Kurukshetra University, Kurukshetra
Institute of Environmental Studies

M. Sc.
(Environmental Science)

Scheme and Syllabus
(Based on CBCS-LOCF Pattern)
(Effective from 2020-21 in phased manner)

Faculty of Life Science, KUK
(August, 2020)

VISION AND MISSION OF THE INSTITUTE

To contribute to environmental sustainability and wise use of natural resources for the benefit of society through education, research, outreach and networking on the environment.

Programme Outcomes (POs) for PG courses of Faculty of Life Sciences

The PG Courses of Faculty of Life Sciences will be able:

PO1 To acquaint students with recent knowledge and techniques in basic and applied biological sciences.

PO2 To develop understanding of organismal, cellular, biochemical and environmental basis of life.

PO3 To provide insight in to ethical implications of biological research for environmental protection and good laboratory practices and biosafety.

PO4 To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.

PO5 To understand application of biotic material in health, medicine, food security for human well being and sustainable development.

PO6 To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self reliance

Programme Specific Outcomes of M.Sc. (Environmental Science)

PSO1 To contribute to Environmental Sustainability and wise use of Natural Resources for benefit of society through education and research on environment with a multidisciplinary and professional approach

PSO2 To provide knowledge on Ecology, Biodiversity Conservation, Remediation and Restoration

PSO3 To create awareness on Pollution, Climate Change, Ecotoxicology and their linkages to human health

PSO4 To educate students on Environmental Impact Assessment, Monitoring and Policy frameworks

PSO5 To give knowledge on concepts, tools and modern techniques for Environmental Analysis and Management

PSO6 To educate students on Natural Resource Management and Economics for Sustainable Development.

KURUKSHETRA UNIVERSITY KURUKSHETRA
INSTITUTE OF ENVIRONMENTAL STUDIES
SCHEME OF EXAMINATION FOR
M.Sc. ENVIRONMENTAL SCIENCE

First Semester

Paper code	Title of Paper	Type of paper	Hours/ week	Credits	Internal Assessment	Final Exam	Total Marks
MES-101	The Biophysical Environment	Core	4	4	20	80	100
MES-102	Environmental Chemistry	Core	4	4	20	80	100
MES-103	Ecology and Ecosystem Dynamics	Core	4	4	20	80	100
MES-104	Environmental Modelling and Statistics	Core	4	4	20	80	100
MES-105	Practical-I	Core	8	4	20	80	100
MES-106	Practical-II	Core	8	4	20	80	100
	Semester Total			24	-		600

Note 1: Each core paper final examination will be of 3 hours and practical examination will be of 6 hours duration.

Note 2: The practical classes will be held in two groups.

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M.Sc. ENVIRONMENTAL SCIENCE

Second Semester

Paper code	Title of Paper	Type of paper	Hours /week	Credits	Internal Assessment	Final Exam	Total Marks
MES-201	Natural Resource Management	Core	4	4	20	80	100
MES-202	Conservation and Biodiversity	Core	4	4	20	80	100
MES-203	Pollution and Global Climate Change	Core	4	4	20	80	100
MES-204	Environmental Methods and Analytical Techniques	Core	4	4	20	80	100
MES-205	Seminars	Core		1			25
MES-206	Water Resource Management	Open Elective	2	2	10	40	50
MES-207	Practical-III	Core	8	4	20	80	100
MES-208	Practical-IV	Core	8	4	20	80	100
	Semester Total			27			675

Note 1: Each core paper final examination will be of 3 hours and practical examination will be of 6 hours duration.

Note 2: The practical classes will be held in two groups.

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Third Semester

Paper code	Title of Paper	Type of paper	Hours/ Week	Credits	Internal Assessment	Final Exam	Total Marks
MES-301	Environmental Biotechnology	Core	4	4	20	80	100
MES-302	Remote Sensing and Geographical Information Systems	Core	4	4	20	80	100
MES-303	Ecotoxicology and Environmental Health	Core	4	4	20	80	100
MES-304	(EL-1A) Environmental Planning , Policy and Law (EL-1B) Waste Management	Elective	4	4	20	80	100
MES-305	Summer training (Report +Seminar)	Core	2	2	10	40	50
MES-306	Global Climate Change	Open elective	2	2	10	40	50
MES-307	Practical-V	Core	8	4	20	80	100
MES-308	Practical-VI	Core + Elective	6	3	15	60	75
	Semester Total		34	27	-		675

Note: (a) Each core paper final examination will be of 3 hours and practical examination will be of 6 hours duration.

(b) The minor project in the form of summer training (4-5 weeks) 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.

(c) The practical classes will be held in two groups.

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M.Sc. ENVIRONMENTAL SCIENCE

Fourth Semester

Paper code	Title of Paper	Type of paper	Hours /week	Credits	Internal Assessment	Final Exam	Total Marks
MES-401	Agroecology and Agroforestry	Core	4	4	20	80	100
MES-402	Environmental Impact Assessment and Auditing	Core	4	4	20	80	100
MES-403	Ecotechnology and Ecological Restoration	Core	4	4	20	80	100
MES-404	(EL-II A)Ecological Economics (EL-II B) Environmental Health and Industrial Safety	Elective	4	4	20	80	100
MES-405	Practical-VII	Core	8	4	20	80	100
MES-406	Practical- VIII/ Dissertation	Core	8	4	20	80	100
	Semester Total			24	-		600

Note: (a) Each core paper final examination will be of 3 hours and practical examination will be of 6 hours duration.

(c) M.Sc. Dissertation will be based on scientific data collection, fieldwork as well as community participation and will be evaluated by the Internal Supervisor/Examiner and an External Examiner.

(d) The practical classes will be held in two groups.

MES -101: THE BIOPHYSICAL ENVIRONMENT

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is to give information about the various aspects of biophysical components of the environment. This course gives opportunity for the students to learn about all components of physical environment including earth science, soil, atmosphere and aquatic ecosystem along with their interaction.

Outcomes: On successful completion of this course, the students will be able:

CO1. To acquire the knowledge and understanding of structure, functions and distribution of different components of the environment.
CO2. To have in-depth knowledge of the process of origination of earth with help of various theories.
CO3. To analyze how tectonic movement is responsible for various geographical features such as mountains, earthquake, volcanoes, trenches etc.
CO4. To understand the complex interactions between the land surface, atmosphere, water movement and life (flora and fauna) in sustaining the earth's biophysical environment.
CO5. To gather information about various parameters of meteorology and be able to predict their role in weather prediction and climate science.
CO6. To classify the various biogeographical zones and learn their distribution in the world.
CO7. To apply the knowledge of soil science, aquatic science and climate science to resolve present day environmental issues.
CO8. To appraise how anthropogenic factors and natural factors modify the biophysical environment.

Note:-
For final theory exam time allowed 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.

UNIT-1

Environmental Science: Introduction, Principles and scope; environmental issues: local and global scales; man-made and natural hazards; Environment and sustainability
Environmental Education: Introduction, principles and scope; Role of NGOs in Environmental protection; environmental ethics.

UNIT-II

Earth System: Origin structure and compositions; geological time scale; basic concept of plate tectonics and continental drift.
Soil formation processes: weathering and erosion; transport and deposition of earth's material by running water, wind, glaciers. Thermal, magnetic and gravitational fields of earth.

UNIT-III

Atmosphere: Composition and structure; heat budget, lapse rate , thermal inversion and mixing height; cloud formation, winds, coriolis force; waves and currents; ocean circulation and global pressure belt system, El nino, La nina and monsoons,
Applied aspects of meteorology: weather and climate, spatial scales (micro, meso, synoptic and global scales), wind roses.

UNIT-IV

Environmental components and their interactions; aquatic ecosystem: Classification, salient features of fresh and marine ecosystems; Basic concepts of floristic realms and biogeographical regions; biogeographical regions of India.

Suggested Readings:

1. Botkin, D.B. and Keller E.A (2004). *Environment Science: Earth as a Living Planet*. John Wiley & Sons Inc., New York.
2. Robert E. Ricklefs (2001). *The Ecology of Nature*. Fifth Edition, W.H. Freeman and Company.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*, S. Chand Publishing, New Delhi.
4. Steffen, W., Sanderson, A., Tyson, P.D., Jager, J., Matson, P.M., Moore, III, B., Oldfield, F., Richardson, K., Schnellnhuber, H.J., Turner, II, B.L. and Wasson. R.J (2004). *Global change and the Earth System: A Planet under Pressure*. Springer-Verlag, New York, New York, USA Reference books.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MES- 101

MES 101	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	-	-	-
CO2	3	-	-	-	-	-
CO3	2	3	-	-	-	2
CO4	3	1	2	2	3	-
CO5	2	-	1	1	-	-
CO6	1	-	-	-	-	-
CO7	2	2	2	3	2	2
CO8	1	1		3	-	-
Average	2.1	2	1.7	2.25	2.5	2

CO-PSO MAPPING for MES- 101

MES 101	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	-	-	-	-	-
CO2	2	-	-	-	-	-
CO3	2	-	-	2	2	-
CO4	3	2	2	3	1	2
CO5	2	-	3	2	2	-
CO6	2	3	-	-	-	-
CO7	2	1	3	3	3	3
CO8	1	2	3	2	2	1
Average	**2.1**	**2**	**2.8**	**2.4**	**2**	**2**

MES -102: ENVIRONMENTAL CHEMISTRY

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The course provides students an introduction to chemical processes that regulate the composition of air, water, and soil so as to understand the photochemical reactions in atmosphere and how they are influenced by human actions. The students can develop analytical and conceptual skills required for research in environmental chemistry.

Outcomes: On successful completion of this course, the students will be able to:

CO1: Obtain basic knowledge about rock forming minerals and deposits.
CO2: Develop understanding on the concept of soil composition, properties and chemistry in detail.
CO3: Learn about composition and photo-chemical reactions in the atmosphere.
CO4: Develop understanding about atmospheric reactions, greenhouse gases and global warming.
CO5: Obtain knowledge about water structure, composition**,** standards and aquatic microbial chemistry.
CO6: Analyze & apply the concept of thermodynamics, laws and heat transformation processes in different spheres of environment.

Note:-
For final theory exam time allowed 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.

UNIT-I

Lithosphere and Soil chemistry: Chemical composition of the earth, origin of mineral deposits and fossil fuels, major rock forming minerals, elements and isotopes.
Soil Profiles, chemical and mineralogical composition of soils; soil organic matter, soil nutrients; soil properties of fundamental importance in soil management.

UNIT-II

Atmospheric Chemistry: Chemical composition of atmosphere- atmospheric water and CO_2; ions and radicals in atmosphere, formation of particulate matter, Photo-chemical and chemical reactions in the atmosphere, thermal inversion, particles in atmosphere; photochemical smog, acid rain, chemistry of ozone layer depletion; greenhouse gases and global warming.

UNIT III

Aquatic Chemistry: Structure and properties of water; water quality parameters, standards, chemistry of inland water bodies- lakes, streams, rivers estuaries and wetlands, solubility of gases in water, carbonate system in water, redox reaction (oxidation-reduction); aquatic microbial chemistry-a brief account.

UNIT IV

Interaction between atmosphere, hydrosphere and lithosphere; Enthalpy and First law of thermodynamics, adiabatic transformations, entropy and second law of thermodynamics,

absolute temperature, Carnot's cycle, Gibbs force energy, chemical potential, third law of thermodynamics, Gibb's - Donnan membrane equilibrium, phase equilibrium.

Suggested Readings:

1. Botkin, D.B. and Keller E.A (2004). *Environment Science: Earth as a Living Plant.* John Wiley & Sons Inc., New York.
2. Manahan, S.E. (2000). *Environmental Chemistry*. Seventh Edition. Lewis Publishers, New York
3. Mitsch, W.J. and Jorgensen, S.E. (eds.) (1989). *Ecological Engineering: An Introduction to Ecotechnology*. John Wiley and Sons, New York.
4. Pierzynski, G.M., Sims, J.T. and Vance, G.F. (2000). *Soils and Environmental Quality*. Second Edition. CRC press, New York.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*, S. Chand Publishing, New Delhi.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MES- 102

MES 102	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	2	1	-	-
CO2	-	1	2	1	2	1
CO3	2	1	2	1	-	-
CO4	2	2	2	1	-	1
CO5	3	2	3	1	3	1
CO6	2	1	-	1	-	2
Average	**2.3**	**1.3**	**2.2**	**1**	**2.5**	**1.3**

CO-PSO MAPPING for MES- 102

MES 102	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	-	-	-	-	1
CO2	2	-	-	-	-	2
CO3	1	-	-	1	-	1
CO4	2	-	3	-	1	-
CO5	2	2	1	2	1	2
CO6	1	-	-	-	2	-
Average	**1.5**	**2**	**2**	**1.5**	**1.3**	**1.5**

MES -103: ECOLOGY AND ECOSYSTEM DYNAMICS

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is to make students understand the basic concepts of ecology, structure and function of ecosystems and concepts of energy flow, biogeochemical cycles, community ecology and succession. The students will develop understanding of concepts of ecosystem development and significance of biotic interactions and ecosystem stability.

Outcomes:

CO1: Students will be exposed to the fundamental aspects of ecology.
CO2: Students will have in-depth knowledge about biotic and abiotic factors that are related to individual, population, community and ecosystem, as well as interrelationships
CO3: The students will understand and be able to analyze evolutionary changes and environmental adaptations.
CO4: Students will understand the concept of different food interactions, trophic levels, enegy transfer, energy flow and sedimentary cycles.
CO5: Student will analyze the importance of various ecosystems such as territorial ecosystems, freshwater ecosystems, ocean ecosystems and wetlands.

Note:-
For final theory exam time allowed 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.

UNIT-I

Introduction : Aims and scope of ecology, biological levels of organization-genes to biosphere; tolerance range and limiting factors, adaptations, ecotypes and ecads.
Population ecology: Characteristics, evolutionary strategies r and k selection; population growth and regulation, Species Interactions: Competition, mutualism, parasitism, predator-prey relations, allelopathy, behavioural ecology-a brief account.

UNIT-II

Community structure and Organization**:** nature of community, life-forms, vertical and horizontal stratification; functional role and niche, keystone species, ecotone and edge-effect; plant-animal interaction.
Ecological Succession –concept, primary and secondary succession; concept of climax and types of climax; changes in ecosystem properties during succession.

UNIT-III

The Ecosystem concept, biotic and abiotic components; ecosystem processes-photosynthesis and decomposition; ecological pyramids, food webs, trophic levels, energy transfer, ecological efficiencies, models of energy flow.

