SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

SYLLABUS FOR

M.Sc. Environmental Science

(Two-Year Course- Semester System)

School of Basic and Applied Sciences

(Effective from Academic Session 2023-2024)

Revised on 30 July 2024

Master of Science (Environmental Science)

OUTCOME BASED EDUCATION

Programme outcomes (POs)

Students will be able to:

PO1	Implement strong theoretical and practical knowledge of biological science to solve complex scientific problems.
PO2	Problem Analysis: Identify the situation-based problem, formulation and action taken based on analytical thinking and principles of science.
PO3	Execute effective communication through interactive and presenting skills, technical report writing and proper documentation of ideas.
PO4	Formulate, design, experimental techniques, scientific tools, analysis of scientific data, interpretation of data and establish a hypothesis for various interdisciplinary research problem.
PO5	Create a new conceptual, theoretical and operational approach to address various problem of interdisciplinary fields.
PO6	Enables individuals to function effectively in cross-cultural environment as an individual and as a member or leader.
PO7	Understand the ethical issues, academic and research ethics, need and value of adding, learning, scientific misconduct of a scientist to serve society.
PO8	Understand the contribution of scientific knowledge in environmental sciences for sustainable development.
PO9	Enhance and adopt employability skills through research, internship and dissertation.
PO10	Successfully compete at the state level, national level and international level exams or competition.
PO11	Understand the complex evolutionary complex processes and behaviour of animals.
PO12	Understanding of environmental conservation processes and its importance, pollution control and biodiversity and protection of endangered species.

Program Specific Outcome (PSOs)

After completion of this course, the student will be able to

PSO 1	Understand the nature and basic concepts of environment, its different spheres, structure and function of ecosystem, pollution and its abatement, natural resources-depletion and management, ecology and biodiversity, climate change, and laws, acts and policies related to environment.
PSO2	Employ experimental skills for multi-disciplinary research work.
PSO3	Analyze the applications of environmental sciences in soil science, agriculture, industries, medicines, meteorology, wild life conservation, environmental impact assessment and disaster management.
PSO4	Gain knowledge about research methodologies, effective communication and skills.

Eligibility for admission:

Any candidate who has passed the B.Sc./B.Tech/BE with not less than 45% marks in aggregate is eligible for admission. However, SC/ST, OBC, and other eligible communities shall be given relaxation as per university norms.

Duration of the Programme: 2 Years (4 semesters)

STUDY & EVALUATION SCHEME
Choice-Based Credit System
Master of Science
(Environmental Science)

First Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC101	Fundamentals of Environmental Sciences	3	0	0	03	40	60	100
2	Core	MESC102	Man, and Environment	3	0	0	03	40	60	100
3	Core	MESC103	Natural Resource Management	3	0	0	03	40	60	100
4	Core	MESC104	Environmental Chemistry and Instrumentation	3	0	0	03	40	60	100
Practical										
1	Core	MESL105	Lab Course-I (Based on MESC101 and MESC102)	0	0	4	04	40	60	100
2	Core	MESL106	Lab Course-II (Based on MESC103 and MESC104)	0	0	4	04	40	60	100
			Total							600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC201	Ecological Monitoring and Pollution Control	3	0	0	03	40	60	100
2	Core	MESC202	Energy Resources and Management	3	0	0	03	40	60	100
3	Core	MESC203	Environmental Microbiology and Environmental Biotechnology	3	0	0	03	40	60	100
4	Core	MESC204	Freshwater Ecology	3	0	0	03	40	60	100
Practical										
1	Core	MESL205	Lab Course-I (Based on MESC201 and MESC202)	0	0	4	04	40	60	100
2	Core	MESL206	Lab Course-II (Based on MESC203 and MESC204)	0	0	4	04	40	60	100
Total										600

L – Lecture, T – Tutorial, P – Practical, C – Credit

SGRR UNIVERSITY, DEHRADUN

Program Name: M.Sc. Environmental Science

STUDY & EVALUATION SCHEME
Choice-Based Credit System
Master of Science
(Environmental Science)

First Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC101	Fundamentals of Environmental Sciences	3	0	0	03	40	60	100
2	Core	MESC102	Man, and Environment	3	0	0	03	40	60	100
3	Core	MESC103	Natural Resource Management	3	0	0	03	40	60	100
4	Core	MESC104	Environmental Chemistry and Instrumentation	3	0	0	03	40	60	100
Practical										
1	Core	MESL105	Lab Course-I (Based on MESC101 and MESC102)	0	0	4	04	40	60	100
2	Core	MESL106	Lab Course-II (Based on MESC103 and MESC104)	0	0	4	04	40	60	100
			Total							600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC201	Ecological Monitoring and Pollution Control	3	0	0	03	40	60	100
2	Core	MESC202	Energy Resources and Management	3	0	0	03	40	60	100
3	Core	MESC203	Environmental Microbiology and Environmental Biotechnology	3	0	0	03	40	60	100
4	Core	MESC204	Freshwater Ecology	3	0	0	03	40	60	100
Practical										
1	Core	MESL205	Lab Course-I (Based on MESC201 and MESC202)	0	0	4	04	40	60	100
2	Core	MESL206	Lab Course-II (Based on MESC203 and MESC204)	0	0	4	04	40	60	100
Total										600

L – Lecture, T – Tutorial, P – Practical, C – Credit

STUDY & EVALUATION SCHEME
Choice-Based Credit System
Master of Science
(Environmental Science)

First Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC101	Fundamentals of Environmental Sciences	3	0	0	03	40	60	100
2	Core	MESC102	Man, and Environment	3	0	0	03	40	60	100
3	Core	MESC103	Natural Resource Management	3	0	0	03	40	60	100
4	Core	MESC104	Environmental Chemistry and Instrumentation	3	0	0	03	40	60	100
Practical										
1	Core	MESL105	Lab Course-I (Based on MESC101 and MESC102)	0	0	4	04	40	60	100
2	Core	MESL106	Lab Course-II (Based on MESC103 and MESC104)	0	0	4	04	40	60	100
			Total							600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC201	Ecological Monitoring and Pollution Control	3	0	0	03	40	60	100
2	Core	MESC202	Energy Resources and Management	3	0	0	03	40	60	100
3	Core	MESC203	Environmental Microbiology and Environmental Biotechnology	3	0	0	03	40	60	100
4	Core	MESC204	Freshwater Ecology	3	0	0	03	40	60	100
Practical										
1	Core	MESL205	Lab Course-I (Based on MESC201 and MESC202)	0	0	4	04	40	60	100
2	Core	MESL206	Lab Course-II (Based on MESC203 and MESC204)	0	0	4	04	40	60	100
Total										600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Third Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC301	Environmental Economics, Environmental Sociology and Sustainable Development	3	0	0	03	40	60	100
2	Core	MESC302	Remote Sensing, GIS and Environmental Statistics	3	0	0	03	40	60	100
3	Elective- I	MESE304	Climatology and Environmental Modelling	3	0	0	03	40	60	100
4		MESE305	Environmental Geosciences and Disaster Management	3	0	0	03	40	60	100
5	Elective- II	MESE306	Biodiversity Conservation and Restoration Ecology	3	0	0	03	40	60	100
6		MESE307	Environmental Toxicology	3	0	0	03	40	60	100
7	Self-Study	MESS309	History and Philosophy of Sciences	3	0	0	03	40	60	100
8	Self-Study	MESS310	Himalayan Wildlife	3	0	0	03	40	60	100
Practical										
1	Core	MESL303	Lab Course-I (Based on MESC301 and MESC302)	0	0	4	04	40	60	100
2	Core	MESL308	Lab Course-II (Based on Elective I and Elective II)	0	0	4	04	40	60	100
Total										600

L – Lecture, T – Tutorial, P – Practical, C – Credit
*Self-study marks not to be included while calculating grades.

Fourth Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MESC401	Environment Management: EIA and Auditing	3	0	0	3	40	60	100
2	Core	MESC402	Environmental laws, Ethics and Policies	3	0	0	3	40	60	100
3	Elective	MESE404	Dissertation	-	-	-	10	60	240	300
4	Elective-I	MESE405	Mountain Ecology	3	0	0	3	40	60	100
5	Elective- II	MESE406	Wildlife Conservation and Management	3	0	0	3	40	60	100
6	Elective- III	MESE407	Climate Change and Sustainable Development	3	0	0	3	40	60	100
7	Elective- IV	MESE408	Solid Waste Management	3	0	0	3	40	60	100
8	Self-Study	MESS410	Traditional Ecological Knowledge	3	0	0	3	40	60	100
Practicals										
1	Core	MESL403	Lab Course I (Based on MESC401 and MESC402)	0	0	4	04	40	60	100
2	Elective	MESL409	Lab Course II (Based on Elective I and Elective II)	0	0	4	04	40	60	100
			Total	12		6	26	240	360	600

L – Lecture, T – Tutorial, P – Practical, C – Credit

#Dissertation (in lieu of the elective courses) shall be allotted to the students securing above 70% in the First & Second Semester together. The dissertation (academic writing based on original research/Training) shall be evaluated jointly by an internal examiner and one external examiner.

Total Credits 80 (60 core credit+20 elective+6 self-study)

The distribution of marks for the Dissertation will be as below:

Periodical Presentation	: 40 Marks
Dissertation	: 100 Marks
Viva Voce	: 60 Marks
Total	: 200 Marks

The dissertation/ project report shall be evaluated jointly by the supervisor and one external examiner.

