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 combatthe 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