Biogeochemical cycles, gaseous and sedimentary cycles-carbon cycle, nitrogen cycle, sulphur cycle and phosphorus cycle, Man's impact on nutrient cycles.

UNIT-IV

Biome and aquatic systems- distribution, characteristics, climate and biota.

Distinguishing characters of forests, grasslands, and arid lands.

A brief account of lakes and wetlands, and coral reefs.

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

Suggested Readings:

1. Brewer, R. (1994). The Science of Ecology, Sanders College Publishing Co., Tokyo.
2. Lieth, H. and Whittaker, R.H. (Eds). (1975). *Primary Productivity of the Biosphere.* Springer-Verlag, New York.
3. Odum, E.P and Barrett, G.W. (2004). Fundamentals of Ecology. 5th edition. Thomson Brooks/Cole, Belmont, California.
4. Odum, E.P. (1983). *Basic Ecology*, W.B. Saunders, Philadelphia.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology*, *Environment and Resource Conservation*, S. Chand Publishing, New Delhi.
6. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.
7. Townsend, C.R., Begon, M. and Harper, J.L. (2003). *Essentials of Ecology*. Second Edition. Blackwell Publishing, Oxford.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MES- 103

MES 103	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	-	-	-	-
CO2	1	3	1	-	-	-
CO3	1	2	2	2	2	1
CO4	3	2	1	-	2	-
CO5	2	2	2	2	2	2
Average	**1.8**	**2.4**	**1.5**	**2**	**2**	**1.5**

CO-PSO MAPPING for MES- 103

MES 103	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	1	-	-	1
CO2	2	3	2	-	1	-
CO3	2	2	2	-	-	-
CO4	3	3	2	2	-	-
CO5	3	3	3	1	-	2
Average	**2.6**	**2.8**	**2**	**1.5**	**1**	**1.5**

MES -104: ENVIRONMENTAL MODELLING AND STATISTICS

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The course provides students with an introduction to the knowledge on models, its different types, different statistical technique, and softwares. The students will acquire skills in various statistical tools, techniques and models which will be used for statistical analysis and modeling of environmental systems for applications in research and industrial organizations.

Outcomes: On successful completion of this course, the students will be able to:

CO1. Understand the idea, methodology and basic tools of environmental modeling
CO2. Become aware of different modeling approaches, their scope, limitations and applications
CO3. Gain knowledge about different analytical models and their applications in Ecological Studies
CO4. Describe how basic statistical methods can be used to analyze environmental data
CO5. Have theoretical and practical understanding of different descriptive and inferential statistical tools and techniques to provide meaningful inference from environmental data.
CO6. Gain knowledge about experimental designs and computer graphics.

Note:-
For final theory exam time allowed 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.

UNIT-I

Concept of models and ecosystem modeling; model classification- deterministic models, stochastic models steady state models dynamic models. Different stages involved in model building.
Ecosystem stability, Cybernetics and ecosystem regulation. Ecoinformatics- A brief account and scope in environmental analysis.

UNIT-II

Elementary aspects of System Analysis: Systems theory, ecological models- characteristics and applications, compartment model, matrix model, statistical model, mathematical model, energy circuit analog model. Box model, Gaussian plume model. Analytical models in Ecology: logistic model of population growth; Hardy- Weinberg model; Lotka - Volterra model of competition and predation; models of succession.

UNIT-III

Statistics- Measures of central tendency – Mean, Median, Mode, Geometric Mean and Harmonic Mean, measures of dispersion, moments, standard deviation, variance skewness and kurtosis Basic laws of probability, definition of a random variable and concept of a probability density function; binominal, poison and normal distributions.

UNIT-IV

Principles of experimental design-randomization; replication and local control, randomized block design; application of one-way and two-way analysis of variable. Correlation and linear regression of one independent variable. A basic idea of computer graphics, use of different software; information retrieval and data management.

Suggested Readings:

1. Gomez, K.A. and Gomes, A.A. (1984). Statistical Procedures for Agricultural Research, John Wiley and Sons, New York.
2. Gupta S.C. (1981). Fundamentals of Statistics, Himalaya Publishing House, Mumbai.
3. Hoshmand, A.R. (1998). Statistical Methods for Environmental and Agricultural Sciences, CRP Press, New York.
4. John, W. and Mark, M. (Eds). (2004). Environmental Modeling: Finding Simplicity in Complexity, John Wiley and Sons Inc., New York.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MES- 104

MES 104	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	-	-	-
CO2	3	-	2	2	-	-
CO3	3	1	2	2	-	-
CO4	2	1	3	2	-	2
CO5	2	1	2	2	-	3
CO6	2	-	2	1	-	3
Average	**2.5**	**1**	**2.17**	**1.8**	**-**	**2.7**

CO-PSO MAPPING for MES- 104

MES 104	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	-	-	1	3	1
CO2	3	-	1	-	1	1
CO3	3	3	1	-	3	-
CO4	3	-	3	2	3	-
CO5	3	-	3	2	3	-
CO6	3	3	-	-	-	1
Average	**3**	**3**	**2**	**1.7**	**2.6**	**1**

MES-201 : NATURAL RESOURCE MANAGEMENT

Max. Marks : 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The course provides students a comprehensive review of our natural resources including land, water, energy, mineral, forest, range land, fisheries and marine resources and also economically sustainable forest management designs. The students will be able to understand the importance of natural resource management and market based mechanisms for environment protection.

Outcomes: On successful completion of this course, the students will be able to:

CO1. Understand types, degradation and conservation of resources.
CO2. Acquire knowledge about land resources, soil related issues and their management.
CO3. Develop understanding about water resources and conservation techniques.
CO4. Become familiar with various sources of energy and their environmental impacts in detail.
CO5. Become familiar with mineral resources and their conservation strategies.
CO6. Obtain knowledge about forest resources, deforestation and sustainable forest management.
CO7. Learn about rangelands, medicinal plant resources and marine resources.
CO8. Develop understanding about economic categories of resources, theories and economically sustainable management of resources.

Note:-
For final theory exam time allowed 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.

UNIT -I

Resources: Types, Renewable & non-renewable resources; resource degradation and conservation; Human impact on natural resources.
Land resources: Land degradation and desertification; Soil erosion and control; reclamation & management of waste lands with special reference to India.
Water resources: Pools of water and hydrological cycle; Surface water, ground water,
Human use of freshwater. Rain water harvesting; watershed management

UNIT -II

Energy resources: Fossil fuels, nuclear energy, solar energy, wind energy, tidal energy, geothermal energy, hydropower. Global energy consumption; Environmental impacts of various forms of energy use.
Hydrogen as a source of energy, energy from biomass, bioconversion technology, energy plantations and petro-crops. Bioenergy-Prospects in India.
Mineral resource conservation & recycling, bacterial leaching of metals from low grade ores.

UNIT -III

Forest resources: Forests, their importance, types, global distribution; primary and secondary products, forest resources of India. Impact of deforestation; Sustainable forest Forest Management.
Range lands: Types, uses, grassland types and management in India.
Medicinal plant resources and bioprospecting-a brief account.
Fisheries and Marine resources- a general account; aquaculture

UNIT –IV

Economics, environment and development: Economic categories of resources; the market, environment and natural resources; the economics theory- market, demand and supply relationships.
The limit of growth; cost benefit ratio; natural resources accounting; market based mechanisms for environmental protection.
Economically sustainable forest management designs- green certification, resource conservation, community forest management; ecotourism.
Economic efficient model of sustainable fisheries; designs for renewable energy resources.

Suggested Readings:

1. Brown, L. (2001). *State of the World 2001*. World watch Institute in association with Earthscan, London.
2. Chape, S., Fish, L., Fox, P. and Spalding, M. (2003). *United Nations list of protected areas.* IUCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge
3. Cunningham, W.P. and Cunningham, M.A. (2002*). Environmental Science: Inquiry and Applications.* A Global Concern. Tata McGraw-Hill Publishing Company, New Delhi.
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 201

MES 201	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	-	-
CO2	2	1	-	-	-	1
CO3	3	1	-	-	-	2
CO4	2	1	2	-	-	1
CO5	2	1	2	2	-	2
CO6	2	1	2	2	3	-
CO7	2	1	-	-	2	-
CO8	2	1	3	-	3	2
Average	**2.1**	**1.0**	**2.25**	**2**	**2.7**	**1.6**

CO-PSO MAPPING for MES- 201

MES 201	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2		3
CO2	3	2	2	2	2	3
CO3	3	2	2	3	2	3
CO4	3	2	2	3	2	3
CO5	3	2	2	2	2	3
CO6	3	1	2	3	2	3
CO7	3	3	2	3	2	3
CO8	3	2	2	2	3	3
Average	**3**	**2.1**	**2**	**2.5**	**2.1**	**3**

MES-202: CONSERVATION AND BIODIVERSITY

Max. Marks: 80 + 20
Total Credits-4
Time: 3 Hours

Objectives: The aim of the course is to make students aware about diversity existing at different level of biological organizations, the values and threats to biodiversity and approaches for biodiversity conservation. The students will be able to understand the significance of diversity existing at different level of biological organizations and contribution of conservation measures to sustainability.

Outcomes: On successful completion of this course, the students will be able to:

CO1. Become familiar with principles of conservation biology and acquire knowledge about levels of biodiversity.
CO2. Build an understanding about biodiversity patterns, biodiversity of mangroves, wetlands and coral reefs,
CO3. Learn about biodiversity assessment and monitoring.
CO4. Gain knowledge about biodiversity uses, services and threats to biodiversity (aquatic and marine).
CO5. Become familiar with the various biodiversity conservation strategies and approaches.
CO6. Develop knowledge about national and international efforts for biodiversity conservation.

Note:-
For final theory exam time allowed 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.

UNIT – I

Principles and importance of conservation biology; genetic variations, natural selection, genetic drift and gene flow, minimum viable populations, genetic swamping.
Biodiversity, magnitude, global accumulation; levels biodiversity- species, genetic and ecosystem diversity; species diversity indices, rank abundance patterns.

UNIT – II

Biodiversity gradient – latitudinal and altitudinal, regional patterns of biodiversity; factors affecting biodiversity patterns; Biodiversity and ecosystem functioning; Terrestrial and marine hotspot of biodiversity.
Biodiversity of mangroves, wetlands and coral reefs – A general account

UNIT – III

Biodiversity uses and ecosystem services; threats to biodiversity- habitat loss, habitat fragmentation, exotic species and environmental pollution; species extinction ; IUCN threat categories- global and national status; Threats to aquatic and marine biodiversity.
Endangered and threatened species of India; Biodiversity assessment and monitoring.

Unit – IV

In situ Biodiversity conservation strategies and approaches: Protected areas, biosphere resource, protected areas in India – Sanctuaries, national parks and biosphere resources.
Ex Situ Biodiversity conservation: Species management plans, captive breeding, field gene banks, seed gene banks, cryopreservation, gene banks.
National and international efforts for biodiversity conservation- CITES, Ramsar Convention, Convention on biological diversity, IPR and Patent rights.

Suggested Readings:

1. Chandel, K.P.S., Shukla, G. And Sharma, N. (1996). Biodiversity in Medicinal and Aromatic Plants in India Conservation and Utilization, National Bureau of Plant Genetic Resources, New Delhi.
2. Heywood, V. (ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.
3. Huston, M.A. (1994). *Biological Diversity: The Coexistence of Species on Changing Landscapes*. Cambridge University Press, Cambridge.
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.
5. Soule, M.E. (ed.) (1986): Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 202

MES 202	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	-	-
CO2	2	3	-	-	2	-
CO3	3	-	3	3	-	3
CO4	2	2	-	-	3	-
CO5	2	2	2	2	-	-
CO6	2	2	2	2	-	-
Average	**2.3**	**2.4**	**2.5**	**2.3**	**2.5**	**3.0**

CO-PSO MAPPING for MES- 202

MES 202	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	-	1	-	2
CO2	3	3	2	1	-	2
CO3	3	3	-	3	2	2
CO4	3	3	-	-	-	2
CO5	3	3	1	-	2	2
CO6	3	3	-	-	2	3
Average	**3**	**3**	**1.5**	**1.7**	**2**	**2.2**

MES-203: POLLUTION AND GLOBAL CLIMATE CHANGE

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is to impart knowledge to the students about the sources and fate of air and water pollutants and the phenomena of global climate change. The students will be able to identify different environmental pollutants and their impacts on environment and understand climate change phenomenon, adaptation and mitigation strategies.

Outcomes: On successful completion of this course, the students will be able to:

CO1. Understand the complex environmental issues, sources and fate of different environmental pollutants along with their effects on environment.
CO2. Learn the standard methods of sampling, analysis and standards set up for different environmental pollutants
CO3. Understand the concept of global climate change, its causes, impacts, adaptation and mitigation strategies
CO4. Learn the role of international and national organizations in mitigating climate change
CO5. Predict the environmental changes and provide simple, technological and socially acceptable solutions
CO6. Understand the tools to study climate change and importance of carbon trading

Note:-
For final theory exam time allowed 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.

UNIT-I

Air and noise Pollution : Sources, classification and properties of air pollutants, behaviour and fate of air pollutants, effects of air pollution on human health & materials, sampling and analysis of air pollutants, SOx, NOx, CO, Ozone, hydrocarbons and particulate matter, meteorological aspects of air pollutant dispersion, Air quality standards.
Noise pollution**:** Definition, sources and effects; noise-monitoring-sound level meter.

UNIT-II

Water Pollution: Sources, consequences, ecological and biochemical aspects of water pollution, characteristics of domestic, industrial and agricultural wastes, their effects on water bodies; thermal pollution. Marine pollution-a general account; water quality standards.
Soil Pollution: Soil pollution from use of fertilizers, pesticides, heavy metals, waste disposal, industrial effluents and surfactants. Detrimental effects of soil pollutants, Remedial measures for soil pollution.

UNIT -III

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

CO_2 fertilization effect on plants; potential impacts of global warming – polar ice caps and melting of glaciers, sea level increase, weather extreme, ecosystems , human health, coral leaf bleaching , surface ocean chemistry, biogenic calcification in oceans.

UNIT IV

Tools to study global climate change- paleoclimatic records, general circulation models, ice cores.

Mitigation strategies for global warming; biological carbon sequestration, carbon sequestration in geological formations; role of forests in soil carbon storage.

Kyoto protocol; carbon trading.

Global environmental change programmes, IPCC; Indian initiative for mitigating global climate change.