Abbreviation:
MESC (M-Master, ES- Environment Science, C-Core) MESE (M-Master, ES- Environment Science, E-Elective) MESL (M-Master, ES- Environment Science, L-Lab Course) MESS (M-Master, ES- Environment Science, S-Self Study) L (Lecture) T (Tutorial) P (Practical) IA (Internal Assessment), ESE (End Semester Examination)

(03 credits of self-study shall be mandatory but not to be included while calculating the grades).

01 credits= 01 hours of lecture/instructions per week, 01 credit course= 15 hours of lecture per semester

Max. Marks for each paper: 100 (40 marks Sessional Tests/exam + 60 marks End Term Test/Exam).

Sessional may be in the form of Mid Term Test/exam, Assignment, Seminar & Laboratory Work, Internship, Industrial / Institutional visits, winter/Summer Training based report Writing & Presentation, Report based on field trips, excursions, etc. organized by the Department.

Examination Scheme:

Components	Ist internal (Assignment/Presentation-I, etc.)	IInd Internal (Written Exam/Attendance/Presentation-II, etc.)	External (ESE)
Weightage (%)	20 Marks	20 Marks	60
Weightage (%) Dissertation	30 Marks	30 Marks	240

Course code	**: MESC101**				
Course Name	**: Fundamentals of Environmental Science**				
Semester	**: Ist sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop an understanding about the basic concepts of environment – its structure and functions, interrelationships among organisms and interaction with the abiotic factors.

Course Contents **No. of Credits=03**

Unit I. Environment

1.1. Definition, scope and importance of Environmental Sciences
1.2. Components of environment: atmosphere, hydrosphere, lithosphere and biosphere
1.3. Concept of Biosphere-2, Noosphere and Technosphere

Unit II. Ecosystem

2.1. Structure of an ecosystem
2.2 Major ecosystems: Himalaya, Marine ecosystems, Deserts, Freshwater ecosystems, Forests and Antarctica ecosystem
2.2. Energy pathways and ecological processes
2.3. Ecosystem productivity (primary and secondary)
2.4. Biogeochemical cycles: Nitrogen, Carbon, Phosphorus, Sulphur, Water and Oxygen
2.5. Food chain, food web and ecological pyramids
2.6. Ecosystem goods and services

Unit III. Population, Community, Ecological Succession

3.1. Characteristics of population
3.2. Population growth
3.3. Concept and characteristics of communities (concept of habitat, niche, keystone species, dominant species, flagship species and ecotones)
3.4. Ecological succession: primary and secondary succession, climax communities and trends in succession
3.5 Ecological adaptations (air, hill stream water, desert and deep sea)

Unit IV. Self-Sustenance of Ecosystem

4.1. Homeostasis in natural ecosystems
4.2. Ecosystem stability and resilience
4.3. Biodiversity and ecosystem stability
4.4 Drivers influencing ecosystem stability

Unit V. Meteorology

5.1. Meteorological parameters: temperature, pressure, precipitation, humidity, radiation, wind and clouds
5.2. First and second laws of Thermodynamics
5.3. Heat transferring process and stability
5.4. Inversion and mixing heights, wind roses

5.5. Concept of weather, seasons and climate

Suggested Reading

1. Odum: Fundamentals of Ecology (Saunders, 1971)
2. Odum: Basic Ecology (Saunders, 1985)
3. Turk and Turk: Environmental Science (4rth ed. Saunders, 1993)
4. Primark: A Primer of Conservation Biology (2nd ed. Sinauer Associates)
5. Calabrese: Pollutants and High-Risk Groups (John Wiley,1978)
6. Raven, Berg, Johnson: Environment (Saunders College Publishing, 1993)
7. Sharma: Ecology and Environment (Rastogi Publication, 7th ed. 2000)
8. Y.K. Singh: Environmental Science (NEW AGE INTERNATIONAL (P) LIMITED, PUBLISHERS, 2006)

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To demonstrate comprehensive understanding of the environment, environmental processes, theories and ethics.
CO2	To recognize the resource management and sustainability relationship.
CO3	To evaluate the interactions between different spheres of environment.
CO4	To analyse the measures for ecosystem stability and resilience to the climate change.
CO5	To understand the alterations in environment quality and their causes as well as impacts.
CO6	To develop an understanding of heat balance of the earth and climate variability

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	-	-	-	-	3	3	1	3	2	1	2	-
CO2	3	2	-	3	1	1	1	3	2	3	3	1	1	2
CO3	1	-	1	1	-	-	2	2	-	3	1	2	2	1
CO4	3	1	-	1	2	1	1	3	-	1	2	3	1	1
CO5	3	2	-	-	1	-	2	2	2	2	2	1	2	1
CO6	2	1	1	1	-	-	2	3	-	3	2	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MESC102			
Course Name	: Man and Environment			
Semester	: I[st] sem			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop an understanding towards the current environmental issues arising from urbanization and technological development, and analyzing its impact and mitigation approach.

Course Contents **No. of Credits 03**

Unit I. Man and Environment Relationship

1.1. Pre-historic man and environment
1.2. Hunting and Gathering society and environment
1.3. Pastoralism and environment
1.4. Agro-society and environment
1.5. Industrial society and environment
1.6. Future Society (Sustainable Society)

Unit II. Religion, Culture and Environment

2.1. Role of religion, culture and traditions in conserving environment
2.2. Hinduism and environment
2.3. Buddhism and environment
2.4. Islam and environment
2.5. Christianity and environment
2.6. Sacred grooves and sacred landscapes

Unit III. Environmental Issues and Problems: Causes, Concepts and Control

3.1. Greenhouse effect, global warming and climate change
3.2. Ozone layer depletion
3.3. Acid rains
3.4. Deforestation in the Himalaya
3.5. Desertification
3.6. El Nino, ENSO
3.7. Eutrophication in lakes
3.8. Mega dams and environment (Tehri dam, Narmada dam, Almetti dam)
3.9. Various activities under National Environment Awareness Campaigns (NEAC)

Unit IV. Politics of Ecosystems

4.1. International and National water disputes
4.2. International coastal zone conflicts
4.3. Conflicts on emission of greenhouse gases

Suggested Reading:

1. E.P. Odum and G.W. Barrett. 2005. Fundamentals of Ecology. Cengage Learning India Pvt. Ltd.
2. J.S. Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment & Resource Conservation.

Anamaya Publications.
3. Environmental Science — S. C. Santra, New Central Book Agency.
4. Ecology a bridge between science & society, by E. P. Odum, Sinauer associates.

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	To understand the different aspects of humans and their environment
CO2	To identify and analyze the role of social structures (culture, religion, history, urbanization etc.) in the distribution of impacts and responses to environmental issues
CO3	To develop attitude towards the current environmental issues arising from urbanization and technological development, and analyzing its impact and mitigation approach
CO4	To identify possible future implications of societal approaches to the environment
CO5	To demonstrate sound understanding of social and cultural diversity in environment-society relations around the world
CO6	To apply a critical mind in finding the solutions of national and international socio-environmental conflicts, by strengthening environmental governance and policy interventions

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	-	1	-	1	3	2	1	3	1	2	2
CO2	3	3	1	2	2	1	1	2	1	-	3	-	1	1
CO3	3	2	-	1	1	-	1	2	1	2	2	2	1	2
CO4	1	1	-	2	1	-	1	3	-	1	2	-	1	1
CO5	1	1	-	1	1	2	3	2	-	2	2	2	2	2
CO6	2	2	-	2	1	2	3	2	-	3	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MESC103				
Course Name	: Natural Resource Management				
Semester	: I[st] sem				
		L	T	P	C
		3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop an insight into natural resource management- resource exploitation, challenges faced and strategies to be adopted for their management.

Course Contents **No. of Credits=03**

Unit I. Principles of Natural Resource Management

1.1. Natural resources- concepts, kinds and their values
1.2. Factors influencing resource availability, distribution and uses
1.3. Process of resource depletion
1.4. Resource management: preservation, conservation and restoration
1.5. Ecological principles of natural resource conservation
1.6. Ancient ethics for conservation and management of natural resources

Unit II. Forest Resources and their Management

2.1. Forest resources: Major Forest types, their characteristics, forest vegetation, status, distribution and ecosystem services
2.2. Forest use and over exploitation: Timber extraction, mining, dams and their effects on forest and tribal people
2.3. Forest management practices including Joint Forest Management (JFM)
2.4. National Forest Policy

Unit III. Wildlife Resources and their Management

3.1. Wildlife resources: Current status, services and threats
3.2. Wildlife-Animal conflict and its resolution
3.3. WCS and IUCN categories of wildlife species
3.4. Principles and practices of wildlife management: Need for wildlife planning
3.5. Management of special habitats; riparian zones, grasslands, *etc.*
3.6. Human dimensions in wildlife management: Project Planning, Monitoring and Evaluation.
3.7. National Parks, Sanctuaries, Biosphere Reserves for *in- situ* conservation of wildlife
3.8. Wildlife Projects: Tiger, Elephant, Rhino, Snow leopard

Unit IV. Water Resources and their Management

4.1 Water resources: Historical background, world scenario and current challenges, status of surface and ground water
4.2 Use and over exploitation of surface and ground waters
4.3 Integrated Water Resource Management (IWRM): Key challenges and issues
4.4 Legal aspects of water resources and management: Water legislations in India, Water Governance, Policies and legal frameworks

45 National/State Water Policy

Unit V. Geo Resources and their Management

5.1. Mineral resources: Minerals, their classification, resources and reserves, uses and exploitation of mineral resources.
5.2. Environmental impact of extracting, processing and smelting of minerals
5.3. Mineral Resources of India
5.4. Conservation and Management of geo-resources

Suggested Reading:

1. Heywood, H.V. 1995. Global Biodiversity Assessment.
2. Lochwood, M., Worboys, G.L. and Ashish, K. 2006. Managing Protected Areas: A Global Guide.
3. Singh, J.S. Singh, S.P. and Gupta, S.R. 2005. Ecology, Environment and Resource Conservation. Anamaya Publ., F-154/2 Ladosarai, New Delhi- 110 030. anamayapub@vsnl.net.in

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To develop an in-depth insight into topics in natural resource management through relating theory to practical management.
CO2	To recognize current management challenges through active contributions in lectures and reflexive use of examples from field.
CO3	To critically evaluate and reflect on the positive and negative characteristics of the different approaches to planning and management of natural resources.
CO4	To evaluate Resource Management – effects of land management activities on, and restoration and rehabilitation of, soil and water resources
CO5	To exhibit an understanding of their professional and ethical responsibilities as sustainability managers, environmental managers, natural resources managers, forest managers, including respect for diversity
CO6	To realize the importance of sustainable utilization of resources and approaches to be followed

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	-	2	1	-	2	2	1	3	2	1	1	2
CO2	3	1	1	-	1	1	2	2	-	1	2	2	2	1
CO3	1	1	1	1	-	2	2	3	2	1	-	-	2	-
CO4	2	2	1	1	2	-	2	3	1	3	1	1	-	2
CO5	1	-	2	-	-	1	3	2	-	2	-	-	1	1
CO6	2	1	2	1	1	-	3	3	-	3	1	2	-	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MESC104			
Course Name	: Environmental Chemistry and Instrumentation			
Semester	: I[st] sem			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To learn and understand the basic concepts of environmental chemistry and develop skills to quantify the level and effects of xenobiotics on environmental compartments.

Course Contents **No. of Credit- 03**

Unit I. Fundamentals of Environmental Chemistry

1.1. Stochiometric
1.2. Gibb's energy
1.3. Chemical potential
1.4. Acid base equilibria
1.5. Solubility product
1.6. Concept of Normality, Molarity and Molality
1.7. The carbonate system
1.8. Saturated and unsaturated hydrocarbons
1.9. Radionuclides
1.10. Filtration
1.11. Redox Potential

Unit II. Chemical Composition of Air

2.1. Tropospheric chemistry- Smog and Fog
2.2. Stratospheric chemistry
2.3. Carbon dioxide emission and Global temperature
2.4. Chemistry of gaseous and particulate pollutants
2.5. Atmospheric aerosols

Unit III. Water Chemistry

3.1. Physico-chemical properties of water
3.2. Concepts of DO, BOD, COD, Sedimentation, Coagulation
3.3. Chemistry of fresh water
3.4. Estuarine process and major ions
3.5. Chemistry of marine water

Unit IV. Toxic Chemicals in the Environment (Air and Water)

4.1 Xenobiotic components- dyes and detergents, pesticides
4.2 Biochemical aspects of Carbon monoxide, Arsenic, Cadmium and Mercury
4.3 Chemistry of food additives

Unit V. Soil Chemistry

5.1. Inorganic and organic components of soil
5.2. Mechanism of chemical weathering
5.3. Soil pH, Nitrogen pathways
5.4. NPK in soil

Unit VI Instrumentation Techniques

6.1. Instruments for Limnological analysis (pH meter, Turbidity meter, Conductivity meter, DO Analyzer)
6.2. Colorimetry

6.3. Spectrophotometry and Flame photometry
6.4. Atomic absorption and emission spectrophotometry
6.5. Chromatography- Paper, TLC, GLC, HPLC
6.6. Electrophoresis
6.7. Handling of air pollution measuring devices (SO_x, NO_x, CO_2, PM $_{10}$, PM $_{2.5}$)

Suggested Reading

1. Baird, C. and Cann, M. Environmental Chemistry. W.H. Freeman and Company 2008.
2. Banerji, S. K. Environmental Chemistry. 2nd ed. Prentice-Hall, New Delhi, India. 1999.
3. De, A. K. Environmental Chemistry. 4th ed. New Age International (P) Ltd., New Delhi 2001
4. Chatwal, G. R., and Anand, S. K. Instrumental Methods of Chemical Analysis. Himalaya Publishing House, Delhi. 2007.

Course Outcomes (COs):

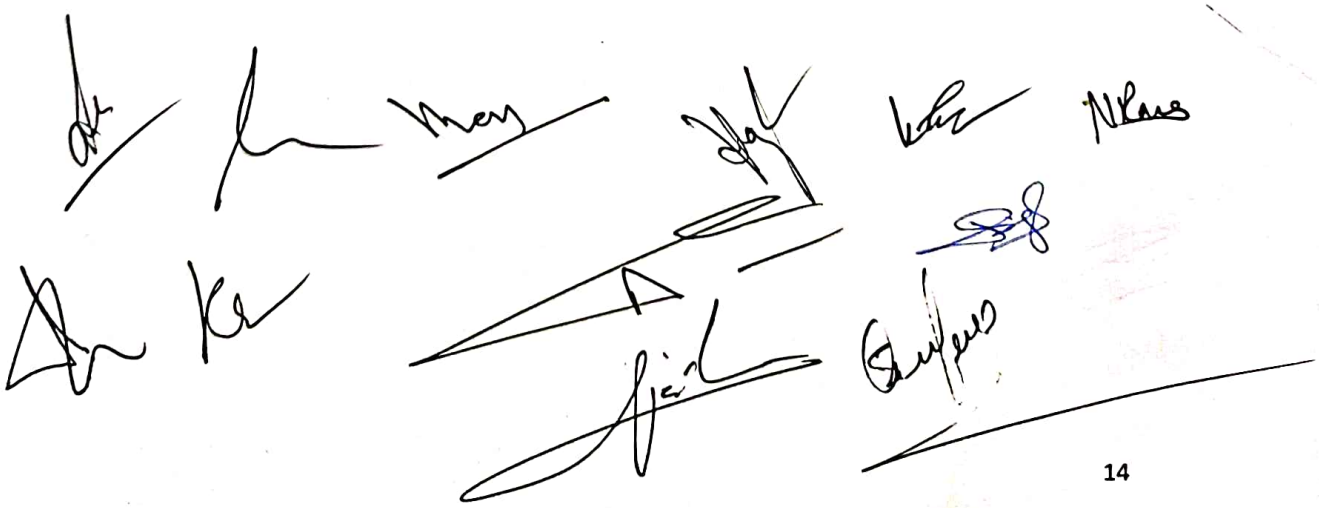
Upon successful completion of the course, a student will be able to

CO1	To learn and understand the basic concepts of environmental chemistry, the presence and impacts of toxic substances in the environment and their remedial measures.
CO2	To identify relationships between chemical exposure and effects on physiological systems and design strategies for study of dose-response relationships.
CO3	To develop analytical skills to evaluate the methods for quality analysis of environmental compartments (air, water, soil, biota).
CO4	To analyse techniques and skills to quantify the level and effects of xenobiotics on environmental compartments.
CO5	To synthesize and apply concepts from multiple sub-disciplines in environmental chemistry and toxicology.
CO6	To analyse local and global environmental issues based on the knowledge gained throughout the course

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	1	1	-	2	2	1	3	3	2	2	3
CO2	1	3	1	1	1	2	1	2	2	2	2	2	1	1
CO3	3	2	2	2	2	2	1	2	1	1	1	2	1	2
CO4	1	1	1	-	-	-	-	2	1	1	1	-	2	1
CO5	2	3	2	-	-	1	2	1	3	2	2	1	-	1
CO6	2	3	1	1	-	2	-	3	1	3	-	2	-	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code : **MESL105**				
Course Name : **Lab Course I Based on MESC101 & MESC102**				
Semester : **Ist sem**				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 60**

COURSE OBJECTIVE: To demonstrate and explain the vegetational analysis and measure biodiversity of various ecosystems

