 04**

**Objectives and Outcomes of Course:**

The course provides the students, knowledge on principles and practices of energy conservation, renewable energy systems and efficiency of various energy related processes.The students will be able to learn about global/local energy issues, opportunity and techniques of saving energy, energy auditing for applications in industries and research.

**Unit –I**

Conservation of energy: overview, concept and principle of energy conservation, Laws of Thermodynamics, Energy conservation as preservation of resources, Conservation measures for energy, Energy scenario: energy pricing in India, energy sector reforms, managing an effective energy conservation programme, Material and energy balance.

**Unit-II**

Energy efficiency: introduction, definition and importance, benefits of energy efficiency, potential for energy efficiency, industrial energy efficiency, The effect of efficiency improvement on primary energy demand, Energy distribution, generation and Demand Side

Management (DSM).Energy analysis.

**Unit-III**

Sustainable energy technologies and energy efficiency, Energy intensity, Pathways to improve energy intensity.Cogeneration, concept, options (steam/gas, turbine, diesel engine based), Reduction of energy loss, energy recovery, urban ecosystems and quality of environment. Energy efficiency in buildings (green building and built up area), Passive solar heating, low and high temperature solar water heating, Photovoltaics

**Unit-IV**

Wind power, Wave tidal power and technologies for use. Biomass and technologies, geothermal, nuclear, alternative transport, hydrogen economy, energy efficient motors, windows, lighting. Energy consumption in pumps, fans, compressed air systems, refrigeneration and air conditioning system and energy saving opportunities with energy efficiency, waste heat recovery. Bureau of energy efficiency and star rating.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Reading:**

1. Cleveland, Cutler J. 2008. *Encyclopedia of Energy*, Elsevier, New Delhi.
2. Kothari. D.P., Singal, K.C. and Ranjan, R. 2008. *Renewable Energy Sources and*

*Emerging Technologies,* Prentice hall, New Delhi.

1. Kreithand F., Goswami D.Y., *Handbook of Energy Efficiency and Renewable Energy*,

C.R.C. Press.

1. Kreith. F., Goswami. D.Y.2007. *Handbook of Energy Efficiency and Renewable*

*Energy*, Taylor & Francis Group, LLC

1. Owen, Oliver S. and Chiras, Daniel D. (1990). *Natural Resource Conservation-An*

*Ecological Approach* Macmillon, New York.

1. Wiley J.S., Turner W.C., *Energy Management Handbook*.

**Environmental Bioremediation Technology**

**W.e.f. 2016-17**

**MEMT-301 (EL-IB)**

**Max. Marks: 60 + 40**

**Total Credits-04**

**Objectives and Outcomes of Course:**

The aim of this course is to make students understand biotransformation, biodegradation of Xenobiotics, bioremediation strategies and their applications. The students will be able to understand the various applications of bioremediation technologies and the kinetics and modelling of biodegradation.

 **Unit-I**

Introduction to bioremediation, Historical development of environmental bioremediation,

Requirements for bioremediation, Constraints and priorities of bioremediation, Applications of bioremediation technologies.Xenobiotic compounds, their structure and persistance in environment, Oil spills, Oil products in environment. Biodegradation- principles and mircobiology; Microconversions of xenobiotics

 **Unit-II**

Biotransformation of pesticides and hydrocarbons, Biodegradation kinetics, Bioavailability,

Biomineralization, Testing for biodegradability, Numerical modelling of biodegradation.

Biological processing of waste water, Bioreactors – designs used for treatement of sludge and

removal of metals from waste water. Biodegradable plastic, Biodegradation of PAH in

environment.

 **Unit-III**

Bioremediation strategies – biostimulation and bioaugmentation, Bioremediation techniques *in-situ* and*ex-situ*. Bioremediation of organic and metal contaminated environments. Metal toxicityand bioavailability. Biosorption and precipitation.Bioremediation technologies for heavy metaland radionuclides removal.Phytoremediation and its processes, role of phytochelatins.Applications of genetic engineering in phytoremediation. Algal and fungal based bioremediation.

 **Unit-IV**

Gaseous bioremediation, biofilms, bioscrubbers, bioventing, Soil Vapour Extraction (SVE),

Water recirculation systems, Air sparging, Biobarriers, Composting, Phytoremediation for air technologies.Role of biosensors in bioremediation technologies, Biofilms and their applications.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Reading:**

1. Scragg A., 2008. *Environmental Biotechnology*, Oxford Univesity Press. New

York

1. Singh S.N., Tripathi R.D., 2007. *Environmental Bioremediation Technologies*,

Springer, New York.

1. Mohapatra P.K. 2007. *Textbook of Environmental Biotechnology*, I.K. Publishing

House, New Delhi.

1. Olguin E.J., Sanchez G., Hernandez E. 2005. Environmental Biotechnology and

Cleaner Processes, Replika Press, Kundli.