Suggested Readings:

1. Botkin, D.B. and E.A. Keller (2004). *Environment Science: Earth as a Living Planet*, John Wiley & Sons Inc., New York.
2. Miller Jr., G.T. (1997). *Environmental Science: Working With the Earth*. Wadsworth Publishing Company, Belmont, California
3. Philander, S.G. (ed.) (2008). Encyclopedia of global warming and climate change. 2nd edition, SAGE Publications, Inc., California.
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*, S. Chand Publishing, New Delhi.
5. Steffen, W., A. Sanderson, P. D. Tyson, J. Jager, P. M. Matson, B. Moore, III, F. Oldfield, K. Richardson, H. J. Schnellnhuber, B. L. Turner, II, and R. J. Wasson. (2004). *Global change and the Earth system: a Planet under Pressure*. Springer-Verlag, New York, New York, USA.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 203

MES 203	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	-	-	-
CO2	3	2	2	2	-	3
CO3	2	2	2	3	-	-
CO4	-	-	2	2	-	-
CO5	2	-	2	3	-	3
CO6	2	1	2	2	-	-
Average	**2.2**	**2**	**2**	**2.4**	**-**	**3**

CO-PSO MAPPING for MES- 203

MES 203	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	2	-
CO2	3	1	3	3	3	-
CO3	3	1	3	3	-	3
CO4	3	-	3	3	3	-
CO5	3	2	3	3	3	-
CO6	3	-	3	2	2	2
Average	**3**	**1.5**	**3**	**2.7**	**2.6**	**2.5**

MES – 204: ENVIRONMENTAL METHODS AND ANALYTICAL TECHNIQUES

Max. Marks: 80

+ 20

Total Credits: 4

Time: 3 Hours

Objectives: The aim of this course is to give the students, knowledge of conventional and modern techniques of analysis of abiotic factors of ecosystems, pollutants in environmental sampling and spectroscopic and chromatographic techniques. The students can apply the knowledge of methods and techniques in research and analysis of environment.

Outcomes: On successful completion of this course, the students will be able to:

CO1: Learn characters of vegetation and measurement of biodiversity with different methods.

CO2: Use microbiology knowledge and skills to analyze environmental problems involving microbes.

CO3: Attain knowledge about designing of molecular diagnosis of plant disease and development of transgenic plants with applications.

CO4: Describe various important issues in disease control and disease forecasting relevant in farming.

CO5: Demonstrate key practical skills in working with microbes for study and use in the laboratory as well as outside.

CO6: Demonstrate a broad and coherent knowledge and understanding of analytical chemistry and instrumental methods of analysis (photometry, spectrophotometry, chromatography)

CO7: Use spectroscopic techniques to analyze various pollutants in environment and understand theory and techniques for their measurements of pollutants

Note:-

For final theory exam time allowed 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.

UNIT-I

Analytic and synthetic characters of vegetation, methods of vegetation analysis; Species diversity and measurement of diversity; primary and secondary production, methods of measuring primary productivity; techniques for quantifying nitrogen fixation; estimation of ecosystem nutrient budget. Germ plasm evaluation and conservation- survey, inventorization, and analysis.

UNIT-II

Techniques in environmental microbiology and its applications.

Methods of analyzing soil microbial populations and diversity

Measurement of microbial activity in environmental samples: microbial biomass, nitrogen mineralization soil respiration, microbial respiration and enzymatic activities.

Assessment and characterization of arbuscular mycorrhizal fungal the soil-plant system.

UNIT-III

Instrumentation Principles and applications of Spectrophotometry (UV-Visible spectrophotometry, flame photometry, Atomic Absorption spectrophotometry); Chromatographic techniques (Paper chromatography, thin layer chromatography, Gas liquid chromatography, High pressure liquid chromatography, Ion exchange chromatography, Column chromatography), Fluorometry, X-ray diffraction,.

UNIT-IV

Analytical Techniques: Air, Water & Soil samples. Sampling and analysis of air pollutants. Chemical and bacteriological sampling and analysis, water quality parameters, criteria and standards. Soil analysis - sample preparation and chemical methods of soil analysis.
Vocational prospects in field of environmental analysis and research

Suggested Readings:

1. Chapin, F.S., Matson, P.A. and Mooney, H.A. (2002). *Principles of Terrestrial Ecosystem Ecology*. Springer-Verlag, New York
2. Clark, R.N. (1999). *Spectroscopy of Rocks and Minerals, and Principles of Spectroscopy*. U.S. Geological Survey, Denver
3. John Wainwright and Mark Mulligan (Eds). (2004). Environmental Modelling: Finding Simplicity in Complexity. John Wiley & Sons Inc., New York.
4. Manahan, S.E. (2000). *Environmental Chemistry*. Seventh Edition. Lewis Publishers, New York

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 204

MES 204	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	-	-
CO2	3	3	2	2	3	-
CO3	3	3	2	2	3	2
CO4	1	3	2	2	2	-
CO5	3	2	3	2	2	3
CO6	3	2	3	3	-	3
CO7	3	2	3	3	-	3
Average	**2.7**	**2.6**	**2.5**	**2.3**	**2.5**	**2.8**

CO-PSO MAPPING for MES-204

MES 204	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	-	3	3	-
CO2	2	2	1	2	3	2
CO3	2	2	3	2	3	-
CO4	3	3	3	-	3	3
CO5	2	3	-	3	3	-
CO6	2	-	-	3	3	-
CO7	2	-	3	-	3	2
Average	**2.3**	**2.6**	**2.5**	**2.6**	**3**	**2.3**

MES -206: WATER RESOURCE MANAGEMENT
(Open Elective)

Max. Marks: 40 + 10
Total Credits: 2
Time: 3 Hours

Objectives: The purpose of the course is to provide knowledge about various water resources, their uses and types. The students will also learn about the water quality parameters and standards, waste water treatment for recycling and reuse, water conservation and management practices.

Outcomes: On successful completion of this course, the students will be able to:

CO1 Develop an in-depth understanding of the water resources and hydrological cycle.
CO2: Explain various threats like pollution and exploitation of water resources
CO3: Explain physical, chemical and biological parameters of water quality
CO4 Describe the appropriate rain water harvesting methods
CO5 Understand treatment, recycling and reuse of wastewater
CO6 Understand different techniques of water conservation and management

Note:-
For final theory exam, five questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory carrying 10 marks. The remaining four questions will be set unit-wise with two questions from each unit carrying 15 marks each.
The candidates will be required to attempt Q.No.1 and any two, selecting one question from each unit.

UNIT-1

Introduction to water resources. Water use and availability: domestic use, industrial use, agricultural use, In-stream use. Hydrological cycle. Surface water. Ground water: unconfined and confined aquifer, effect of ground water usage. Threats to water resources: water pollution, flooding, overexploitation.

UNIT-II

Sustainable use of water resources. Physical, chemical and biological parameters of water quality. Water quality standards. Wastewater treatment, recycling and reuse of wastewater. Water conservation and management practices, Rain water harvesting.

Suggested Readings:

1. CPCB (Central Pollution Control Board) (1999). *Water quality Status and Statistics* (1996 and 1997). Central Pollution Control Board, New Delhi.
2. DeBarry, P.A. (2004). Watersheds: Processes, Assessment and Management. John Wiley and Sons, Inc, Hoboken, New Jersey.
3. Grafton R.Q. and Hussey, K. (eds.) (2011). Water Resources Planning and Management. Cambridge University Press.
4. Manahan, S.E. (2000). *Environmental Chemistry*. 7th Edition. Lewis Publishers, New York.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*, S. Chand Publishing, New Delhi.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MES- 206

MES 206 (OE)	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	-
CO2	1	2	-	-	-	-
CO3	-	3	-	-	-	-
CO4	2	-	2	2	2	1
CO5	2	-	3	3	1	1
CO6	2	-	3	2	-	1
Average	**1.8**	**2.3**	**2.7**	**2.3**	**1.5**	**1.0**

CO-PSO MAPPING for MES-206

MES 206 (OE)	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	-	-	-	-	3
CO2	3	-	3	-	-	2
CO3	3	-	3	3	2	-
CO4	3	-	-	-	3	3
CO5	3	-	2	2	3	2
CO6	3	2	1	2	3	3
Average	**3**	**2.0**	**2.3**	**2.3**	**2.8**	**2.6**

MES-301: ENVIRONMENTAL BIOTECHNOLOGY

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is to make students understand the basic techniques of biotechnology and their applications for bioremediation of contaminants and conservation of biodiversity. The students will be able to understand the recent trends in environmental biotechnology and use of phytotechnology for remediation of environmental contaminants.

Outcomes: On successful completion of this course, the students will be able to:

CO1: Understand the recent trends in environmental biotechnology and its application in different fields of bioremediation.

CO2: Explain the microbial processes for the degradation of xenobiotics and understand the role and application of biosensors to assess the pollutants in environment.

CO3: Understand the basic tools of genetic engineering and application of molecular biology techniques for characterizing the composition of microbial communities.

CO4: Explain different strategies of environmental biotechnology in forest and wasteland management.

CO5: Understand the basics of GMOs/LMOs and biosafety protocol.

CO6: Describe and evaluate the processes of biological treatment of wastewater and alternative process schemes for biological nutrient removal.

CO7: Understand the solid waste management, application of phytotechnology and composting for waste treatments.

Note:-

For final theory exam time allowed 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.

UNIT-I

The scope of environmental biotechnology; Biodegradation of macromolecules; biodegradation of xenobiotics.

Heavy metal pollution; Bioremediation of metal contaminated soils, spilled oil and grease deposits and synthetic pesticides.

Biosensors to detect environmental pollutants.

Fermentation technology (Bioreactors).

Unit-II

Basic techniques in genetic engineering: Genetic manipulation, Restriction endonucleases.

Introduction of cloned genes into new hosts using plasmid and phage vector systems. RFLP, Polymerase chain reaction.

Environmental genomics/metagenomics - a general account.

Microbes and environmental management.

Microorganisms and organic pollutants; Extremophiles.

Unit-III

Basic concepts of genetic engineering of plants and its applications-herbicide and stress tolerant plant.

Biotechnological strategies in forestry and wasteland management.
Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA banks.
Genetically modified organisms and Biosafety- a general account.

Unit-IV

Bioenergy, ethanol fermentation.
Liquid waste treatment; Biofilters, activated sludge systems; membrane bioreactors.
Biotechnological approaches for solid waste management, Vermicomposting.
Phytotechnology- terrestrial phytosystems, metal phytoremediation.
Phytotechnology-aquatic phytosystems, nutrient film techniques, algal treatment systems.
Vocational possibilities in field of Environmental Biotechnology.

Suggested Readings:

1. Evans, G.M. and Furlong J.C. (2003). Environmental Biotechnology: Theory and Application. John Wiley and Sons.
2. Glick, B.R. and Pasternak J.J. (2007). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C. ASN Press.
3. Horton, H.R., Moran L.A., Perry M.D. and Rawn J.D. (2006). Principles of Biochemistry, Pearson Education International.
4. Metcalf and Eddy (Eds). (2003). Wastewater Engineering: Treatment and Reuse. Tata McGraw-Hill, New Delhi.
5. Sathyanarayanan. B.N and Varghese, D.B. (2007). Plant Tissue Culture Practices and New Experimental Protocols. I.K.International, New Delhi.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 301

MES 301	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	2
CO2	3	2	3	2	3	2
CO3	3	2	2	2	3	2
CO4	2	2	2	2	3	2
CO5	2	2	3	2	3	2
CO6	2	-	3	2	-	2
CO7	2	-	3	2	3	2
Average	**2.4**	**2.0**	**2.7**	**2**	**3.0**	**2**

CO-PSO MAPPING for MES- 301

MES 301	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	-	-	2	2
CO2	2	2	3	3	3	-
CO3	3	3	-	-	3	-
CO4	3	3	-	-	3	3
CO5	3	3	-	3	2	1
CO6	3	2	3	3	3	2
CO7	3	2	3	3	3	2
Average	**2.7**	**2.6**	**3**	**3**	**2.7**	**2**

MES -302: REMOTE SENSING AND GIS

Max. Marks: 80 + 20
Total Credits: 04
Time: 3 Hours

Objectives: The course provides students with an introduction to the principles and techniques of Remote Sensing (RS) and Geographic Information Systems (GIS) and the application of these techniques to the various aspects of environment. The students will be able to understand the scope of RS and GIS technology, its application and its requirement in research and business applications. The software and technical skills obtained from this course will prepare the students for national and global employability in Geospatial domain.

Outcomes: The students will:

CO1. Build a foundation of Remote Sensing (RS) and Geographic Information System (GIS) as an IT tool, its scope and usage for monitoring and analyzing the changes in earth and its environment.

CO2. Build an understating of types, process, platforms and sensors used in RS with an emphasis on optical and microwave remote sensing.

CO3. Build an understating about the elements and techniques of visual image interpretation, concepts and techniques of digital image processing, photogrammetry and aerial photography.

CO4. Learn about details of topographic maps and its georeferencing, ground truthing and theoretical and practical aspects of global positioning system (GPS).

CO5. Learn about spatial and non-spatial data types and sources and its integration and analysis in a GIS environment, and problem-based designing and management of GIS projects.

CO6. Have a basic competence in skills with functional knowledge of the fundamentals to carry out RS and GIS based projects.

CO7. Become familiar with the scope of RS and GIS technology in to the spheres of environment management.

Note:-

For final theory exam time allowed 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.

UNIT-I

Physical basis of remote sensing (Plank's law, Stefan- Boltzmann law, Wien's Displacement law, blackbody concept and scattering); electromagnetic spectrum; interaction of earth surface features with EMR; spectral reflectance; spectral signature and atmospheric windows; basic principle of Global Positioning System (GPS).

UNIT-II

Basic concepts of remote sensing and its types, resolutions, scanning technologies,

optical and microwave remote sensing; ground truth surveys; georeferencing. Visual image interpretation; digital image processing, supervised and unsupervised classification. Basic concepts of aerial photography and photogrammetry.

UNIT-III

Components and indexing of topographic sheets; Basic concept GIS; vector and raster data; GIS spatial and analytical modeling, attribute data management, processes and steps in GIS; GIS project management, architecture design, implementation strategy and, evaluation. Digital Elevation Model (DEM) and its application.

UNIT-IV

Role of Remote Sensing and GIS in Environmental Management: natural resource management (water, forests and soil), biodiversity monitoring, vegetation analysis, biomass and productivity estimation, coastal zone management, land use/land cover evaluation, wetland management, disaster management and Environment Impact Assessment (EIA), Vocational aspects geospatial domain.