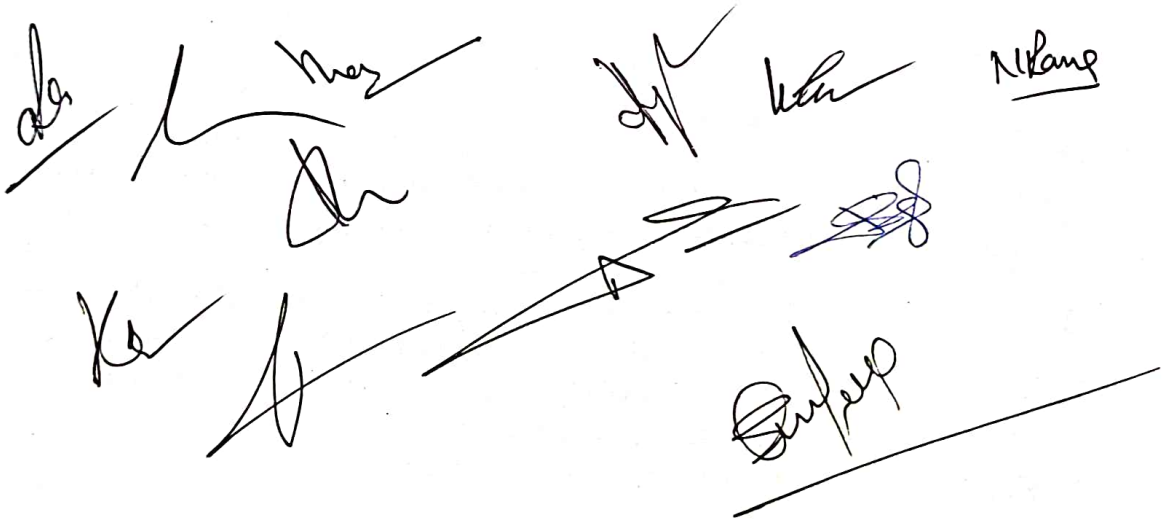
Course Contents

- Exercise 1. Analysis of various components (producer, consumer, decomposer) of ecosystems- lake, pond, river, forest, and mountain
- Exercise 2. Calculation of Importance Value Index (IVI) of different plant species in a grassland ecosystem/forest patch
- Exercise 3. Calculation of frequency, density and abundance of different macro zoobenthos dwelling in the riverine/lacustrine ecosystem
- Exercise 4. Determination of soil texture in different terrestrial habitats
- Exercise 5. Monitoring of biological diversity and calculation of Shannon Wiener diversity index and DBDI in aquatic/ terrestrial habitats
- Exercise 6. Ecological adaptations in extreme environments
  - Morphological adaptations in fish in hill streams developed under fast water current
  - Desert adaptations in animals and plants
  - High altitude adaptations in organisms
  - Deep sea water adaptations in marine organisms
  - Arboreal adaptations in animals
  - Flight adaptation in birds
- Exercise 07. Recording diurnal variations in temperature
- Exercise 08. Measurement of light intensity by the Lux meter
- Exercise 9. Production of artifacts for expansion by hunting and gathering society
- Exercise 10. Term paper on impact of mega dams on environment
- Exercise 11. Term paper on the manifestation of global warming/ climate change in your area
- Exercise 12. Development of food web with the help of various food chains available in your nearby ecosystem (grassland/river/ pond ecosystem)
- Exercise 13. Preparation of an inventory of traditions prevalent in Hinduism/Islam/ Buddhism/ Christianity for protection of environment
- Exercise 14. Preparation of report on any Sacred groove/ landscapes

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To measure different parameters of environment like temperature and solar intensity etc.
CO2	To understand and analyze the important concepts of ecology and ecosystems with the help of field observations
CO3	To monitor and calculate important biological diversity components like IVI, Shannon Wiener diversity indices in different types of habitats
CO4	To evaluate current environmental/ecological issues like global warming and climate change, impacts of mega dams on environment, role of traditions beliefs in protection of wildlife
CO5	To demonstrate a critical understanding on the practical knowledge of the topics covered during lectures
CO6	To understand the impact of mega dams on Environment



Course code	**: MESL106**			
Course Name	**: Lab Course II Based on MESC103 & MESC104**			
Semester	**: Ist sem**			
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 60**

COURSE OBJECTIVE: To train and develop analytical skills for working and handling of instruments in the laboratory as well as give an overview of field through National Park visit.

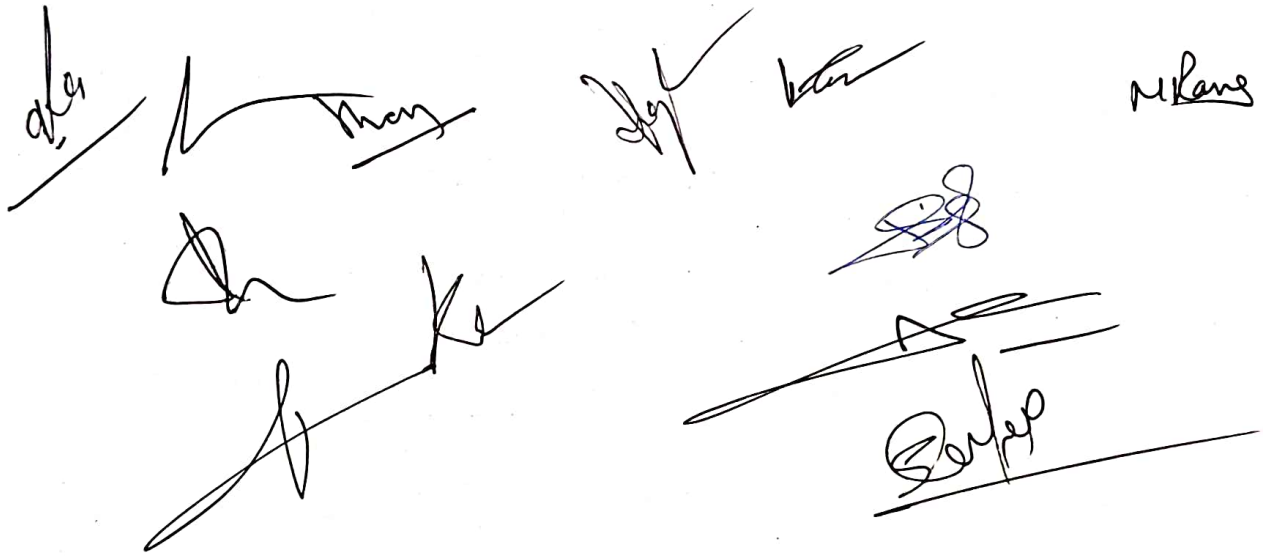
Course content

- Exercise 1: Preparation of inventory of natural resources of your campus
- Exercise 2: Inventorization of natural resources of a nearby water body
- Exercise 3: Inventorization of natural resources of any National Park/Wildlife Sanctuary
- Exercise 4: To study modern methods of conservation (*in- situ* and *ex-situ*) of natural resources by visiting the establishment
- Exercise 5: Inventorization of drivers of depletions of natural resources of nearbyecosystem (grassland/river/ pond /spring)
- Exercise 6: Principle, working and handling of Flame photometer.
- Exercise 7: Principle, working and handling of Spectrophotometer.
- Exercise 8: Principle, working and handling of Atomic Absorption Spectrophotometer (AAS).
- Exercise 9: Principle, working and handling of Turbidity meter.
- Exercise 10: Principle, working and handling of Conductivity meter.
- Exercise 11: Principle, working and handling of pH meter
- Exercise 12: Principle, working and handling of Electrophoresis unit
- Exercise 13: Determination of dissolved oxygen (Modified Winkler's method) in a given sample of water
- Exercise 14: Determination of Chloride contents in a given sample of water
- Exercise 15: Determination of total dissolved solids (TDS) in a water sample
- Exercise 16 Determination of free CO_2 in a given sample of water
- Exercise17: Estimation of Potassium and Sodium in a given sample of water and soil
- Exercise 18: Determination of alkalinity in water and soil samples
- Exercise 19: Estimation of Calcium in a water sample
- Exercise 20: Estimation of phosphates and nitrates in a water sample

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	To understand the principle, working and handling procedure of different analytical instruments like pH meter, spectrophotometer, flame photometer, Atomic Absorption Spectrometer, etc.
CO2	Analyze water quality parameters like DO, Chloride, TDS, free CO2, Calcium, alkalinity etc. in different water samples
CO3	Prepare inventory of the natural resources in different ecosystems like protected areas, water bodies, grasslands, rivers, springs ponds etc.
CO4	Analyze soil properties such as sodium, potassium, alkalinity etc. in different types of soil samples
CO5	Evaluate different conservation strategies for natural resources
CO6	Analyze the impact of toxic chemicals on life and property



Course code	**: MESC201**			
Course Name	**: Ecological Monitoring and Pollution Control**			
Semester	**: IInd Sem**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop analytical skills related to environmental pollution monitoring and assessment methods (air, water, marine, noise, radioactive radiation etc.), and waste management

Course Contents **No. of Credits=03**

Unit I. Environmental Monitoring

1.1. Concept and objectives of environmental monitoring
1.2. Global environmental monitoring system (GEMS)
1.3. National environmental monitoring programmes
1.4. Bioindicators and biological monitoring

Unit II. Air Pollution

2.1 Sources of air pollution
2.2 Methods of monitoring of SOx, NOx, CO, $PM_{2.5}$, PM_{10}
2.3 Effects of pollutants on human beings, plants and animals
2.4 Ambient air quality standards
2.5 Indoor air pollution (smoke, hydrocarbons, particulate matter, radon)
2.6 Control of air pollution
2.7 Light Pollution (Causes and Impacts)

Unit III. Water Pollution

3.1 Major sources of water pollution
3.2 Water quality indices
3.3 Water quality standards (National and International)
3.4 Water pollution and human health
3.5 Heavy metals and their impact on aquatic life
3.6 Sewage and wastewater treatment and recycling
3.7 Industrial effluent treatment
3.8 Marine water pollution

Unit IV. Noise Pollution

4.1. Sources of noise pollution
4.2. Measurement of noise, exposure levels and standards
4.3. Impact of noise on human health
4.4. Noise control and abatement measures

Unit V. Radioactive and Thermal Pollution

5.1 Radioactive pollution: causes and consequences
5.2. Radioactive fallout, Chernobyl Accident: Three Mile Island accident, Fukushima radio-active leakage
5.3. Radioactive waste management
5.4. Thermal pollution: causes and consequences

Unit VI. Solid Waste Management

6.1 Types and major sources of solid waste
6.2. Solid waste and environmental problems
6.3. Integrated solid waste management of municipal waste
6.4. Management of industrial waste
6.5. E-waste and its management

Suggested Reading:

1. Shukla, S. K. and Srivastava, P. R. Methodology of Environmental monitoring and Assessment. Commonwealth Publishers.1992.
2. Air Pollution Control Engineering, Ed. Noel De Nevers, McGraw-Hill International Editions, 2000, ISBN 0-07-116207- 0.
3. Air Quality Management, Issues in Environmental Science & Technology –Pub-8, Eds. K.E. Hester and R.M. Harrison, The Royal Society of Chemistry, UK, 1997. 18
4. APHA, Standard Methods of Analysis for Water and Waste Water, American Public Health Association Publication, 2004.
5. Bhargava, S. K. Practical Methods for Water and Air Pollution Monitoring, New Age International Pub., New Delhi. 2008.