1. Trivedi P.C. 2008. Pollution and Bioremediation, Sheetal Printer, Jaipur, India.

**ENVIRONMENTAL POLICIES, LAW AND IMPACT ASSESSMENT**

**w.e.f. 2016- 17**

**MEMT- 301 (EL - IC)**

**Max.Marks: 60+40**

**Total Credits: 04**

**Objectives and outcomes of Course:**

The aim of the course is to make the students understand the environmental policies and planning, environment impact assessment and environment clearance process. The course will enable students to apply the knowledge of EIAand environment clearance for systematic assessment of industrial and infrastructural projects.

**Unit –I**

National and International environmental issues**,** International Conventions and Agreements on environmental issues: UNFCCC, Stockholm Conference, The Rio Earth Summit 2012 (Rio +20), Convention on Climate Change, Agenda 21, Kyoto Protocol, Montreal Protocol, Convention on Biological diversity, Ramsar Convention on Wetlands, The Environmental (Protection) Act1986, The Biological Diversity Act, 2002,Wild Life (Protection) Act, 1972.

**Unit- II**

Approaches, objectives, principles and frameworks of: Air (Prevention & control of pollution)Act, 1981, Motor Vehicle Act, 1988, The water (Prevention & control) Pollution Act, 1974,Solid wastes (Management and Handling) Rules, 2000, Coastal Regulation Zone Notification1991, Disaster Management Act, 2005. CPCB,BIS and APHA standards for air, water and soil; Scheme of labelling of Environment friendly product (Eco mark).

**Unit – III**

Energy policies in the country; Tariffs and subsidies; Energy utility interface; National Energy Plan, Energy Investment Planning & Energy pricing, Concept of Energy & Environment Management System (EEMS), Role of modelling in energy policy analysis, Role of BEE(Bureauof Energy Efficiency) in energy conservation.

**Unit –IV**

Environmental Impact Assessment, EIA guidelines of Ministry of Environment and Forest(MoEF), Strategic Environmental Assessment and Cumulative Effects Assessment, Preparation of ISO Manuals for Industry; Integrating ISO 9000, ISO 14001 and OHSAS 18001, GRIHA(Green Rating for Integrated Habitat Assessment) - Guidelines.

Case studies: EIA for Metro Stations, IT Parks, Nuclear Power Plant and Infrastructure.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Reading:**

1. Kathryn L. Schroder 2008 *Environmental Law* Thomson Delmar learning, New York.
2. Karen E. Makuch, Richard Pereira 2012. *Environmental & Energy Law* Wiley- Blackwell, UK.
3. MEA 2005. *Ecosystems and Human Well-being: health synthesis, a report of the WorldResources Institute,* Washington, D.C.
4. Singh, J.S., Singh S.P. and Gupta S.R. 2015. *Ecology, Environmental Science andConservation,* S.Chand Publishers, New Delhi.

**INDUSTRIAL ENERGY**

**w.e.f. 2016-17**

**MEMT-302 (EL - IIA)**

**Max. Marks: 60 + 40**

**Total Credits- 4**

**Objectives and Outcomes of Course:**

The aim of this course is to enable the students to understand different aspects of energy conservation and recovery systems in industries. The students will able to understand energy efficiency practices and technologies that can be applied at the component, process, facility, and organizational levels.

**Unit-I**

Types of energy; Energy conversion steps; Energy use in industrial operations; Energy

conservation potential in various industries and commercial establishments - Energy intensive

industries - an overview; End use energy efficiency.

Energy Storage Systems - storage of mechanical energy, electrical energy, chemical energy,

thermal energy; Industrial safety measures.

**Unit-II**

Industry energy systems, Properties of steam - Steam distribution (Assessment of steam

distribution losses, Steam leakages, Steam trapping) - Condensate recovery and flash steam

utilisation system. Identifying opportunities for energy savings.Thermal insulation.boiler –

efficiency testing, excess air control, steam boiler monitoring.

Electrical Systems: Demand control, power factor correction, load scheduling/shifting. Lighting, lighting levels, efficient options, fixtures, day lighting, timers, Energy efficient windows.

**Unit-III**

Waste Heat Recovery: Recuperators, regenerators, heat pipes, heat pumps. Cogeneration -

concept, options (steam/gas turbines/diesel engine based), selection criteria, control strategy.

Heat exchanger networking - concept of pinch, target setting, problem table approach, composite curves. Demand side management.

Energy conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration andair conditioning systems, boilers, and furnaces.

**Unit-IV**

Hydrogen fuel technology- production of hydrogen from electrolysis and photochemical

methods, hydrogen storage technologies, fuel cell systems, hydrides as fuels.

Energy Saving Measures in Energy Intensive Process Industries − Pulp and Paper, Sugar,

Textile, Fertilizer and their case studies. Chemical, Petrochemical Processes, Chlor-Alkali and

their case studies. Aluminum, Iron and Steel, Cement and their case Studies; Railways, Ports,

Transport Sector, Power Stations and their case studies.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Reading:**

1. Zoran K. Morvay and Dusan D. Gvozdenac,2008 “Applied Industrial Energy and Environmental Management”, John Wiley.
2. Guide book for “National Certification Examination for Energy Managers and Energy

Auditors” 2007, Dr.Ambedkar Institute of Productivity, National Productivity Council, Chennai.