Suggested Readings:

1. Campbell J.B. and Wynne R.H (2011), Introduction to Remote Sensing, 5th edition, Guilford Press, New York.
2. Harvey, F. (2009). A Primer of GIS: Fundamental Geographic and Cartographic Concepts Rawat Publication, New Delhi, India.
3. Ian H. (2010). An Introduction to Geographical Information Systems, Pearson Education, New Delhi, India.
4. Lillesand, T.M., Kiefer, R.W. and Chipman, J.W. (2015). Remote Sensing and Image Interpretation 7th edition, John Wiley and Sons, USA.

Teaching-Learning Process

- **Lectures :** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 302

MES 302	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	-	3
CO2	3	-	-	3	-	3
CO3	3	-	-	3	-	3
CO4	3	-	-	3	-	3
CO5	3	-	-	3	-	3
CO6	3	-	-	3	-	3
CO7	3	-	2	3	-	3
Average	**3.0**	**2.0**	**2.0**	**3.0**	**-**	**3.0**

CO-PSO MAPPING for MES- 302

MES 302	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	-
CO2	2	-	-	-	3	-
CO3	2	-	-	-	3	-
CO4	2	-	-	2	3	2
CO5	2	-	-	2	3	2
CO6	2	-	-	2	3	2
CO7	3	2	2	3	3	3
Average	**2.3**	**2.5**	**2.0**	**2.4**	**3.0**	**2.3**

MES -303: ECOTOXICOLOGY AND ENVIRONMENTAL HEALTH

Max. Marks: 80 + 20
Total Credits- 4
Time: 3 Hours

Objectives: The aim of this course is to make students understand the concepts of ecotoxicology, vector and water borne diseases and strategies of sustainable development. The students will be able to understand the symptoms, epidemiology and control of different diseases and their impacts on human health.

Outcomes: The students will be able to

CO1. Understand the basic concept of ecotoxicology, toxic elements, their distribution, fate and biochemical aspects
CO2. Learn about the importance of ecological monitoring, testing methods and ecological risk assessment associated with toxic chemicals.
CO3. Develop the understanding of symptoms, epidemiology and control of vector borne disease and control of water borne diseases.
CO4. Examine various standard methods of monitoring and control of air pollution and noise pollution
CO5. Understand the treatment and recycling methods of sewage and waste water
CO6. Understand the concept and strategies of sustainable development and the sources, generation, disposal and management of solid wastes

Note:-
For final theory exam time allowed 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.

UNIT-I

Ecotoxicology: introduction and importance. Types of toxic elements- inorganic, organic and radionuclide. Distribution and fate of toxic substances- physical, chemical and biological processes. Dose response relationships; biomagnification, bioaccumulation. Pesticides in water. Biochemical aspects of toxicity of Arsenic, Cadmium, Lead, Mercury, Carbon Monoxide, O_3 and PAN, Insecticides, MIC, Carcinogens and Carcinogenicity.

UNIT-II

Indices of Toxicology, Detoxification; Ecological Monitoring and Tests; Ecological risk assessment of toxic chemicals. Symptoms, epidemiology and control of vector borne diseases: amoebiasis, trypanosomiasis, filariasis, leishmaniasis, schistosomiasis.
Water borne diseases and their control-cholera, diarrhea.
Control of Malaria, Tuberculosis Dengue, Chicken guinea and AIDS

UNIT-III

Methods of monitoring and control of air pollution, air quality standards. Sewage and waste water treatment and recycling, physico-chemical and biological parameters for water analysis, water quality standards, Noise control and abatement measures. Noise exposure levels and standards.

UNIT-IV

Concept and strategies of Sustainable development.

Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes (Biomedical wastes, E- waste and other hazardous wastes)

Recycling of waste material. Waste minimization technologies. Resource management, Disaster management.

Suggested Readings:

1. Botkin, D.B. and. Keller E.A (2004). *Environment Science: Earth as a Living Planet*, John Wiley & Sons Inc., New York.
2. Carson and Rachel. (1962). *Silent Spring*, Houghton Mifflin, Boston
3. Manahan, S.E. 2000. *Environmental Chemistry*. Seventh Edition. Lewis Publishers, New York.
4. Pierzynski, G.M., Vance, G.F. and Sims, J.T. (2000). Soils and Environmental Quality. Second Edition. CRC press, New York.
5. Singh, J.S. and Sharma V.P. (Eds) 2005. *Glimpses of the work on environment and development in India.* Angkor New Delhi.
6. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 303

MES 303	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	-	2	-
CO2	3	3	2	2	-	3
CO3	2	3	2	2	-	2
CO4	3	2	2	3	-	3
CO5	3	2	2	2	-	2
CO6	2	-	2	2	-	-
Average	**2. 7**	**2.6**	**2**	**2.2**	**2**	**2.5**

CO-PSO MAPPING for MES- 303

MES 303	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	-	3	-	3	-
CO2	3	3	3	3	3	-
CO3	3	2	3	3	1	-
CO4	3	2	3	3	3	-
CO5	3	2	2	-	3	-
CO6	3	2	3	-	3	3
Average	**3.0**	**2.2**	**2.8**	**3.0**	**2.7**	**3.0**

MES -304: (EL - 1A) ENVIRONMENTAL PLANNING, POLICY AND LAW

Max Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is enable students understand the range of regulatory instruments to conserve and protect the environment; environment policies and planning and various environment related movements at national and international level. The students will be able to understand the environmental technical and legal aspects of pollution prevention.

Outcomes: It is expected that a student after taking up this course would be able

CO1: To acquire values and attitude towards understanding various environmental policies and constitutional framework governing environment in India.
CO2: To understand the concepts related to various environment planning and procedure with current situations and for future scenarios.
CO3: To develop skills in identifying the problems and loop-holes in policies and to understand its legal issues and legislative provisions.
CO4: To have in-depth knowledge of various environmental legislations in India.
CO5: To understand the emerging environmental issues and key international treaties for environment protection.
CO6: To critically analyze and apply legislations, rules and cases in context.
CO7: To understand judicial response to environmental issues in India

Note:-
For final theory exam time allowed 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.

UNIT-I

Policy Frameworks on environment in India. National Environmental Policy 2006 - Approaches, Objectives, Principles and Framework.
Policy parameters related to conserving environmental resources-forests and wildlife, Biodiversity fresh water resources and coastal resources.
Policy perspectives for land degradation and desert ecosystems.
Sustainable food policy challenges and institutional designs for improving food production Scheme of labeling of environmentally friendly products (Ecomark)

UNIT-II

Basic concepts of Environmental Planning, Integrated land –use planning land-use patterns, urban planning-impact of population growth.
Water Resources planning in India: Ground water; water harvesting technologies; interlinking of rivers in India.
Institutional design for renewable energy resources, hazardous waste management and handling rules, 1989; resource management; disaster management.

UNIT-III

Provision in constitution of India regarding environment article 48-A and 51-A (g).

Environmental legislation India: Water (Prevention and Control of Pollution) Act, 1974; The Air(Prevention and Control of Pollution) Act, 1981; The Environmental Protection Act, 1986; Wild Life Protection Act 1972, 1991; Forest Conservation Act,1980; Indian Forest Act, 1982; Motor Vehicle Act,1988 (Environmental aspects). Public Liability Insurance Act, 1991 and rules, National Green Tribunal Act (2010).

Unit-IV

International Conventions and Agreements on environmental issues:
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); Convention on Biological Diversity (CBD); United Nations Convention to Combat Desertification; Ramsar Convention.
United Nations Convention on the Law of the Sea; Antarctic Treaty; Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).
United Nations Framework Convention on Climate Change (UNFCCC); Climate change Convention and CDM; Montreal Protocol; Basel Convention - Convention on the Control of Tran boundary Movement of Hazardous Wastes and their Disposal.

Suggested Readings:

1. Barrow, C.J. (2005). *Environmental Management and Development*. Taylor and Francis Group, London and New York.
2. Divan S. and Rosencranz A. (2002). *Environmental law and policy in India: cases, materials and statutes.* Oxford University Press.
3. Ferrey S. (2004). *Environmental Law: Examples and Explanations*. Aspen Law & Business. Springer-Verlag New York, LLC.
4. James C., Werksman H. and Roderick P. (2006). *Improving compliance with International Environmental Law,* Earth Scan London.
5. Pushpam, K. (2005). *Economics of Environment and Development*. ANE Books, New Delhi.
6. Stavin, R.N. (2005). *Economics of the Environment: Selected Readings*. W.W. Norton and Comparus, London.
7. Vig, N.J. and Axelrod R.S. (Eds) (1999). *The Global Environment: Institutions, Law and Policy*. EarthScan London.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 304-EL-IA

MES 304(EL-1A)	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	2	2	-	-
CO2	1	-	3	2	-	-
CO3	1	-	2	2	-	3
CO4	1	-	-	2	-	-
CO5	1	2	3	3	2	-
CO6	1	-	-	3	-	3
CO7	1	-	-	3	2	-
Average	**1**	**2**	**2.5**	**2.4**	**2**	**3**

CO-PSO MAPPING for MES- 304-EL-IA

MES 304(EL-1A)	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	-	-	3	-	2
CO2	3	2	2	3	-	2
CO3	3	-	-	3	2	2
CO4	3	-	-	3	-	-
CO5	3	2	3	3	2	2
CO6	3	-	-	3	2	-
CO7	3	2	2	3	-	2
Average	**3**	**2**	**2.3**	**3**	**2**	**2**

MES-304: (EL - 1B) WASTE MANAGEMENT

Max Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The purpose of this course is to impart knowledge about the essential principles of management of waste generated from different sectors in a manner to meet public health and environmental concerns. The students will learn how to advance the scientific, technical and practical aspects of waste management and recycling.

Outcomes: The students will be able to:

CO1: Understand the types, characterization and problems of municipal waste, biomedical waste, hazardous waste, e waste, industrial and other wastes.
CO2: Become aware of environment and health impacts of different types of solid wastes.
CO3: Gain the knowledge of the needs to manage waste and waste disposal techniques.
CO4: Understand the different types of waste generated from food, paper, steel etc. industries and their management processes.
CO5: Understand the role of biotechnology in waste management.
CO6: Understand the concept of waste reuse and recovery of protein, carbohydrates, biogas, and biomass for energy, oil, fats and metals.

Note:-
For final theory exam time allowed 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.

UNIT I

Classification of different type of Waste; its generations and characterization. MSW – Sources and generation, chemical and physical characterization and classification, different methods of disposal and management, land filling, incineration, composting, vermicomposting, energy and resource recovery.
Hazardous waste –Definition, sources, effects and management. Biomedical wastes – Definition, categories, and management.

UNIT II

Principles of Industrial waste treatment - sources of pollution physical chemical, organic and biological properties.
Manufacturing processes, flow sheets, characteristics and composition of wastes including waste reduction, treatment and disposal methods for Food Industries: Sugar, Fermentation, Meat, dairy and Rice- milling; Material Industries: Paper, Steel - Metal - plating and petroleum refineries; Miscellaneous Industries: Textile, Tanning, Fertilizers and Atomic energy plants.

UNIT III

Role of Biotechnology in waste minimization; Recovery of by-products and raw material from wastewater conversion: waste recovery and reuse, reclamation by ground water

recharge, agriculture reuse of effluent; sludge as fertilizer; recovery of protein, carbohydrates, biogas, biomass for energy, oil and fats, metal recovery, bioscrubbing.

UNIT IV

Environmental regulation for waste management: hazardous waste (management and handling) rules 1989, amendments 2000 and 2003; Batteries (management and handling) rules, 2001; Biomedical waste (management and handling) rules, 1998; Municipal solid waste (management and handling) rules, 2000; Plastic waste (management and recycling) rules, 1999.

Suggested Readings:

1. Crites R.W., Reed S.C. and Bastion R. (2000), "Land Treatment Systems for Municipal & Industrial Wastes" McGraw Hill Companies Inc.
2. Eckenfelder W.W. (Jr.) (1966). "Industrial Water Pollution Control", McGraw Hill Publications.
3. Lal B. and Reddy M.R.V.P. (2005). Wealth from waste: trends and technologies, Teri Press, New Delhi.
4. Neal K. Ostler (1998), "Industrial Waste Stream Generation", Prentice Hall.
5. Sidwick J.M and Holdom R.S. (1987). Biotechnology waste treatment and exploitation, Ellis horwood limited, England.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MES- 304 (EL-1B)

MES (304 EL-1B)	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	3	1
CO2	2	2	3	2	2	-
CO3	3	1	2	3	2	-
CO4	2	1	3	2	3	2
CO5	3	2	3	3	3	2
CO6	3	3	3	2	3	2
CO7	2	-	2	-	-	-
Average	**2.4**	**1.8**	**2.6**	**2.3**	**2.7**	**1.8**

CO-PSO MAPPING for MES- 304 (EL-1B)

MES (304 EL-1B)	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	3	3	2	3
CO2	2	2	3	3	2	-
CO3	2	2	3	3	3	3
CO4	2	2	3	3	3	3
CO5	2	2	3	3	3	3
CO6	2	2	3	3	3	3
CO7	2	2	2	3	3	3
Average	**2**	**2**	**2.9**	**3**	**2.7**	**3**

MES -306: GLOBAL CLIMATE CHANGE
(Open Elective)

Max. Marks: 40 + 10
Total Credits: 2
Time: 3 Hours

Objectives: The purpose of the course is to impart knowledge about the concept of global climate change and its impacts on environment and human health. The students will learn about various adaptation and mitigation strategies for global warming and about carbon trading.

Outcomes: On successful completion of the course, the students will be able to

- **CO1.** Understand the concept of changing climate, sources, trends and radiative forcing of greenhouse gases
- **CO2.** Gain knowledge of impacts of climate change on different environmental components, ecosystems and human health.
- **CO3.** Describe various tools to study climate change and explain various mitigation strategies
- **CO4.** Explain various national and international programs, protocols and measures to combat the problem of changing climate

Note:-
For final theory exam, five questions will be set. Question No.1 (objective/short answer type) covering the entire syllabus, will be compulsory carrying 10 marks. The remaining four questions will be set unit-wise with two questions from each unit carrying 15 marks each.
The candidates will be required to attempt Q.No.1 and any two, selecting one question from each unit.

UNIT-1

Global climate change**:** Greenhouse effect, greenhouse gases: sources, trends, radiative forcing, warming potential of gases. Impacts of global warming on melting of polar ice caps and glaciers, sea level rise, weather extremes, impacts on ecosystems and human health and on coral reef bleaching

UNIT-II

Mitigation strategies for global warming; biological carbon sequestration, carbon sequestration in geological formations, role of forests in carbon sequestration; Geoengineering; Kyoto protocol, CDM and carbon trading, IPCC.