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Understand the concept of environmental monitoring and environmental pollution control
CO2	Identify and distinguish different types of pollution and solid waste, their sources, and negative impacts on human health, biodiversity and the environment
CO3	Develop analytical skills related to environmental pollution monitoring and assessment methods (air, water, marine, noise, radioactive radiation etc.), and waste management
CO4	Analyze the categories and sources of solid waste and its management practices
CO5	Evaluate different methods and techniques for efficient mitigation of environmental pollution and waste generation
CO6	Create ideas for solving the real-world environmental problems by analyzing different case studies based on air, water, noise, radioactive pollution, thermal pollution and solid waste generation

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	3	3	1	3	2	1	2	-
CO2	2	2	2	3	1	1	-	2	2	1	3	1	1	2
CO3	1	-	1	1	-	-	2	1	-	3	1	2	2	1
CO4	2	1	-	1	2	1	1	3	-	2	2	3	1	1
CO5	2	2	2	-	1	-	1	2	2	-	2	-	-	1
CO6	2	2	-	1	-	1	-	3	2	3	1	-	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESC202**				
Course Name	**: Energy Resources Management**				
Semester	**: IInd Sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop an understanding for meeting the challenges of energy management and environmental security at national and global level

Course Contents **No. of Credits=03**

Unit I. An Introduction to Energy Resources

1.1. Definition, concept and classification of energy resources
1.2. History of energy resource and their development
1.3. Global energy and its availability
1.4. Global energy use in various sectors
1.5. Energy use and its implications (atmospheric pollution and climate change)
1.6. Energy crisis and its solution: development of renewable resources
1.7. Renewable Energy Application Park (REAP) for public awareness

Unit II. Non-Renewable Sources

2.1 Fossil fuels: current status and future scenario, limitations, classification, composition, physico- chemical characteristics and energy contents of fossil fuels
2.2 Nuclear energy: Status, power generation, energy conversion through fission and fusion, international nuclear energy policies and regulations, nuclear waste disposal
2.3 Hydrogen fuel cell: sources of hydrogen, fuel for vehicles, working of hydrogen fuel cell; future of hydrogen as a energy
2.4 Earth minerals and ores as an energy source
2.5 Future of non-renewable energy resources

Unit III. Renewable Energy Resources

3.1. **Solar Energy:** Sun as source of energy, availability of solar energy, photothermal, photovoltaic cell, various methods of using solar energy (solar cooker, solar still, solar street light, solar lantern, solar domestic light, solar grain dryer, solar water pump, solar heating system, solar T.V.)
3.2. **Wind Energy**: History, basic principle, structure of wind mill, advantages and limitations; wind potential at global and national level.
3.3. **Hydropower:** Basic principle, status and prospects of hydro power, small hydropower system and their benefits and limitations
3.4. **Bio-energy**: Concept, status and future prospects, generation and utilization, biogas and biofuels
3.5 Magneto Hydro Dynamic Power (MHD):
Principle, status, performance and limitations

3.6. **Geo-thermal Energy:** Potential sites, origin, types, estimation of geothermal power, application of geothermal energy, environmental issues

3.7. **Tidal Energy and Ocean Energy:** principle, performance and limitations

3.8. Introduction of Hybrid System: Wind-PV system, Wind- Hydel system, *etc.*

Unit IV. Energy Management

4.1. Definition and objectives of energy management

4.2. Energy Audit: needs, types and methodology

4.3. Energy costs: fuel costs, power cost

4.4. Fuel and energy substitution of limited energy resources

4.5. Sustainable use of energy resources

4.6 Clean Development Mechanism (CDM)

Suggested Reading:

1. Andrew R.W., Jackson & Julie M. Jackson, Environmental Science – The Natural Environment and Human Impact, Addison Wesley Longman Limited, 1996. 12
2. Carless, Jennifer, Renewable Energy: A Concise Guide to Green Alternative, Walker, New York, 1993
3. Ebbing, D.D., General Chemistry, (International 4th Edition) MA: Houghton Mifflin, Boston, 1993.
4. Eisenbud, M.., Environmental Radioactivity, Academic Press, Orlando, USA,1987.
5. Flowler, John M., Energy and the Environment, 2nd Edition, McGraw Hill, New York, 1984.
6. Santra, S.C. Environmental Science, 2nd Edition, New Central Book Agency (P) Ltd, Kolkata, India, 2005.
7. United Nations Scientific Committee on Effects of Atomic Radiation Report 2000, New York, USA, 2000.
8. Weast R.C., Handbook of Chemistry and Physics, CRC Press, 1994.
9. Rao, P. S. and Rao, P. M. Environmental Management and Audit. Deep and Deep Publications.2000.
10. Raymond, A. B. and Fenn, D. H. The Corporate Social Audit. Russell Sage Foundation New York.1992.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define the concept, classification and uses of renewable and non-renewable energy resources to find solutions for their sustainable utilization and management
CO2	Understand the harmful impacts of non-renewable energy resources on the environment and identify appropriate technological approaches for their efficient mitigation
CO3	Actively participate in analyzing different aspects of energy resources to solve the issues pertaining to their sustainable management at national and global level
CO4	Evaluate the working principle, application, advantages and limitations of the renewable energy resources (solar energy, wind energy, hydropower, biomass energy, MHD, geothermal energy etc)
CO5	Gain in-depth knowledge of energy auditing as a tool for green policy and energy management
CO6	Create a sound understanding for meeting the challenges of energy management and environmental security and to be aware about the concepts such as REAP and CDM

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	-	1	2	1	1	2	1	2	1	1	1
CO2	2	1	2	1	-	-	2	2	1	2	1	2	-	2
CO3	1	-	1	3	2	1	-	-	-	-	1	1	2	-
CO4	2	3	-	-	1	2	1	1	2	1	2	1	1	1
CO5	1	1	2	1	-	3	2	2	1	2	1	2	-	2
CO6	3	-	-	2	-	2	-	3	-	3	2	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESC203**			
Course Name	**: Environmental Microbiology and Environmental Biotechnology**			
Semester	**: IInd Sem**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To gain the knowledge of basic concepts of microbial ecology, its scope, diversity and current applications of biotechnology in environmental quality evaluation, monitoring and bioremediation.

Course Contents **No. of Credits=03**

Unit I. Environmental Microbiology

1.1. Introduction, history and scope of Environmental Microbiology
1.2. Microbial diversity: major groups of microbes
1.2. Microbial diversity of soil
1.3. Microbial diversity of water
1.4. Microbial diversity of air
1.5. Microbes of extreme environments
1.6. Microbial pathogens and their control

Unit II. Microbial Nutrition

2.1. Mode of microbial nutrition
2.2. Determination of growth
2.3. Microbial interactions
2.4. Chemolithotrophy and humus

Unit III. Microbial Ecology

3.1. Effects of environmental factors (Light, temperature, moisture, pH) on microorganisms
3.2. Mechanism of chemotaxis
3.3. Biochemical and molecular methods for microbial isolation and identification

Unit IV. Environmental Biotechnology

4.1. Concept, history and scope of Environmental Biotechnology
4.2. Bioremediation and bio-augmentation
4.3. Microbial degradation of environmental pollutants (detergents, pesticides, plastics)
4.4. Vermiculture technology
4.5. Fermentation technology
4.6. Bio-fertilizer technology
4.7. Aquaculture improvement through biotechnology

Suggested Readings:

1. Raina M. Maier. 2000. Environmental Microbiology. Academic Press.
2. Pepper, I. and C. P. Gerba. 2004. Environmental Microbiology (2nd Edition). Academic

Press.
3. Environmental Biotechnology, Eastern book Corporation, Hemant Rawat.2008
4. Environmental Biotechnology, Indian Book.Co.in S.K. Agarwal, 1998

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain the knowledge of basic concepts of microbial ecology, its scope, diversity and significance in agriculture, industries; microbial techniques and remediation of contaminants.
CO2	Learn the role of microbes as pathogens, their nutrition, growth and interaction with environment.
CO3	Analyse the theoretical and practical knowledge of biochemical and molecular techniques in isolation and identification of microbes.
CO4	Evaluate the significance of microbes in agriculture sector and their importance as biofertilizers.
CO5	Gain in-depth knowledge of economic importance of microbes in industries.
CO6	Learn and apply the current applications of biotechnology in environmental quality evaluation, monitoring and remediation of contaminants.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	-	1	2	3	-	2	2	1	1	2
CO2	1	2	1	2	2	-	2	2	2	1	1	1	1	2
CO3	2	-	1	-	1	2	-	1	1	2	2	-	1	1
CO4	3	1	-	1	-	-	1	1	1	1	-	2	2	1
CO5	1	2	1	-	1	2	3	2	1	2	1	2	-	1
CO6	3	1	1	1	-	1	1	3	2	3	1	1	1	2

Course code	**: MESC204**			
Course Name	**: Freshwater Ecology**			
Semester	**: IInd Sem**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop an understanding of fresh water ecology, drivers for their degradation and realize the need to adopt appropriate strategies for conservation and management of all fresh waterbodies.