1. Doty S. and TurnerW.C., 2012,“Energy Management Handbook” Eighth Edition, Wiley Eastern Publication, New York.
2. Dryden I.G.C. 1982, *“The Efficient Use of Energy”*, Butterworths, London,.

**ENERGY FROM WASTE**

**w.e.f. 2016-17**

**MEMT-302 (EL-2B)**

 **Max.Marks: 60+40**

**Total Credits: 04**

**Objectives and Outcomes of Course:**

The aim of this course is to give information about different sources of the waste which can be utilized in efficient energy generation. The students will get opportunity to know about the biochemical conversions, Thermochemical conversions, biomass gasification and bioethanol production, generation of energy from the waste and their environmental impacts.

**Unit-I**

Definition, classification & sources of waste; physical, chemical and biological properties of waste as a fuel; Waste handling before thermal conversion, Preparation of recycled fuel, Mass combustion of waste, Combustion of recycled fuel.Emission reduction during combustion.

**Unit-II**

Technologies for solid waste disposal and recovery of energy from municipal solid waste and industrial waste, Organic waste blending systems, Utilization and treatment of fly ash, land-fill gas utilization in energy production.

Energy generation from waste: Refuse Derived Fuel RDF - waste to energy- design and fuel analysis.

**Unit-III**

Biochemical conversions: sources of energy generation: industrial waste, agro residues; anaerobic digestion biogas production; types of biogas plant Thermochemical conversions: sources of energy generation, Industrial applications of gasifiers, Briquetting; utilization and advantages of briquetting; Environmental impacts of biochemical and thermochemical conversion.

**Unit-IV**

Biomass: procedures of characterization, Integrated biomass gasification for electricity generation. Bio-energy as byproduct of waste processing, bioenergy assessment; biomethanation from sludge digestion, types of reactors, UASBR (Upper Anaerobic Sludge Blanket Reactor), Biorefinery concept.

Alcohol fuels: vegetable oil as fuels, bioethanol production and technology; biodiesel, biohydrogen technology: potential of organic waste for hydrogen production; biofuel refining and technology; commercial biomass energy markets and economics**.**

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Readings:**

1. Lal B., Reddy MRVP, 2005. *Wealth from Waste*, Rajkamal Electric Press, Delhi.
2. Cleveland C.J., 2008. *Encyclopedia of Energy*, Elsevier, New Delhi
3. Bhatia S.C., 2007. *Solid and Hazardous Waste Management*, Nice Printing Press, Delhi.
4. Wall J.D., Harwood C.S., Demain A., 2008. *Bioenergy*, Printed in USA.

**ENVIRONMENTAL MODELLING**

**w.e.f. 2016-17**

**MEMT- 302 (EL-2C)**

**Max. Marks: 60+40**

 **Total Credits: 04**

**Objectives and Outcomes of Course:**

The course provides students with advance knowledge on predictive and forecasting modelling tools and techniques to be used in environmental and energy systems and for their analysis. The students will develop a broader understanding of tools of environmental modelling and techniques used for applications in predictive and forecasting services.

**Unit I**

Principles of model development & solution for environmental systems (air, water and soil), Basic steps in the model development: problem definition, model design and development & evaluation. Concept of system, sub-system, system modeling and simulation.Simple and complex calculation models, linear vs. non-linear models, Time series analysis.

**Unit II**

Optimization models and their evaluation, Probabilistic methods for modeling: weibull, gamma and lognormal models. Predictive and Forecasting modeling of air pollution, hydrology and climate change. Gaussian plume model, gradient transport, eddy diffusion modeling, modelling fugitiveemissions,

**Unit III**

Modeling of Spatio‐Temporal Dynamics, Surface water modeling: DO sag model, BOD model, Eutrophication model, Elements of groundwater modeling, Case study: predicting the mixing and dispersion of air pollutants in the environment, GIS-based human exposure modeling system for traffic air pollution.

**Unit IV**

Model applications in the area of climate change,air and water pollution, biodiversity, and natural resource management. Forecast service, Social and economic aspects of environmental modelling, Role of modeling in energy policy analysis.

**Note:-**

For final theory exam, time allotted will be of 3 hours and nine questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each Unit.

**The candidates will be required to attempt Q.No.1 and any four, selecting one question from each unit. All the questions will carry equal marks.**

**Suggested Readings**:

1. John, W. and Mark, M. (eds). 2004. Environmental Modeling: Finding Simplicity in Complexity, John Wiley and Sons Inc., New York.
2. Andrew Ford, 2009. Modeling the Environment, Island Press; 2 edition
3. Jo Smith, Peter Smith, 2007. Environmental Modelling: An Introduction. Oxford University Press.
4. Fung, F., Lopez, A. and New, M. (eds.). 2011. Modelling the impact of climate change on water resources. Willey-Blackwell Ltd., U.K.
5. Barnsley, Michael, J. 2007. Environmental Modelling: A practical introduction. CRC Press, USA