Suggested Readings:

1. IPCC (Intergovernmental Panel on Climate Change) (1990). *Climate Change: The IPCC Assessment*. Cambridge University Press, Cambridge.
2. Sorokhtin, O.G., Chilingar, G.V. and Khilyuk, L.F. (2007). *Global warming and global cooling: Evolution of climate and earth,* Elsevier, Netherland.
3. Steffen, W., Sanderson A., Tyson P.D., Jager J., Matson P.M., Moore B., Oldfield F., Richardson K., Schnellnhuber H.J., Turner B.L. and Wasson R.J. (2004). *Global change and the Earth system: a Planet under Pressure*, Springer-Verlag, New York, USA.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests.

CO-PO MAPPING for MES- 306

MES 306 (OE)	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	-	-
CO2	3	2	-	2	3	-
CO3	3	-	3	2	-	2
CO4	3	-	3	2	-	2
Average	**2.8**	**2**	**3**	**2**	**3**	**2**

CO-PSO MAPPING for MES- 306

MES 306 (OE)	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3		3			
CO2	3	2	3	1		2
CO3	3	2	3	2	2	
CO4	3		3	2		1
Average	**3**	**2**	**3**	**1.7**	**2**	**1.5**

MES – 401: AGROECOLOGY AND AGROFORESTRY

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is to provide the knowledge of environment friendly agricultural techniques, importance of environment in agriculture and agroforestry and seed regulatory and certification systems. The students can apply the knowledge of agroforestry for the betterment of soil for sustainable agricultural practices and to prevent pollution.

Outcomes: Course outcomes: The students will be able to

- **CO1.** Understand different agricultural ecosystems and sustainable agricultural practices
- **CO2.** Understand the linkage between green revolution and environmental implications
- **CO3.** Understand the variations in irrigation practices, problems of water logging and secondary salinization
- **CO4.** Develop the understanding of agrochemicals, their impact, pest management techniques and biosafety issues associated with agriculture.
- **CO5.** Understand the importance of seed quality, testing, seed regulatory and certification systems
- **CO6.** Examine the linkage between soil productivity and crop residue management; weather and crop productivity
- **CO7.** Examine the linkage between global warming and agriculture and food security
- **CO8.** Understand the concept of agroforestry, classification, models and role in soil management and carbon sequestration

Note:-
For final theory exam time allowed 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.

Unit-I

Agricultural ecosystems; Agricultural practices; Green revolution-environmental implications; Ecology of shifting agriculture.
Sustainable agriculture, organic farming, eco-farming, dry-land farming, zero-tillage, bio fertilizer, plant growth promoting bacteria.
Agro biodiversity and sustainability.

Unit-II

Environmental impacts of agriculture; Soils and agriculture, Irrigation practices, water logging and secondary salinization; agrochemicals, pesticide residues.
Crop Protection: biodegradable and non-biodegradable pesticides; pesticide resistance.
Biological and ecological pest control, integrated pest management, pesticide safety and microbial insecticides.
Biosafety issues in agriculture.
The role of microbes in agriculture-beneficial root-microbial interaction.

Unit-III

Seed quality and seed testing; Hybrid seed production.
Seed regulatory and certification systems;
Soil productivity and Crop residue management.
Weather and crop productivity.
Impact of global warming on agriculture and food security.

Unit-IV

Scope and importance of Agroforestry.
Classification of agroforestry systems. Models of agroforestry systems.
Traditional agroforestry systems of India.
Agroforestry for soil management and carbon sequestration.
Agroforestry for mitigating climate change.
Agroforestry for conserving soil biodiversity.

Suggested Reading:

1. Gliessman, S.R. (2002). *Agroecosystem Sustainability: Developing Practical Strategies*. CRC Press.
2. Kumar, B.M. and Nair P.K.R. (eds.) (2006). *Tropical Homegardens*: A Time-Tested Example of Sustainable Agroforestry. Series, Advances in Agroforestry, Vol. 3. Kluwer Academic Publishers, Dordrecht, the Netherlands.
3. Lynggaard, K. (2006). *The Common Agricultural Policy and Organic Farming: An Institutional Perspective on Continuity & Change*. CAB International.
4. Newton, Paul C.D., Carran R.A., Edwards, G.R. and Niklaus, P.A. (2007). *Agroecosystems in a Changing Climate.* Advances in Agroecology Vol.12 CRC/Taylor & Francis.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.
6. Young, A. (1997). *Agroforestry for Soil Management*, CAB International, UK.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and sessional tests.

CO-PO MAPPING for MES- 401

MES 401	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	-	3	-
CO2	-	2	3	-	-	-
CO3	2	2	2	2	-	-
CO4	2	2	3	3	2	-
CO5	2	2	2	3	3	-
CO6	2	2	3	2	2	2
CO7	2	2	3	3	2	2
CO8	3	2	2	2	3	-
Average	**2.1**	**2.0**	**2.6**	**2.5**	**2.5**	**2.0**

CO-PSO MAPPING for MES- 401

MES 401	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	-	-	3	2
CO2	3	2	-	-	1	-
CO3	3	2	-	2	2	-
CO4	3	2	3	2	2	1
CO5	3	2	-	3	3	-
CO6	3	2	-	3	2	3
CO7	3	2	3	3	-	3
CO8	3	2	-	-	-	3
Average	**3**	**2.1**	**3**	**2.6**	**2.2**	**2.4**

MES – 402: ENVIRONMENTAL IMPACT ASSESSMENT AND AUDITING

Max Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is to impart knowledge on Environmental Impact Assessment process and methodology, impacts of different industries on environment, Risk Assessment, Environmental Auditing, Occupation Health and Safety and Environmental Management Systems (EMS) in India. The students will be able to apply concepts of EIA in environmental planning.

Outcomes: On completion of this course, the students will be able to:
CO1: Perform the screening and scoping of EIA based on existing requirements, evaluate the impacts and draw the conclusions from the results of EIA.
CO2: Gain an overview of legislative framework for EIA, with a focus towards its application in India.
CO3: Understand the role of EIA in decision making.
CO4: Understand the concepts of EIA and develop the professional skills necessary to enable them to undertake EIA.
CO5: Familiarize themselves through a variety of professional tools used in predicting environmental impacts.
CO6: Develop understanding through various case-studies on impact assessment and be able to relate to other fields.
CO7: Develop critical thinking for shaping strategies for environmental management planning, environment auditing and risk assessment.
CO8: Conduct various environmental and energy audits of various industries and institutions by applying this knowledge.

Note:-
For final theory exam time allowed 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.

UNIT-I

EIA origin, development, purpose and aims; core values and principles of Ecological 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.
Environmental Management Plan, Environmental components of EIA.

UNIT-II

Environmental Appraisal procedures in India, Impact identification methods. Environmental impacts of mining industry; nuclear power plant, textile industry; pulp and paper industry; petroleum refining; pesticide manufacturing industry; fertilizer industry.
Case studies of EIA – Hydroelectric dam and river valley projects; thermal power plants and petroleum exploration.

UNIT-III

Risk Analysis: Definition of risk, environmental risk analysis-risk assessment and risk management. Basic steps in risk assessment - Hazard identification. Dose-response

assessment, Exposure assessment, Risk characterization, Risk assessment in EIA. Strategic Environmental Assessment (SEA)-principles and potential, improving the effectiveness of EIA.

UNIT-IV

Aims and objectives of public involvement in EIA; Public involvement methods; approaches for EIA reviewing; Economic efficiency and valuation methods.

Types of environmental audits: Assessment and compliance audit, occupation health and safety; Energy audits. ISO 14001; Environmental Management systems in India;

Drivers for the development of audit programme. General audit process- preparation, excretions, performance valuation and execution. Environmental risk insurance; Environmental audit and EIA, Vocational prospects in the field of EIA, Auditing and EMS.

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.
3. Morgan, R.K. (2002). Environmental Impact Assessment: A Methodological Perspective, Kluwer Academic Publishers, London.
4. Morris, P. and Thesivel, R. (eds.) (2001). Methods in Environmental Impact Assessment. UCL Press, London.
5. Therivel, R., Wilson E., Thompson O., Heaney D. and Pritchard D. (1992). Strategic Environmental Assessment. Earthscan, London.
6. Treweek, J. (1999). Ecological Impact Assessment. Blackwell Science, UK.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MES- 402

MES 402	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	-	3
CO2	2	-	-	2	-	-
CO3	3	-	-	2	2	-
CO4	3	2	3	2	-	2
CO5	3	2	3	2	-	2
CO6	2	-	2	3	2	3
CO7	2	2	3	3	-	2
CO8	2	-	-	3	-	3
Average	**2.5**	**2**	**2.6**	**2.4**	**2**	**2.5**

CO-PSO MAPPING for MES- 402

MES 402	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	-	-	3	2	-
CO2	3	-	-	3	2	-
CO3	3	-	-	3	2	-
CO4	3	-	-	3	2	-
CO5	3	2	2	3	2	-
CO6	3	2	2	3	2	2
CO7	3	-	-	3	2	2
CO8	3	-	-	3	2	2
Average	**3**	**2**	**2**	**3**	**2**	**2**

MES – 403: ECOTECHNOLOGY AND ECOLOGICAL RESTORATION

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The aim of this course is to make students aware about the concepts of ecotechnology and strategies for restoration of terrestrial and aquatic ecosystems. The students will be able to understand the principles and applications of ecotechnology for restoration of different ecosystems with the help of case studies.

Outcomes: The student will be able to

CO1. Understand the basic concept of ecological principles and their applications in ecosystem restoration

CO2. Understand the sources and effects of natural and anthropogenic disturbances on aquatic and terrestrial ecosystems

CO3. Learn about various strategies of restoration of degraded, salt affected and water logged areas.

CO4. Understand and apply the concept of biosaline agriculture, its scope and importance for resource conservation

CO5. Understand and apply the concept of Integrated watershed management and its restoration

CO6. Understand the mitigation strategies of invasive species with the help of case studies.

CO7. Understand the restoration of Coastal ecosystems, wetlands, riparian and floodplain ecosystems with case studies.

Note:-

For final theory exam time allowed 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.

Unit-I

Basic principles and applications of Ecotechnology.

Restoration Ecology-Terms and definitions, Importance of ecological restoration: Strategies of Restoration-Natural recovery, active restoration, rehabilitation; Restoration plan and rehabilitation measures; Reference ecosystem.

Natural and anthropogenic disturbances: Characteristics and sources, effects on structure and functioning of terrestrial and aquatic ecosystems. Habitat fragmentation, Ecosystem Stability and regulation.

Global change and Human impact on ecological systems.

Unit-II

Physical, Chemical, Biological tools of restoration. Ecological design principles.

Restoration of soil fertility of degraded lands: No-tillage, role of mycorrhizae, forestry Plantations, biofertilizers.

Rehabilitation of salt affected soils and water logged soils.

Biosaline agriculture- Scope and importance and strategies.

Unit-III

Ecological restoration of forest and grassland ecosystems.
Forest landscape restoration; Basic concepts and case studies.
Reclamation of mining sites and disturbed lands.
Integrated watershed management and restoration.
Prevention and mitigation of invasive species.

Unit-IV

Ecological restoration of aquatic systems: River corridors, wetlands and lakes.
Coastal restoration- mangroves and coral reefs.
Rehabilitation of Tsunami affected areas- a general account
Treatment wetlands, Constructed wetlands and adaptive restoration of wetlands.
Restoration of riparian and floodplain ecosystems.

Suggested Readings :

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Mitsch, W.J. and Jorgensen, S.E 2003. Ecological engineering and Ecosystem restoration. ical Perspective. John Wiley and Sons, New York.
3. Mitsch, W.J. and Jorgensen, S.E. (eds.) 1989. *Ecological Engineering: An Introduction to Ecotechnology*. John Wiley and Sons, New York.
4. Pace, M.L. and Groffman, P.M. (Eds.) (1998). Success, limitations and Frontiers in Ecosystem Science, Springer Verlag, New York.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*, S. Chand Publishing, New Delhi.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and sessional tests.

CO-PO MAPPING for MES- 403

MES 403	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	-	-
CO2	-	2	2	2	-	-
CO3	3	2	2	2	-	2
CO4	2	2	2	2	2	2
CO5	2	2	2	2	-	2
CO6	2	2	2	2	-	3
CO7	2	2	2	2	-	-
Average	**2.3**	**2.0**	**2**	**2**	**2**	**2.3**

CO-PSO MAPPING for MES- 403

MES 403	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	-	-	-	1
CO2	3	3	2	2	-	-
CO3	3	3	-	-	2	-
CO4	3	3	-	-	2	2
CO5	3	2	-	-	2	2
CO6	3	2	-	-	2	2
CO7	3	2	-	-	2	2
Average	**3**	**2.6**	**2**	**2**	**2**	**1.8**

MES - 404: (EL-IIA) ECOLOGICAL ECONOMICS

Max. Marks: 80 + 20
Total Credits: 4
Time: 3 Hours

Objectives: The course provides the students knowledge on the principles of ecological economics and sustainability, physical and economic valuation of environment, market based mechanisms and various models of sustainability. The students will develop a demonstrated theoretical knowledge of ecological economics, and its possible contribution to a vision of a sustainable planet.

Outcomes: On completion of this course, the students will be able to:

CO1 Understand the concepts of market and the economics of our environment.

CO2 Develop an understanding and use of cost-benefit analysis of environmental components and different valuation techniques to measure economic value of ecological goods and services.

CO3 Develop an ability to identify the role of market based instruments to deal with environmental issues and the concepts of environmental accounting.

CO4 Understand in-depth concepts of sustainable development, its indicators, and the challenges to meet sustainable development.

CO5 Attain knowledge about the strategies and actions adopted at national and global scale to attain sustainability.

CO6 Develop skills to learn and analyze different instruments and models to achieve sustainability.

Note:-

For final theory exam time allowed 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.

Unit-I

Scope and importance of ecological economics. Economics and environmental policy; the market mechanisms and choices; benefits of environmental protection. Demand and Supply; market price and quality. Environmental externalities and the problem of social cost. Ecosystem services and their valuation. Value addition in agriculture crops; Agricultural marketing. Industrial ecology - concepts, material flow analysis and life cycle analysis

Unit-II

Economic analysis of climate change. Benefits of controlling greenhouse gases; cost of controlling greenhouse gases; carbon trading and CDM mechanisms. Measuring the costs and benefits of pollution control. Overview of benefit-cost analysis; Economic principles of cost benefit analysis; Measurement of economic value of environment: contingent valuation method, Travel cost methods, Hedonic market methods. Market based instruments for controlling pollution; Systems of Integrated environmental accounting; Green accounting.