Course Contents

Unit I Fundamentals of Freshwater Ecology **No. of Credits=03**

1.1 Definition, concept and scope of Freshwater Ecology
1.2 History of Freshwater Ecology
1.3 Freshwater: distribution and depletion
1.4 Goods and services of freshwater ecosystem
1.5 Paleolimnology and climate change

Unit II Stream Ecology

2.1 Definition, concept and scope of Stream Ecology
2.2 Origin and evolution of streams/ rivers
2.3 Stream structure and zonation
2.4 Stream hydrology and channel structure
2.5 Physical environment, water movement and chemistry
2.6 Energy sources and nutrient cycle
2.7 Stream biota (Periphyton, plankton, macrophytes, zoobenthos fish, fish otter, dolphin and other aquatic chordates) and evolution
2.8 Stream food webs
2.9 Basic concepts of Hyporheic biodiversity and creno biodiversity
2.10 Stream Productivity (primary productivity and secondary productivity)
2.11 Recent advance in stream ecology (River Continuum Concept; Nutrient Spiraling Concept; Flood Pulse Concept; Hyporheic dynamics; Serial Discontinuity Concept)

Unit III Wetland Ecology

3.1 Definition, concept, history and scope of Wetland Ecology
3.2 Classification of wetland
3.3 The origin and evolution of wetlands
3.4 Morphometry, bathymetry and physiography of wetlands
3.5 Wetland: Structure and function
3.6 Hydrology, chemistry and the physical environment
3.7 Stratification of lakes: Temperature and chemical; and their influence on mixing regimes
3.8 Energy sources and nutrient cycles in wetland
3.9 Primary producers (phytoplankton, macrophytes) measurement indices and factor influencing
3.10 Secondary producers (zooplankton, zoobenthos and nekton)

3.11 Ecology of reservoirs

3.12 Wetland and migratory birds

Unit IV Drivers for Degradation of Streams and Wetlands

4.1 Natural drivers (flash floods, landslides, soil erosion, sedimentation, cloud burst, earthquake)

4.2 Anthropogenic drivers (Eutrophication, deforestation, agriculture and horticulture practices in catchment area, road constructions and other developmental projects)

4.3 Controversies of Hydropower development and Rivers

Unit V Conservation and Management of Streams and Wetlands

5.1 Natural and international initiatives

5.2 Riparian Area Developmental Plan

5.3 Ancient man and stewardship of streams and wetlands

5.4 Sacred water bodies

5.5 National efforts for conservation of wetlands and streams

5.6 Wetland (Conservation & Management) Rules 2010

5.7 National initiatives (GAP, YAP, *Namami Gange*)

5.8 International initiatives (Ramsar convection, *etc.*)

Course Outcome: Upon successful completion of the course, the students will be able to

CO1	Gain an in-depth knowledge of hydrobiology, abiotic factors, aquatic organisms and drivers for their degradation.
CO2	Analyse the importance of managing the natural hazards, their impact and pollution in relation to aquatic life.
CO3	Realize the need to adopt appropriate strategies for conservation and management of all fresh waterbodies.
CO4	Comprehend the origin and importance of streams, wetlands, other freshwater bodies and their relation to climate change.
CO5	Evaluate the course of evolution of aquatic organisms and the basic concepts of biological productivity of aquatic flora and fauna.
CO6	Learn about the wetland ecology, structure, function importance and its relation to migratory birds.

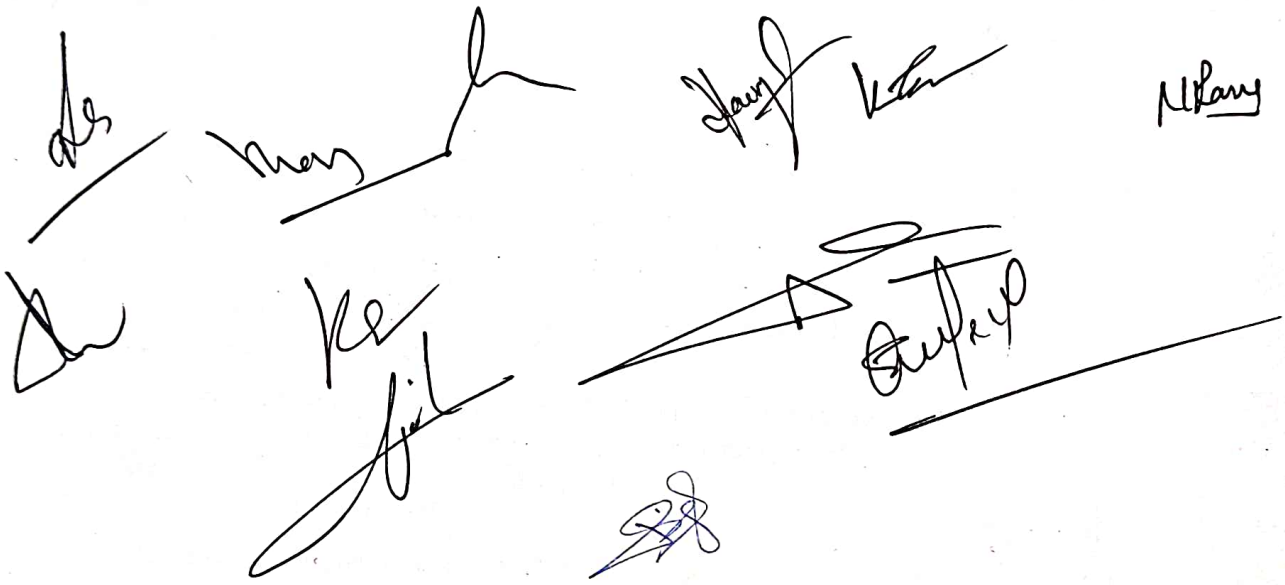
Suggested Reading:

1. KJ Gaston & JI Spicer: Biodiversity: An Introduction
2. WT Edmondson: Freshwater Biology
3. VG Jhingran: Fish & Fisheries of India
4. EP Odum: Ecology
5. HBN Hynes: Freshwater Ecology
6. WK Dodds: Freshwater Ecology
7. Rivers for Life: Managing water for people and nature, Sandra Postel, Brain D. Richter
8. Singh, J.S., Singh, S.P. & Gupta, S.R. 2007. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	-	1	1	-	1	2	-	3	3	3	2	2
CO2	1	1	1	2	1	3	2	3	3	2	1	2	2	3
CO3	-	2	1	2	1	2	2	2	2	1	1	1	2	1
CO4	2	1	-	1	2	-	1	1	2	2	1	1	1	2
CO5	2	-	1	2	1	1	2	1	2	2	2	2	1	1
CO6	1	2	2	1	-	-	1	2	-	2	1	-	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	**: MESL205**				
Course Name	**: Lab Course I Based on MESC201 & MESC202**				
Semester	**: IInd Sem**				
	L	**T**	**P**	**C**	
	0	**0**	**4**	**4**	

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 60**

COURSE OBJECTIVE: To give practical knowledge of energy resources and sampling and detection of environmental pollutants.

Course Content **No. of Credits=04**

- Exercise 1: Principle and working of solar cooker
- Exercise 2: Principle and working of solar lantern
- Exercise 3: Principle and working of solar street light
- Exercise 4: Principle and working of water heating system
- Exercise 5: Principle and working of water mill (*Gharat*)
- Exercise 6: To demonstrate the I-V and P-V characteristics of PV module with varyingradiations and temperature levels
- Exercise 7: To demonstrate the effect of variations in tilt angle on PV module power
- Exercise 8: To demonstrate the effect of shading on module output power
- Exercise 9: To calculate carbon reduction by using solar module
- Exercise 10 Monitoring of PM_{10} and $PM_{2.5}$
- Exercise 11: Determination of noise levels at different places
- Exercise 12: Determination of CO_2 emission at different places
- Exercise 13: Determination of SOx and NOx in ambient air
- Exercise14: Identification of biological indicators of pollution in terrestrial and aquatic habitats

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain knowledge about principle and working of different energy systems such as solar energy and wind energy
CO2	To monitor and analyze different air pollutants in ambient air
CO3	To measure ambient noise pollution levels at different sites
CO4	To identify the biological indicators of environmental pollution in terrestrial and aquatic habitats
CO5	To demonstrate critical thinking and problem-solving skills in the context of energy resources and environmental pollution analysis
CO6	To synthesize information about energy resources and environmental quality monitoring by conducting practical exercises

Course code	**: MESL206**				
Course Name	**: Lab Course II Based on MESC203 & MESC204**				
Semester	**: IInd Sem**				
	L	**T**	**P**	**C**	
	0	**0**	**4**	**4**	

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 60**

COURSE OBJECTIVE: To deliver hands on training for isolation and identification of microbes from the environment and qualitative analysis of fresh water bodies and determination of primary productivity in fresh water habitats.

Course Content **No. of Credits=04**

- Exercise 01. To study the three-dimensional structure of a stream/river
- Exercise 02. To study the biotopes of riffles, rapids and pools in a hill stream
- Exercise 03. To study the structure and function of hyporheic biotope (self-purification zone) of any stream or river
- Exercise 04. To study the structure and function of freshwater springs
- Exercise 05. To study morphometry of any lake
- Exercise 06. Collection and identification of periphyton, phytoplankton and macrophytes
- Exercise 07. Determination of primary productivity in freshwater habitats
- Exercise 08 Collection of zooplankton and macro-zoobenthos
- Exercise 09. To study the characteristics of a nearby watershed
- Exercise 10. Assessment of the health of the freshwater ecosystem by P/R ratio estimation
- Exercise 11. Assessment of nutrient enrichment of a lake (oligotrophic, mesotrophic, eutrophic, dystrophic)
- Exercise 12. Sampling and enumeration techniques for microbes
- Exercise 13. Determination of total microbial count in a water sample
- Exercise 14. Determination of total count (MPN) of coliform in a water sample
- Exercise 15. To prepare the Nutrient Agar medium for culturing bacteria present in our surroundings
- Exercise 16. Isolation of bacteria by the Pour- plate method
- Exercise 17. Isolation of bacteria by the Spread - plate method
- Exercise 18. Isolation of bacteria by the Streak- plate method
- Exercise 19. To prepare the differential medium (Mac Conky) so as to grow the enteric bacteria
- Exercise 20. Isolation of fungi from the given sample of water
- Exercise 21. Isolation of the *Lactobacillus* bacteria from the given sample of curd.
- Exercise 22. Working principle molecular technique–PCR

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain practical knowledge of collecting water samples and further processing them for analysis
CO2	To acquire skills for conducting bacterial isolation and identification from environment
CO3	To learn collection of samples and determination of primary productivity in fresh water ecosystems
CO4	To train on some molecular techniques - PCR
CO5	To analyse the water quality of a lake and assess its nutrient enrichment
CO6	To analyse the water quality for biological growth of microbes

Course code	**: MESC301**				
Course Name	**: Environmental Economics, Environmental Sociology and Sustainable Development**				
Semester	**: IIIrd sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To understand the root causes of environmental and social problems and to be able to recommend efficient solutions for sustainable development.

Course Content **No. of Credits=03**

Unit I. Fundamentals of Environmental Economics

1.1. Definition, concepts, issues and scope of Environmental Economics
1.2. Concept of the commons, tragedy of commons, externalities (indirect costs), economic goods/ services, supply, demand, intangibles, public goods and bads
1.3. Limitations of Environmental Economics

Unit II. Economic Tools

2.1. Valuing the environment and natural resources
2.2. Ecology and equity
2.3. Natural resource accounting, cost-benefit analysis
2.4. Life cycle assessment (LCA)
2.5. Intellectual property rights (IPR) and environment

Unit III. Fundamentals of Environmental Sociology

3.1. Definition, concepts, issues and scope of Environmental Sociology
3.2. Concept of caste, tribe, clan, society and social structure
3.3. Cultural resources
3.4. Indigenous/traditional wisdom for environmental protection

Unit IV. Social Issues and the Environment

4.1 From unsustainable to sustainable development
4.2 Resettlement and Rehabilitation: Problems and concerns
4.3 National Land Acquisition, Rehabilitation and Resettlement Act, 2013
4.4 Genesis and evolution of environmental movements
4.5 Major environmental movements (Bishnoi movement, Chipko, Appiko, Narmada Bachao, Tehri dam conflict, Silent Valley Movement, *Nadi Bachao*, *Beej Bachao*, *Jungle Bachao*, *Gaon Bachao*)
4.6 Rehabilitation of people of disaster affected areas.

Suggested Reading:

1. The Earthscan reader in Environmental economics, Markandya, A. 1992
2. Hanley, Nick, Jason F. Shogren & Ben White: Environmental Economics in Theory and Practice, New Delhi: Macmillan –India, 1997.
3. James, D.E., Economic Approaches to Environmental Problems: Techniques and Results of Empirical Analysis,

Elsevier Scientific Publishing Co., 1978.
4. Nash, R.F., The Rights of Nature: A History of Environmental Ethics, University of Wisconsin, 1989.
5. Whytte, Anne, V. and Ian Burton (eds), Environmental Risk Assessment, John Wiley & Sons, 1980.
6. Arrow, K.J. and Scitovsky, T., Readings in Welfare Economics Part III, 1969.
7. Coase, R.H., The Problem of Social Cost in Readings in Micro Economics by Breit and Hochman, 1951
8. Allen V. Kneese and James L. Sweeney, eds. Handbook of Natural Resource and Energy Economics, Chapters 2,12,14,17, North Holland,1985.

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To understand the root causes of environmental and social problems and to be able to recommend efficient solutions to them
CO2	To analyse the social issues related to depletion of natural resources and to be able to recommend policies for addressing these issues
CO3	To evaluate and be able to critique the monetary valuation of the environment
CO4	To identify international environmental problems and learn about the policies to manage such issues at national and international level
CO5	To realize climate change and global warming as social and economic global problems and learn and apply policies that address such issues at global, national and individual level
CO6	To learn and understand the importance of sustainable development and effective use of natural resources

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	1	2	2	-	1	1	2	3	1	1	2
CO2	1	1	1	-	1	1	3	2	1	1	3	1	3	1
CO3	3	1	1	1	2	1	1	1	2	1	2	2	1	2
CO4	2	1	2	-	1	-	2	1	1	2	2	1	2	1
CO5	1	2	1	2	-	2	1	-	1	2	2	1	1	2
CO6	2	-	2	-	1	-	2	3	1	2	-	1	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESC302**			
Course Name	**: Remote Sensing, GIS and Environmental Statistics**			
Semester	**: IIIrd sem**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To learn the basic concepts of RS and GIS and evaluate applications of remotely sensed data for monitoring and managing various natural resources.

Course Content **No. of Credits=03**

Unit - I General Introduction to Remote Sensing

1.1 Definition, concepts and scope of remote sensing
1.2 History of remote sensing
1.3 Electromagnetic radiations (EMR) and electromagnetic spectrum and atmosphere window
1.4 Platforms, sensors and types of scanning systems
1.5 Basic characteristics of sensors; salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites
1.6 Earth's and atmospheric interaction with EMR
1.7 Spectral reflectance of vegetation, soil and water

Unit II. Application of Remote Sensing

2.1 Application of remote sensing in EIA
2.2 Application of remote sensing in groundwater
2.3 Applications of remote sensing in mining
2.4 Application of remote sensing in forest management
2.5 Application of remote sensing in characterization and monitoring of biodiversity
2.6. Application of remote sensing in mapping of wetlands

Unit III Geographic Information System (GIS)

3.1 Introduction and basic principle and scope of GIS
3.3 Application of GIS
3.2 Brief outline of Digital Image Processing.

Unit IV Environmental Statistics

4.1 Measurement of central tendency- mean, mode and median
4.2 Dispersion- standard deviation, standard error, mean deviation; and coefficient of variation
4.3 Simple and multiple correlation and regression coefficient
4.4 Basic laws and concept of probability
4.5 Test of hypothesis and significance.
4.6 t, F, chi square tests
4.7 ANOVA

Suggested Reading:

1. Barrett, E.C. 1982. Introduction of Environmental Remote Sensing. Chapman and Hall.

2. Burrough, P.A. 1986. Principle of Geographic Information System for Land Resources Assessment. Oxford University Press.
3. Colwell, R.N. 1983. Manual of Remote Sensing. Vol. I,II American Society of Photogrammetry.
4. Curran, P.J. 1985. Principle of Remote Sensing. Longman Group.
5. Dury, S.A. 1990. A Guide to Sensing. Interpreting Image of Earth. Wiley and Sons.
6. Hord, R.M. 1986. Remote Sensing: Method and Application, John Wiley and Sons.
7. Jenson, J.R. 1996 Introductory Digital Image Processing, Prentice Hall. New Delhi.
8. Johnson, P.l. 1969. Remote Sensing in Ecology. Univ. Georgia Press, Athens.
9. Rampal, K.K. 1982. Text Book of Photogrammetry. Oxford and IBH Press.,
10. Rees, W.G. 1990. Physical Principles of Remote Sensing, Cambridge University Press.
11. Schander, E. 1976, Remote Sensing for Environmental Sciences. Springer Verlag.

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Learn and Understand Remote Sensing Systems and programs (sensors, platforms, etc.) and assess its potential for spatial analysis
CO2	Analyse methods to improve, correct and interpret Remote Sensing Images and interpret information on its basis as needed
CO3	Determine and evaluate applications of remotely sensed data for monitoring and managing various natural resources
CO4	Apply remote sensing and GIS to solve complex problems related to geospatial technologies and its applications
CO5	Learn the basic concepts of GIS and apply its principles to digital image processing
CO6	Understand and realize the basic importance of statistics and its application in research and methods

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	-	2	1	2	2	1	1	2	1	1	2
CO2	1	-	-	1	2	-	2	3	1	1	2	1	2	1
CO3	2	2	1	-	2	1	-	1	1	2	1	2	1	2
CO4	2	1	1	-	1	-	2	2	1	2	2	2	1	2
CO5	2	2	1	1	-	1	1	1	-	2	-	-	-	-
CO6	3	1	1	2	-	-	2	3	1	3	2	1	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESL303**			
Course Name	**: Lab Course I**			
Semester	**: IIIrd sem**			
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 60**

COURSE OBJECTIVE: To deliver knowledge on environmental economics and give hands on training on GIS and remote sensing technology as well as practical use of statistics.