Unit-III

Definition and dimensions of sustainability; global challenges of sustainable development; ecological footprint; global environmental monitoring and assessment. Guiding principles of sustainable development. Strategies for global sustainablility; national sustainable development strategies; sustainability indicators. Models of sustainability, environmental sustainability index; Global action and sustainable development; Education for Sustainability.

Unit-IV

Ecological and economic sustainability of natural resources. An economic perspective to sustainability. Instruments for implementing sustainability- Findings right prices, The Hardwick- Solow Rule, Critical rental capital; Safe Minimum Standard; Daly's Steady State principles, World Bank Approach, Common and Perrings model. Policy implications for implementing sustainability.

Suggested Readings:

1. Harris J.M. and Roach, B. (2009). The Economics of Global Climate Change. Global Development and Environment Institute, Tufts University, Medford, USA.
2. Harris, J. and Roach, B. (2014). Environmental and Natural Resource Economics: A Contemporary Approach, 3rd edition, Routledge.
3. Harris, J.M., Wise, T.A., Gallagher, K.P. and Goodwin, N.R. (2001). A Survey of Sustainable Development: Social and Economic Dimensions. Island Press, Washington, D.C.
4. Smith, S. (2011). Environmental Economics: A Very Short Introduction, Oxford.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and sessional tests.

CO-PO MAPPING for MES- 404 (EL-IIA)

MES 404-EL-IIA	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	-	-
CO2	2	1	-	2	-	2
CO3	2	2	2	2	-	3
CO4	2	-	2	2	3	2
CO5	2	-	-	2	2	-
CO6	2	-	-	2	-	3
Average	**2**	**1.5**	**2**	**2**	**2.5**	**2.5**

CO-PSO MAPPING for MES- 404 (EL-1A)

MES 404-EL-IIA	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	-	-	-	-	3
CO2	3	2	2	-	3	3
CO3	3	2	2	3	3	3
CO4	3	-	-	-	-	3
CO5	3	-	-	-	3	3
CO6	3	-	-	-	3	3
Average	**3**	**2**	**2**	**3**	**3**	**3**

MES - 404: (EL-II B) ENVIRONMENTAL HEALTH AND INDUSTRIAL SAFETY

Max. Marks: 80+20
Total Credits: 4
Time: 3 Hours

Objectives: The course provides students an overview of the basic concepts of Environmental health and epidemiology of different diseases. The students will develop understanding of chemical hazards, industrial safety and preparedness; and acquire knowledge regarding occupational health, safety rules and accident prevention.

Outcomes: The students will be able to:

CO1: Understand causes, and control measure of environmental and transmissible diseases.
CO2: Attain knowledge of unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.
CO3: Identify accident prone areas and adopt methods for reducing accidents following safety precautions by using specific personal protective equipments.
CO4: Identify and apply safety policy in an industry and list out the duties and implement safety targets, objectives, standards, practices and performances.
CO5: Gain knowledge of engineering fundamentals for hazard identification, risk assessment and control of occupational hazards.
CO6: Help in implementation of legislative requirements, industry standards, and best practices in a variety of workplaces.

Note:-
For final theory exam time allowed 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.

Unit-I

Introduction, Environmental Epidemiology, Agents of Environmental diseases: Zoonotic and water-borne disease (Jaundice and diarrhea); Toxic metals and elements; Pesticides and other organic compounds.

Transmissible diseases: Symptoms, epidemiology and control of vector borne diseases amoebiasis, trypanosomiasis, filariasis, leishmaniasis, schistosomiasis, life cycle of Plasmodium, Control of malaria, and tuberculosis. Bio-Terrorism.

Unit-II

Occupational Health: Concept of health and occupational health, Spectrum of health, Occupational and work related diseases; Levels of prevention, History of occupational health, Characteristics of occupational diseases, Essentials of occupational health service, personal protective equipments for head, ear, face, eye, foot, knee and body protection, Respiratory personal protective devices.

Unit-III

Introduction to Industrial safety: Safety legislation: Acts and rules, Safety standards and codes, Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, Safety policy: safety organization and responsibilities and authorities of different levels. ILO Convention and Recommendations in the furtherance of safety, health and welfare. Vocational prospects in Industrial Safety

Unit-IV

Hazardous Chemicals: -Classification of hazardous chemicals, transportation of hazardous chemicals, hazchem code, Storage and handling of hazardous substances and Industrial wastes, Major accidents involving hazardous substances, Emergency preparedness (on site & offsite), and Safety audit.

Suggested Reading:

1. Jain R.K. and Rao S.S. (2006), Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi.
2. Slote.L, Handbook of Occupational Safety and Health, John Willey and Sons, New York.
3. Lees F.P (1991) – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth-Heinemann Ltd., London.
4. Grimaldi and Simonds (2001). Safety Management, AITBS Publishers, New Delhi.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and sessional tests.

CO-PO MAPPING for MES- 404 (EL-IIB)

MES 404-EL-IIB	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	-	-
CO2	1	-	-	2	-	2
CO3	-	-	-	2	-	3
CO4	2	-	3	2	-	3
CO5	-	-	-	2	-	3
CO6	-	-	-	-	-	3
Average	**1.7**	**2**	**2.5**	**2**	**-**	**2.8**

CO-PSO MAPPING for MES- 404 (EL-IIB)

MES 404-EL-IIB	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	3	-	-	-
CO2	2	-	3	3	2	-
CO3	2	-	3	3	2	-
CO4	3	-	3	3	2	-
CO5	3	2	3	3	2	-
CO6	3	-	2	3	3	2
Average	**2.5**	**2**	**2.8**	**3**	**2.2**	**2**

CO-PO-PSO Matrix for M.Sc (Environmental Science)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
MES-101	2.1	2.0	1.7	2.3	2.5	2.0	2.1	2	2.75	2.4	2.0	2.0
MES 102	2.3	1.3	2.2	1.0	2.5	1.3	1.5	2	2	1.5	1.3	1.5
MES103	1.8	2.4	1.5	2.0	2.0	1.5	2.6	2.8	2.0	1.5	1.0	1.5
MES104	2.5	1.0	2.2	1.8	-	2.7	3.0	3.0	2.0	1.5	2.6	1.0
MES201	2.1	1.0	2.3	2.0	2.7	1.6	3.0	2.1	2.0	2.5	2.1	3.0
MES202	2.3	2.4	2.5	2.3	2.5	3.0	3.0	3.0	1.5	1.7	2.0	2.2
MES203	2.2	2.0	2.0	2.4	-	3.0	3.0	1.5	3.0	2.7	2.6	2.5
MES204	2.7	2.6	2.5	2.3	2.5	2.8	2.3	2.6	2.5	2.6	3.0	2.3
MES206	1.8	2.3	2.7	2.3	1.5	1.0	3.0	2.0	2.3	2.3	2.8	2.6
MES301	2.4	2.0	2.7	2.0	3.0	2.0	2.7	2.6	3.0	3.0	2.7	2.0
MES302	3.0	2.0	2.0	3.0	-	3.0	2.3	2.5	2.0	2.4	3.0	2.3
MES303	2.7	2.6	2.0	2.2	2.0	2.5	3.0	2.2	2.8	3.0	2.7	3.0
MES304 EL-1A	1.0	2.0	2.5	2.4	2.0	3.0	3.0	2.0	2.3	3.0	2.0	2.0
MES304 EL-1B	2.4	1.8	2.6	2.3	2.7	1.8	2.0	2.0	2.9	3.0	2.7	3.0
MES306	2.8	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0	1.7	2.0	1.5
MES401	2.1	2.0	2.6	2.5	2.5	2.0	3.0	2.1	3.0	2.6	2.2	2.4
MES402	2.5	2.0	2.6	2.4	2.0	2.5	3.0	2.0	2.0	3.0	2.0	2.0
MES403	2.3	2.0	2.0	2.0	2.0	2.3	3.0	2.6	2.0	2.0	2.0	1.8
MES404 EL-IIA	2.0	1.5	2.0	2.0	2.5	2.5	3.0	2.0	2.0	3.0	3.0	3.0
MES404 EL-IIB	1.7	2.0	2.5	2.0	-	2.8	2.5	2.0	2.8	3.0	2.2	2.0

Kurukshetra University, Kurukshetra
Institute of Environmental Studies

M. Tech.
(Energy & Environmental Management)

Scheme and Syllabus
(Based on CBCS-LOCF Pattern)
(Effective from 2020-21 in phased manner)

Faculty of Life Science, KUK
(August, 2020)

VISION AND MISSION OF THE INSTITUTE

To contribute to environmental sustainability and wise use of natural resources for the benefit of society through education, research, outreach and networking on the environment.

Programme Outcomes (POs) for PG courses of Faculty of Life Sciences

The PG Courses of Faculty of Life Sciences will be able:

PO1 To acquaint students with recent knowledge and techniques in basic and applied biological sciences.

PO2 To develop understanding of organismal, cellular, biochemical and environmental basis of life.

PO3 To provide insight in to ethical implications of biological research for environmental protection and good laboratory practices and biosafety.

PO4 To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.

PO5 To understand application of biotic material in health, medicine, food security for human well being and sustainable development.

PO6 To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self reliance.

Programme Specific Outcomes of M.Tech. (Energy and Environmental Management)

PSO1 To develop professional skills in students on conservation of energy, new energy resources and environmental management with the use of sustainable techniques.

PSO2 To provide knowledge on renewable and alternate energy resources.

PSO3 To provide knowledge on energy and environment system analysis.

PSO4 To create awareness on sustainable technologies in changing climatic scenarios.

PSO5 To educate students on tools, and modern techniques of energy efficiency and conservation.

PSO6 To provide job-oriented skills with training, seminar and projects.

KURUSKHETRA UNIVERSITY, KURUKSHETRA
INSTITUTE OF ENVIRONMENTAL STUDIES
SCHEME OF EXAMINATION FOR
M.Tech. Energy and Environmental Management (EEM)

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 and Management	Core	4	4	40	60	100
MEMT-103	Energy and Climate Change	Core	4	4	40	60	100
MEMT-104	Research Techniques and Quantitative 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.

KURUSKHETRA UNIVERSITY, KURUKSHETRA
INSTITUTE OF ENVIRONMENTAL STUDIES

SCHEME OF EXAMINATION FOR
M.Tech. Energy and Environmental Management (EEM)

SECOND SEMESTER

Paper Code	Title of Paper	Type of Paper	Hours/Week	Credits	Marks		
					Internal Assessment	Final Examination	Total
MEMT-201	Environmental Assessment and Management	Core	4	4	40	60	100
MEMT-202	Renewable Energy and Technology	Core	4	4	40	60	100
MEMT-203	Environmental Remote Sensing & GIS	Core	4	4	40	60	100
MEMT-204	Environmental Biotechnology and 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.

KURUSKHETRA UNIVERSITY, KURUKSHETRA
INSTITUTE OF ENVIRONMENTAL STUDIES
SCHEME OF EXAMINATION FOR
M.Tech. Energy and Environmental Management (EEM)

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.

KURUSKHETRA UNIVERSITY, KURUKSHETRA
INSTITUTE OF ENVIRONMENTAL STUDIES
SCHEME OF EXAMINATION FOR
M.Tech. Energy and Environmental Management (EEM)

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
MEMT-101

Max. Marks: 60 + 40
Total Credits: 4
Time: 3 Hours

Objectives:

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.

Outcomes: On successful completion of the course, the students will be able to:

CO1 Understand the concepts of ecology, population, community and ecosystems interactions.

CO2 Gain knowledge about concept of sustainable development

CO3 Explain the disturbances in natural environment and their mitigation measures

CO4 Understand cycling of nutrients and energy flow (energy transfer and transformation) in ecosystem.

CO5 Understand the concept, methodology and basic tools of environmental modeling

CO6 Become aware of different modeling approaches, their scope, limitations and applications

CO7 Gain knowledge about different analytical models and their applications in ecological 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.

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.

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.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and sessional tests.

CO-PO MAPPING for MEMT 101

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C101.1	3	2	1	2	2	2
C101.2	2	2	2	2	3	3
C101.3	1	2	-	2	1	3
C101.4	2	3	1	2	2	2
C101.5	2	2	1	2	2	3
C101.6	2	2	2	2	2	2
C101.7	3	3	2	2	3	3
Average	2.14	2.29	1.5	2	2.14	2.57

CO-PSO MAPPING for MEMT 101

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C101.1	1	-	1	1	-	-
C101.2	2	2	2	3	2	1
C101.3	1	-	1	2	-	-
C101.4	-	-	1	-	-	-
C101.5	-	-	3	-	3	1
C101.6	-	1	2	-	3	2

C101.7	2	2	3	1	3	2
Average	1.5	1.7	1.86	1.75	2.75	1.5

ENERGY RESOURCES AND MANAGEMENT
MEMT- 102

Max. Marks: 60+40
Total Credits- 04
Time: 3 Hours

Objectives:
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.

Outcomes: On successful completion of this course, the students will be able to**:**
CO1 Explain the concepts of thermodynamics and earth's energy budget
CO2 Categorize various types of energy resources
CO3 Explain origin and development of fossil fuels and their impacts on environment
CO4 Describe present scenario of solar, wind, tidal, geothermal and bioenergy in India
CO5 Describe management of various energy sources
CO6 Understands OPEC market behaviour and 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.

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.

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.
4. Miller, G.T. 1997. *Environmental Science: Working With the Earth*, Wadsworth Publishing Company, Belmont, California.
6. Singh, J.S., Singh S.P. and Gupta S.R. 2015. *Ecology, Environmental Science andConservation,* S.Chand Publishers, New Delhi.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and sessional tests.

CO-PO MAPPING for MEMT 102

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C102.1	2	2	-	2	1	1
C102.2	1	1	-	2	-	2
C102.3	2	2	-	2	-	1
C102.4	1	-	-	3	-	3
C102.5	-	-	-	3	2	3
C102.6	-	-	-	2	-	3
Average	1.5	1.67	-	2.33	1.5	2.17

CO-PSO MAPPING for MEMT 102

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C102.1	1	-	2	-	2	-
C102.2	2	3	1	2	1	-
C102.3	1	-	1	2	1	-
C102.4	3	3	2	3	2	3
C102.5	2	2	1	2	2	2
C102.6	1	-	2	2	-	1
Average	1.7	2.7	1.5	2.2	1.6	2.0

ENERGY AND CLIMATE CHANGE
MEMT-103

Max. Marks: 60+40
Total Credits- 04
Time: 3 Hours

Objectives: The aim of this course is to provide the knowledge of impacts of use 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.

Outcomes: On successful completion of this course, the students will be able to**:**

CO1: Learn about similarities and differences across the fields of climate, energy and environment with a focus on climate change.
CO2: Understand, analyse and compare the trends of carbon emission at national and international levels.
CO3: Determine the production of green house gases based on energy consumption patterns.
CO4: Identify impacts of climate change on human societies and natural ecosystems.
CO5: Describe the main processes involved in climate change and climate modelling.
CO6: Describe the ethical, scientific, and policy strengths and weaknesses of current and proposed mitigation and adaptation strategies.
CO7: Understand main aspects on climate regulation with focus on its impact on the energy sector.
CO8: Understand the possibilities for sustainable development in terms of future energy use.

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.

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 .

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.
4. Sorokhtin, O.G.,Chilingar, G.V. and Khilyuk, L.F. 2007. *Global warming and global cooling: Evolution of climate and earth*, Elsevier, Netherland.
5. Fouquet R. 2015, *Handbook on Energy and Climate Change*, Edward Elgar Publishing, UK.
6. Cherian A. 2015, *Energy and Global Climate Change: Bridging the Sustainable Development Divide*, Wiley Publisher, New York.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and session tests.

CO-PO MAPPING for MEMT 103

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C103.1	3	1	1	2	2	2
C103.2	3	1	-	3	-	3
C103.3	2	-	-	2	2	3
C103.4	3	2	2	3	2	3
C103.5	3	2	-	3	1	3
C103.6	1	-	3	2	2	2
C103.7	2	1	-	3	-	2
C103.8	1	2	1	3	-	2
Average	2.25	1.5	1.75	2.63	1.8	2.5

CO-PSO MAPPING for MEMT 103

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C103.1	2	1	2	1	1	1
C103.2	2	-	2	1	-	1
C103.3	2	1	3	1	-	2
C103.4	1	-	1	1	-	3
C103.5	2	-	2	-	2	3
C103.6	3	2	1	2	2	2
C103.7	2	2	2	3	1	1
C103.8	3	2	2	3	2	1
Average	2.13	1.6	1.88	1.71	1.6	1.75

RESEARCH TECHNIQUES AND QUANTITATIVE METHODS
MEMT-104

Max. Marks: 60+40
Total Credits: 04
Time: 3 Hours

Objectives:
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.

Outcomes: On successful completion of this course, the students will be**:**

CO1 Able to understand the principles and handling of different analytical instruments and techniques used in the environmental (air, water and soil) analysis, and define the terms associated with the instrumentation.

CO2 Able to understand the applications and limitations of widely used instrumentation of spectroscopy, chromatography and microscopy.

CO3 Trained on the theory and practice of descriptive and inferential statistical tools and techniques to analyze environmental data and deriving meaningful conclusions.

CO4 Capable to understand the basics and types of experimental design for data collection under different environmental conditions.

CO5 Equipped with different methods used in the sampling of air, water and soil.

CO6 Able to learn about methods to assess ecological status of a site by measuring plant biomass and productivity, and soil microbial diversity, soil enzymes and 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

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. Vocational prospects of instrumentation.

Unit - III

Types of data and measurement level; Statistical applications in environmental data analysis, , Measures of Central Location and Dispersion, Probability, Correlation, Significance Test for Correlation, Regression, Standard error of estimate, Null hypothesis and Error Types, Statistical significance, t-test - test of difference between means of two populations 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, Methods of Soil Analysis - soil microbial diversity, soil enzymes and soil carbon. Vocational opportunities of statistical techniques/models.

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.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz and sessional tests.

CO-PO MAPPING for MEMT 104

	PO1	PO2	PO3	PO4	PO5	PO6
C104.1	3	3	2	1	-	3
C104.2	3	3	2	2	-	3
C104.3	3	3	2	3	-	3
C104.4	2	1	2	1	-	2
C104.5	2	3	1	3	-	3
C104.6	2	2	1	2	2	3
Average	2.5	2.5	1.67	2	2	2.83

CO-PSO MAPPING for MEMT 104

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C104.1	2	2	3	1	2	3
C104.2	1	-	2	-	-	2
C104.3	1	2	3	2	2	3
C104.4	1	1	2	-	-	2
C104.5	2	-	2	2	1	3
C104.6	2	1	1	1	1	2
Average	**1.5**	**1.5**	**2.17**	**1.5**	**1.5**	**2.5**

ENVIRONMENTAL ASSESSMENT AND MANAGEMENT
MEMT-201

Max. Marks: 60+40
Total Credits: 04

Time: 3 Hours

Objectives:

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.

Outcomes: On successful completion of this course, the students will be able to**:**

CO1. Develop foundation on the concept and process of environmental impact assessment (EIA).

CO2. Equip with various methods used in the prediction and analyses of data for the environmental impact assessment.

CO3. Explain the role and importance of environmental management systems for a project or an activity.

CO4. Use the concept of sustainability in different areas of a project.

CO5. Practice EIA that examines the environmental consequences of development actions, in advance.

CO6. Carry out energy and environmental auditing of the industries.

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.

UNIT-I

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. National Environmental Policy - 2006, EIA notifications.

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. Vocational prospects of EIA and EMS.

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.
3. Morgan, R.K. 2002. Environmental Impact Assessment: A Methodological Perspective, Kluwer Academic Publishers, London.
4. Morris, P. and Thesivel, R. (Eds.) 2001. Methods in Environmental Impact Assessment. UCL Press, London.
5. Treweek, J. 1999. Ecological Impact Assessment. Blackwell Science, UK.
6. Christopher S. and Mark Y.2002. Installing Environmental Management Systems. EarthScan London.
7. Barrow, C. J. 2005. Environmental Management and Development, Taylor and Francis Group, London and New York.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 201

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C201.1	3	-	-	2	1	2
C201.2	3	-	2	3	-	3
C201.3	2	-	-	2	-	3
C201.4	2	2	1	2	2	2
C201.5	2	1	-	3	-	3
C201.6	3	-	-	2	-	3
Average	**2.5**	**1.5**	**1.5**	**2.3**	**1.5**	**2.7**

CO-PSO MAPPING for MEMT 201

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C201.1	2	-	2	-	-	3
C201.2	2	1	3	1	-	3
C201.3	3	1	3	2	-	2
C201.4	2	2	1	2	2	2
C201.5	2	-	2	2	2	3
C201.6	3	2	3	1	3	3
Average	**2.3**	**1.5**	**2.3**	**1.6**	**2.3**	**2.7**

RENEWABLE ENERGY AND TECHNOLOGY
MEMT-202

Max. Marks: 60 + 40
Total Credits: 4
Time: 3 Hours

Objectives: 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.

Outcomes: On successful completion of this course, the students will be able to:

CO1 Describe various energy alternatives like tar sands and oil shale, tidal energy, wave energy, ocean thermal energy and biomass energy.
CO2 Understand renewable energy types, energy storage and energy conversion systems.
CO3 Explain working, construction and design of energy collectors, absorbers and energy concentrators.
CO4 Design and analyze photovoltaic conversion like PV cells and solar power heaters.
CO5 Understand the concepts of wind energy systems, convertion to wind flow, and wind energy converters.
CO6 Apply the concepts of thermo and bio-chemical process along with newer technologies of biomass conversion to bio-fuels.

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.

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. Vocational prospects of renewable and alternate energy sector.

Unit-II

Indirect and direct solar energy conversion. Photovoltaic conversion: Optical effect of p-n 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 collectors, 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.

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.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 202

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C202.1	3	-	-	2	1	2
C202.2	3	-	1	2	1	2
C202.3	2	-	-	3	-	3
C202.4	1	-	-	3	2	3
C202.5	-	-	-	2	-	2
C202.6	3	-	2	3	2	3
Average	**2.4**	**-**	**1.5**	**2.5**	**1.5**	**2.5**

CO-PSO MAPPING for MEMT 202

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C202.1	2	3	2	1	1	2
C202.2	3	3	1	2	3	2
C202.3	2	2	2	3	2	3
C202.4	2	2	2	2	2	3
C202.5	2	2	2	1	2	2
C202.6	3	2	1	3	2	2
Average	**2.3**	**2.3**	**1.7**	**2**	**2**	**2.3**

ENVIRONMENTAL REMOTE SENSING AND GIS

MEMT- 203

Max. Marks: 60+40
Total Credits: 04
Time: 3 Hours

Objectives:
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.

Outcomes: On completion of this course, the students will have:

CO1. A base for understanding Remote Sensing (RS) and Geographic Information System (GIS) as an IT tool, its purpose and utility for the mankind in general and in geospatial study of environmental components, specifically.
CO2. An understanding of types, process, platforms and sensors used in RS with an emphasis on optical and microwave remote sensing.
CO3. An understating about the elements and techniques of image interpretation of different scales and resolution, concepts and techniques of digital image processing, photogrammetry and aerial photography.
CO4. Profound knowledge about ground verification techniques, spatial and non-spatial data types and sources of different domains and its integration and analysis in a GIS environment, and problem-based designing and management of GIS projects.
CO5. Basic competency in skills with functional knowledge to carry out RS and GIS based projects, and usage of GPS.
CO6. Familiarization about the scope of RS and GIS technology in the field of environment and energy 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.

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.

Unit – II

Remote Sensing - processes, platforms, scanners and sensors; Systems for data collection - passive and active remote sensing; Multispectral Remote Sensing; Concepts and applications of Microwave and LiDAR Remote sensing.

Unit-III

Elements of visual image interpretation, Digital image processing, Image Classifications, Ground truthing, Geo-referencing. Photogrammetry: Basic concepts, Types of aerial photographs. Application of Remote Sensing in Energy, Natural resource management, Disaster management, Urban planning, Coastal zone management etc.

Unit-IV

GIS- basic concept. raster and vector data; Analytical modeling in GIS. GIS project management - problem specific design, implementation and evaluation. GIS application in Natural resource management, Biodiversity, EIA, Solid waste management, Disaster management etc. Vocational prospects of remote sensing and GIS.

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).

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 203

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C203.1	-	2	-	2	-	2
C203.2	-	2	-	2	-	3
C203.3	-	1	-	2	-	3
C203.4	-	-	-	2	-	3
C203.5	-	2	-	3	2	3
C203.6	-	2	-	3	2	3
Average	**-**	**1.8**	**-**	**2.3**	**2**	**2.8**

CO-PSO MAPPING for MEMT 203

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C203.1	2	1	2	3	1	3
C203.2	2	-	1	2	1	3
C203.3	2	-	2	2	-	3
C203.4	2	-	2	2	-	3
C203.5	3	2	3	3	2	3
C203.6	3	2	3	3	3	3
Average	**2.3**	**1.7**	**2.2**	**2.5**	**1.8**	**3**

ENVIRONMENTAL BIOTECHNOLOGY AND BIOFUELS
MEMT-204

Max. Marks: 60+40
Total Credits: 04
Time: 3 Hours

Objectives:

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

Outcomes: On completion of this course, the students will able to:

CO1: Understand the applications of environmental biotechnology in different areas of bioremediation.
CO2: Understand the concept and application of biosensors to assess the pollutants in environment.
CO3: Demonstrate the understanding of biotechnological tools used in forest management and biodiversity conservation.
CO4: Understand the concept of biological treatment for wastewater.
CO5: Demonstrate the basics of GMOs, biosafety guidelines and IPR.
CO6: Understand the concept of biofuel production and biorefineries.

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.

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, Biosafety and Bioethics guidelines. IPR and environment. Vocational prospects of environmental biotechnology.

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.

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: Soil Remediation*, Kluwer Academic Publishers, Springer-Verlag , New York.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 204

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C204.1	3	-	-	2	3	3
C204.2	3	-	-	2	3	3
C204.3	3	2	2	2	3	3
C204.4	2	1	2	3	2	2
C204.5	2	-	3	2	2	3
C204.6	3	-	2	3	2	2
Average	**2.7**	**1.5**	**2.3**	**2.3**	**2.5**	**2.7**

CO-PSO MAPPING for MEMT 204

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C204.1	2	3	2	2	2	3
C204.2	2	2	2	2	1	3
C204.3	2	2	2	2	-	3
C204.4	2	-	1	-	1	3
C204.5	1	-	1	1	-	3
C204.6	3	3	2	3	3	3
Average	**2**	**2.5**	**1.7**	**2**	**1.8**	**3**

ENERGY CONSERVATION AND EFFICIENT SYSTEMS
MEMT- 301 (EL-1A)

Max.Marks: 60+40

Total Credits: 04
Time: 3 Hours

Objectives:
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.

Outcomes: On completion of this course, the students will have:
CO1 Knowledge on fundamentals of conservation of energy, energy conservation programmes and different energy scenarios.
CO2 Knowledge on technologies of energy conservation and sustainable energy.
CO3 Awareness on the basics of energy efficiency, methodologies to improve energy efficiency and its effects.
CO4 Understanding on the concepts of energy efficient buildings and utilities such as pumps, motors, fans windows, lighting, compressed air systems, refrigeration and air conditioning system.
CO5 Knowledge about different renewable energy systems such as solar thermal and solar photovoltaic, wind, ocean wave and tidal, geothermal, biomass, nuclear and their applications.
CO6 Familiarization with Bureau of Energy Efficiency (BEE) and star rating concept.

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.

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 of buildings.

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 and energy recovery in urban ecosystems. Energy efficiency in buildings (green building), solar water heating system.

Unit-IV

Wave tidal power technologies. geothermal, nuclear, alternative transport fuels, Energy efficient vehicles technologies - Advance ICE, Hybrid electric, Plug-in hybrid, Flex-fuel, Fuel Cell technology, energy efficient motors, windows, lighting. Energy efficient pumps, fans, compressed air systems, refrigeration and air conditioning systems. Waste heat recovery. Bureau of energy efficiency, Concept of Star rating.

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.
3. Kreithand F., Goswami D.Y., *Handbook of Energy Efficiency and Renewable Energy*, C.R.C. Press.
4. Kreith. F., Goswami. D.Y.2007. *Handbook of Energy Efficiency and Renewable Energy*, Taylor & Francis Group, LLC
5. Owen, Oliver S. and Chiras, Daniel D. (1990). *Natural Resource Conservation-An Ecological Approach* Macmillon, New York.
6. Wiley J.S., Turner W.C., *Energy Management Handbook*.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 301-EL-1A

	PO1	PO2	PO3	PO4	PO5	PO6
C301EL1A.1	-	1	-	2	-	2
C301EL1A.2	-	-	-	3	2	2
C301EL1A.3	-	-	2	3	2	3
C301EL1A.4	-	-	-	3	-	3
C301EL1A.5	-	2	1	3	1	3
C301EL1A.6	-	-	-	1	-	2
Average	**-**	**1.5**	**1.5**	**2.5**	**1.7**	**2.5**

CO-PSO MAPPING for MEMT 301-EL-1A

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C301EL1A.1	3	2	1	2	1	-
C301EL1A.2	3	3	2	3	2	2
C301EL1A.3	2	3	-	3	3	3
C301EL1A.4	2	1	-	2	2	2
C301EL1A.5	2	3	2	2	3	2
C301EL1A.6	1	-	2	-	2	1
Average	**2.2**	**2.4**	**1.8**	**2.4**	**2.2**	**2**

Environmental Bioremediation Technology
MEMT-301 (EL-1B)

Max. Marks: 60 + 40
Total Credits-04
Time: 3 Hours

Objectives:
The aim of this course is to make students understand biotransformation, biodegradation of xenobiotics, bioremediation strategies and their applications for cleanup of environmental contaminants. The students will be able to understand the various applications of bioremediation technologies and the kinetics and modelling of biodegradation.

Outcomes: On completion of this course, the students will able to:
CO1: Understand the characteristics and bioremediation of xenobiotic compounds.
CO2: Develop skills to apply the different bioremediation techniques for the degradation of toxic contaminants.
CO3: Understand the process of phytoremediation and role of algae and fungi in bioremediation.
CO4: Understand the application of genetic engineering in phytoremediation.
CO5: Understand the bioremediation processes for gaseous pollutants, role and applications of biosensors in remediation technologies

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.

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.

Suggested Reading:

1. Scragg A., 2008. *Environmental Biotechnology*, Oxford Univesity Press. New York
2. Singh S.N., Tripathi R.D., 2007. *Environmental Bioremediation Technologies*, Springer, New York.
3. Mohapatra P.K. 2007. *Textbook of Environmental Biotechnology*, I.K. Publishing House, New Delhi.
4. Olguin E.J., Sanchez G., Hernandez E. 2005. Environmental Biotechnology and Cleaner Processes, Replika Press, Kundli.
5. Trivedi P.C. 2008. Pollution and Bioremediation, Sheetal Printer, Jaipur, India.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 301-EL-1B

	PO1	PO2	PO3	PO4	PO5	PO6
C301EL1B.1	2	2	1	1	2	2
C301EL1B.2	3	3	3	3	2	3
C301EL1B.3	3	3	1	2	3	3
C301EL1B.4	3	3	1	2	3	3
C301EL1B.5	3	2	2	2	2	3
Average	**2.8**	**2.6**	**1.6**	**2.0**	**2.4**	**2.8**

CO-PSO MAPPING for MEMT 301-EL-1B

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C301EL1B.1	2	-	-	1	2	2
C301EL1B.2	3	2	2	2	3	3
C301EL1B.3	2	2	3	2	1	2
C301EL1B.4	2	1	2	3	1	2
C301EL1B.5	2	1	3	3	1	2
Average	**2.2**	**1.5**	**2.5**	**2.2**	**1.6**	**2.2**

ENVIRONMENTAL POLICIES, LAW AND IMPACT ASSESSMENT
MEMT- 301 (EL - 1C)

Max.Marks: 60+40
Total Credits: 04
Time: 3 Hours

Objectives:

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 EIA and environment clearance for systematic assessment of industrial and infrastructural projects.

Outcomes: A student after taking up this course would be able

CO1: To acquire values and attitude towards understanding various environmental policies and constitutional framework governing environment in India.

CO2: To learn and apply various environmental legislations/acts in India.

CO3: To understand the emerging environmental issues and key international treaties for environment protection.

CO4: To clarify the concepts of EIA and develop the professional skills necessary to enable them to undertake environment impact assessment

CO5: Learn through a variety of professional tools used in predicting environmental impacts.

CO6: Experience their own perspective through various case-studies on impact assessment and developing critical thinking for shaping strategies for environmental management planning, environment auditing and risk assessment

CO8: To understand the recent trends in energy investment, pricing and energy utilisation through various policies and modelling.

CO9: To understand the energy conservation strategies and role of BEE (Bureau of Energy Efficiency) in conservation.

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.

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, Forest and Climate Change (MoEF&CC), 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.

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 and Conservation*, S.Chand Publishers, New Delhi.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 301-EL-1C

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C301EL1C.1	1	-	2	1	-	2
C301EL1C.2	-	-	2	2	-	2
C301EL1C.3	1	2	-	3	2	3
C301EL1C.4	-	-	2	3	2	3
C301EL1C.5	-	2	2	1	2	3
C301EL1C.6	2	2	2	3	2	3
C301EL1C.7	-	-	-	3	2	3
C301EL1C.8	2	-	1	2	1	3
Average	**1.5**	**2**	**1.8**	**2.3**	**1.8**	**2.8**

CO-PSO MAPPING for MEMT 301-EL-1C

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C301EL1C.1	1	-	1	-	-	1
C301EL1C.2	2	-	-	-	-	2
C301EL1C.3	2	1	1	2	-	2
C301EL1C.4	2	-	2	1	1	3
C301EL1C.5	1	-	2	2	-	2
C301EL1C.6	2	1	2	1	1	2
C301EL1C.7	2	2	2	2	2	3
C301EL1C.8	2	2	2	2	2	2
Average	**1.75**	**1.5**	**1.71**	**1.67**	**1.5**	**2.13**

INDUSTRIAL ENERGY
MEMT-302 (EL - 2A)

Max. Marks: 60 + 40
Total Credits- 4
Time: 3 Hours

Objectives:

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.

Outcomes: On successful completion of this course, the students will be able to:

CO1 Understand energy conservation potential in various industries
CO2 Have a basic knowledge of energy storage systems and industrial safety measures
CO3 Identify energy savings opportunities in thermal and electrical systems
CO4 Apply the knowledge in waste heat recovery and heat exchanger networking
CO5 Understand hydrogen fuel technology
CO6 Apply the knowledge of energy saving measures in different energy intensive process industries

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.

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 and ILO Convention and Recommendations in the furtherance of safety and health.

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 and air 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. Aluminium, Iron and Steel, Cement and their case Studies; Railways, Ports, Transport Sector, Power Stations and their case studies.

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.
3. Doty S. and Turner W.C., 2012,"Energy Management Handbook" Eighth Edition, Wiley Eastern Publication, New York.
4. Dryden I.G.C. 1982, *"The Efficient Use of Energy"*, Butterworths, London,.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 302-EL-2A

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C302EL2A.1	2	-	-	3	1	3
C302EL2A.2	-	-	2	3	2	3
C302EL2A.3	-	2	-	2	2	3
C302EL2A.4	-	-	1	3	2	3
C302EL2A.5	2	2	2	2	2	2
C302EL2A.6	-	-	-	2	2	3
Average	**2**	**2**	**1.7**	**2.5**	**1.8**	**2.8**

CO-PSO MAPPING for MEMT 302-EL-2A

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C302EL2A.1	1	1	1	1	1	2
C302EL2A.2	1	-	2	2	2	3
C302EL2A.3	2	1	1	2	2	2
C302EL2A.4	2	2	2	3	3	2
C302EL2A.5	2	2	1	2	2	1
C302EL2A.6	3	-	2	3	3	3
Average	**1.83**	**1.5**	**1.5**	**2.17**	**2.17**	**2.17**

ENERGY FROM WASTE
MEMT-302 (EL-2B)

Max.Marks: 60+40
Total Credits: 04
Time: 3 Hours

Objectives:

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.

Outcomes: On successful completion of this course, the students will be able to:

CO1 Understand different sources of wastes and various properties of wastes as a fuel
CO2 Select technologies for waste disposal and energy recovery from wastes
CO3 Apply the concepts of thermo and bio-chemical process along with newer technologies of energy generation from wastes.
CO4 Identify environmental impacts of energy generation techniques
CO5 Have knowledge of biofuels, their production and purification methods, and applications in the country economy.
CO6 Apply the knowledge about the operations of waste to energy plants

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.

Unit-I

Definition, classification and 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. Vocational prospects of waste to energy.

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**.**

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.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 302-EL-2B

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C302EL2B.1	2	2	2	-	2	1
C302EL2B.2	2	2	-	3	3	3
C302EL2B.3	3	3	2	2	2	3
C302EL2B.4	-	-	-	2	2	2
C302EL2B.5	3	3	2	2	3	3
C302EL2B.6	2	2	-	2	3	3
Average	**2.4**	**2.4**	**2**	**2.2**	**2.5**	**2.5**

CO-PSO MAPPING for MEMT 302-EL-2B

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C302EL2B.1	1	1	1	-	1	1
C302EL2B.2	3	3	2	3	2	3
C302EL2B.3	2	2	2	3	3	3
C302EL2B.4	1	-	2	1	-	2
C302EL2B.5	2	3	1	3	2	2
C302EL2B.6	2	1	2	3	3	3
Average	**1.8**	**2**	**1.7**	**2.6**	**2.2**	**2.3**

ENVIRONMENTAL MODELLING
MEMT- 302 (EL-2C)

Max. Marks: 60+40
Total Credits: 04
Time: 3 Hours

Objectives:

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.

Outcomes: On completion of this course, the students will have:

CO1 A basic understanding on model development and about the concepts of system and simulation.

CO2 An understanding about different modelling practices such as simple and complex calculation models, linear and non-linear models, optimization models, probabilistic models.

CO3 An understating about the predictive and forecasting modelling of air pollution and its transport.

CO4 Knowledge on surface water modeling and groundwater modeling techniques.

CO5 Basic competency in skills with application of modelling techniques in the different environmental applications such as natural resource management, climate change, forecast services, and 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.

Unit I

Principles of model development and solution for environmental systems (air, water and soil), Basic steps in the model development: problem definition, model design and development and evaluation. Concept of system modeling and simulation. Simple and complex calculation models, linear and 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 fugitive emissions,

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.

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

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz, sessional tests and seminars.

CO-PO MAPPING for MEMT 302-EL-2C

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C302EL2C.1	2	1	-	3	3	2
C302EL2C.2	2	1	-	3	3	3
C302EL2C.3	2	2	-	2	2	3
C302EL2C.4	2	2	-	2	2	3
C302EL2C.5	2	2	2	3	3	3
Average	**2**	**1.6**	**2**	**2.6**	**2.6**	**2.8**

CO-PSO MAPPING for MEMT 302-EL-2C

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C302EL2C.1	1	-	2	1	1	1
C302EL2C.2	3	-	2	1	-	2
C302EL2C.3	2	-	2	2	-	2
C302EL2C.4	2	-	2	2	-	2
C302EL2C.5	3	2	3	3	2	3
Average	**2.2**	**2**	**2.2**	**1.8**	**1.5**	**2**

Dissertation Work
MEMT-401

Max. Marks:250
Total Credits: 10

Objectives

The dissertation provides practical knowledge and skills in the area of energy and environment in the industry or research institute or consultancy. The students receive analytical and problem-solving skills to implement solutions to firm-specific problems which, in turn, also enhance their career prospects.

Outcomes: On completion of the dissertation, the students will be able to:

CO1 Implement knowledge and skills they learnt during the programme in solving specific energy and environment management problems.

CO2 Develop competencies for research, innovations and practical applications.

CO-PO mapping matrix for MEMT-401

	PO1	PO2	PO3	PO4	PO5	PO6
C401.1	3	3	3	3	3	3
C401.2	3	2	2	3	3	3
Average	3	2.5	2.5	3	3	3

CO-PSO mapping matrix for MEMT-401

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C401.1	3	3	3	3	3	3
C401.2	3	3	3	3	3	3
Average	3	3	3	3	3	3

Progressive Seminar/Laboratory Development Work
MEMT-404

Max. Marks: 50
Total Credits: 02

Objectives :
The Progressive Seminar/Laboratory Development work provides an opportunity to students to present the work they executed during their dissertation in industries/organizations, physical laboratories and virtual laboratories such as computer-simulated modelling. The progressive seminar/laboratory learning provides opportunities for students to relate and strengthen the theoretical/practical concepts they learn.

Outcomes: Through seminars and lab development work, the students learn to:

CO1. Present their work including methods adopted, techniques learnt and practical competence acquired during the dissertation.
CO2. Enrich their knowledge/learning in emerging areas related to the subject.

CO-PO mapping matrix for course Progressive Seminar/Laboratory Development Work

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C404.1	3	3	3	3	3	3
C404.2	2	2	2	3	2	3
Average	**2.5**	**2.5**	**2.5**	**3**	**2.5**	**3**

CO-PSO mapping matrix for course Progressive Seminar/Laboratory Development Work

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
C404.1	3	2	2	2	2	3
C404.2	3	3	3	2	2	3
Average	**3**	**2.5**	**2.5**	**2**	**2**	**3**

CO-PO-PSO mapping matrix for all the courses of M.Tech. (Energy and Environmental Management)

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C101	2.14	2.29	1.5	2	2.14	2.57	1.5	1.7	1.86	1.75	2.75	1.5
C102	1.5	1.67	-	2.33	1.5	2.17	1.7	2.7	1.5	2.2	1.6	2.0
C103	2.25	1.5	1.75	2.63	1.8	2.5	2.13	1.6	1.88	1.71	1.6	1.75
C104	2.5	2.5	1.67	2	2	2.83	1.5	1.5	2.17	1.5	1.5	2.5
C201	2.5	1.5	1.5	2.33	1.5	2.67	2.33	1.5	2.33	1.6	2.33	2.67
C202	2.4	-	1.5	2.5	1.5	2.5	2.33	2.33	1.7	2	2	2.33
C203	-	1.8	-	2.33	2	2.83	2.33	1.7	2.17	2.5	1.75	3
C204	2.67	1.5	2.25	2.33	2.5	2.67	2	2.5	1.67	2	1.75	3
C301EL1A	-	1.5	1.5	2.5	1.67	2.5	2.17	2.4	1.75	2.4	2.17	2
C301EL1B	2.8	2.6	1.6	2.0	2.4	2.8	2.2	1.5	2.5	2.2	1.6	2.2
C301EL1C	1.5	2	1.83	2.25	1.83	2.75	1.75	1.5	1.71	1.67	1.5	2.13
C302EL2A	2	2	1.7	2.5	1.8	2.8	1.83	1.5	1.5	2.17	2.17	2.17
C302EL2B	2.4	2.4	2	2.2	2.5	2.5	1.83	2	1.7	2.6	2.2	2.33
C302EL2C	2	1.6	2	2.6	2.6	2.8	2.2	2	2.2	1.8	1.5	2
C401	3	2.5	2.5	3	3	3	3	3	3	3	3	3
C404	2.5	2.5	2.5	3	2.5	3	3	2.5	2.5	2	2	3