Course Contents **No. of Credits=04**

Exercise 1. Study of various stages of human evolution
Exercise 2. Socio-economic status of an area- Preparing of questionnaire and case studies
Exercise 3. Analysis and interpretation of questionnaire
Exercise 4. Preparation of inventory of natural resources and intangibles of a forest area/lake/pond/river
Exercise 5. Economic valuation of a forest/lake/river/spring ecosystem
Exercise 6. Cost-benefit analysis of a river valley project
Exercise 7. Documentation of TEK in any tribal area
Exercise 8. Calculation of mean, mode and median of the given data
Exercise 9. Calculation of standard deviation and standard error for given data
Exercise 10. Application of t-test
Exercise 11. Application of chi square test
Exercise 12. Calculation of Pearson's correlation coefficient of relationship between the given environmental data
Exercise 13. Plotting of a regression line between the given environmental variables
Exercise 14. Familiarity with ANOVA
Exercise 15. Photo-interpretation of satellite imagery
Exercise 16. Ground truth estimation of aerial photographs
Exercise 17. Basic knowledge of GIS
Exercise 18. Basic knowledge and use of GPS

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	To practically acquire training for conducting the socio-economic surveys- Preparing of questionnaire and case studies
CO2	To learn skills required for the documentation of TEK in any tribal area
CO3	To get hands on training how to use GPS and image interpretation
CO4	To analyse the techniques of RS and GIS for interpreting data and information
CO5	To gain basic knowledge of statistics and its relevance with the concerned subject
CO6	To prepare inventories and interpret the information as required

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	1	2	-	2	2	1	2	2	1	2	1
CO2	2	2	1	1	2	1	-	1	-	2	1	2	1	-
CO3	1	1	2	1	1	1	-	1	1	1	1	-	1	1
CO4	1	2	1	2	-	1	1	-	1	2	-	1	2	1
CO5	1	2	-	1	1	-	2	2	2	2	1	-	-	1
CO6	1	-	-	1	-	1	-	1	1	-	-	2	-	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESE304 (Elective-I)**				
Course Name	**: Climatology and Environmental Modelling**				
Semester	**: IIIrd sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To Learn and understand the basic principles of climate modelling and their application in environmental research.

Course Contents **No. of Credits=03**

UNIT I: Introduction to Climatology

1.1 Definition, brief history and scope of Climatology
1.2 Atmospheric variables
1.3 Standard atmosphere
1.4 Vertical structure of the Earth's atmosphere

UNIT II: Physical and Dynamic Climatology

2.1 The energy balance: Nature of radiation, solar source, solar radiation and planetary energy budget
2.2 Atmospheric temperature: Seasons, weather, daily temperature changes, vertical distribution of temperature, factor influencing horizontal distribution of temperature
2.3. Moisture in atmosphere: Hydrological cycle, relative humidity, evaporation, transpiration, condensation, fog, clouds and precipitation
2.4. Motion in the atmosphere: Atmospheric pressure, wind, Coriolis effect
2.5. Global circulation of the atmosphere
2.6. Oceans and international variations in climate (El Nino, ENSO, La Nina)
2.7. Natural and atmospheric extreme events: Tropical cyclone, thunder storms, tornadoes, flood, cloud burst, drought

UNIT III: Regional Climatology

3.1. Definition, microclimate and meso-climate scale
3.2. Climate and distribution of vegetation
3.3. Mid-latitude climate
3.4. Polar and high land climate

UNIT IV: Applied Climatology

4.1. Human response to climate
4.2. Climate, agriculture and industry
4.3. Global changes and atmospheric chemistry: Acid precipitation, Ozone depletion
4.4. Natural causes of climate change
4.5. Warming of the planet Earth and its consequences

UNIT V: Environmental Modelling

5.1. Definition, concept and role of modelling in Environmental Sciences
5.2. Components of a model
5.3. Models of population (growth and interaction) and pollution dispersal
   a. Lotka Voltera model

b. Leslie Matrix model
c. Gaussian Plume model

Suggested Reading:

1. Bailey, N.T.J. Statistical Methods in Biology. 3rd ed. Cambridge University Press, Cambridge, UK. 1994.
2. Banerjee, P.K. Introduction to Biostatistics. S. Chand and Co., New Delhi. 2004.
3. Central Statistical Organization. Compendium of Environmental Statistics India 2003.
4. Ministry of Statistics & Programme implementation. GOI, New Delhi Gardiner, W. P. Statistics for biosciences. Prentice hall, Hamel Hempstead.1997.
5. Gerstman, B.B. Basic Biostatics – Statistics for Public Health Practice. Janes and Bartlett Pub., U.K. 2008
6. Climatology. Lal DS. 2011. Publisher: Sharda Pustak Bhawan
7. Atmosphere, Weather and Climate. 2017. Roger G & Richard J Chorley Barry, Publisher : BARRY, CHORLEY, India

1. Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Learn and understand the basic principles of climate modelling and their application in environmental research
CO2	Apply atmospheric models commonly utilized in climate and air quality studies and interpret their outcomes and limitations
CO3	Evaluate model performance by comparison of model results with observations or other models
CO4	Analyze and compare models to simulate relevant phenomena e.g., extreme weather or air quality
CO5	Determine and implement optimization approaches for modelling codes in connection with novel computer architectures.
CO6	To equip students with the basic knowledge and awareness of advanced concepts and techniques in atmospheric and climate modelling

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	-	2	1	-	2	3	2	1	-	1	2	2
CO2	1	2	2	1	2	2	1	2	1	2	1	2	1	1
CO3	1	1	1	2	1	2	3	2	2	2	1	1	2	2
CO4	2	2	1	1	-	1	2	1	1	2	1	2	1	2
CO5	1	1	1	2	1	2	2	2	2	2	1	1	2	2
CO6	3	2	2	1	2	2	1	2	1	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESE305 (Elective-II)**				
Course Name	**: Environmental Geosciences and Disaster Management**				
Semester	**: IIIrd sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To learn the scientific principles of the earth sciences and apply them to mitigate effects of global climate change.

Course Contents **No. of Credits=03**

Unit I. Fundamentals of Environmental Geosciences and Earth System

1.1. Definition, concept and scope of Environmental Geosciences
1.2. Origin and geological evolution of Earth
1.3. Formation and structure of the Earth; plate tectonics, rocks and their classification
1.4. Brief account of relationship among various geospheres- lithosphere, hydrosphere and biosphere
1.5. Energy budget of the Earth, Earth's thermal environment and seasons

Unit II. Earth's Processes and Geological Hazards

2.1. Earth's processes: Concept of residence time and rates of natural cycles
2.2. Catastrophic geological hazards
2.3. Study of floods, landslides, earthquakes, volcanism and avalanche
2.4. Tsunami, ice sheets and fluctuation s of sea levels, marine pollution by toxic wastes
2.5. Prediction and perception of the hazards and adjustments to hazardous activities

Unit III. Environmental Geochemistry and Land use Planning

3.1. Concept of major, trace and REE (Rare Earth Elements)
3.2. Classification of trace elements, mobility of trace elements
3.3. Human use, trace elements and health, possible effects of some trace elements
3.4. Weathering and soil formation, soil profile, soil classification, soils of India
3.5. Land use planning: Soil surveys in relation to land use planning, methods of site selection and evaluation

Unit IV: Fundamentals of Disaster and Disaster Management

4.1 Definition, types of disaster and need for disaster management
4.2 Natural disasters: Hydrological, wind related, geophysical and climate related
4.3 Man-made disasters: Nuclear disaster, industrial, Environmental (forest fire), rail, road, air and sea accidents
4.4 Disaster preparedness (concept, nature, plan and mitigation)
4.5 Disaster response (Plan, communication, logistic management, stress and panic movement, integration of multiple stakeholders)
4.6 Disaster medicine (Prevention, preparedness, response and recovery of health problems)
4.7 Post disaster management (Relief camps, role of voluntary organizations and armed forces)

Unit V: Rehabilitation, Reconstruction and Recovery

5.1. Reconstruction and rehabilitation as a means of development
5.2. Damage assessment

5.3. Role of various agencies in disaster management
5.4. Development of physical and economic infrastructure
5.5. Information management structure
5.6. Education and awareness
5.7. Constrain in monitoring and evaluation
5.8. Long term planning and counter disaster planning

Suggested Reading:

1. Environmental Geology, Edward A. Keller, Prentice Hall, New Jersey.
2. Geology Environment Society ,K,.S.Valdiya, University press
3. Environmental metereology ,B.Padmanabha Murthy, I.K. International
4. Atmosphere,Weather and Climate, Roger G.Barry Richard J. Charley,Routledge (Taylor &Francis group)
5. Coping with natural hazards; Indian Context, K.S. Valdiya,Orient Longman .
6. Environmental Geology, C.W. Montgomery , Mc. Graw Hill International.
7. Carter, N,W. Disaster Management: A Disaster Manager's Hand Book, Asian Development Bank, Manila. 1992
8. Gautam Ashutosh. Earthquake: A Natural Disaster, Ashok Publishing House, New Delhi. 1994
9. Sahni, P.and Malagola M. (Eds.).Disaster Risk Reduction in South Asia, Prentice-Hall of India, New Delhi. 2003.
10. Sharma, V.K. (Ed.). Disaster Management, IIPA, New Delhi. 1995.
11. Singh T. Disaster management Approaches and Strategies, Akansha Publishing House, New Delhi. 2006
12. Sinha, D. K. Towards Basics of Natural Disaster Reduction, Research Book Centre, New Delhi. 2006
13. Smith, K. Environmental Health, Assessing Risk and Reduction Disaster, 3rd Edition, Routledge, London. 2001 21

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn the Earth's major systems, how they interact, formation of rocks and minerals and the development of landforms and geologic structures; plate tectonic theory and its relationship to earth processes, features, and landforms
CO2	Understand the theory of plate tectonics as related to natural hazards and earth resources
CO3	Identify major sources of water, soil, and sediment, occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use
CO4	Analyse and interpret geologic and topographic maps, cross-sections, and topographic profiles and plate tectonic theory and its relationship to natural hazards
CO5	Evaluate the most common methods used to mitigate and prepare for each type of hazardous natural process
CO6	Learn the scientific principles of the earth sciences and apply them to mitigate effects of global climate change

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	2	-	2	1	2	3	2	3	1	2	3
CO2	1	-	2	1	2	2	1	2	1	1	2	1	2
CO3	2	1	2	1	2	2	2	1	2	2	3	2	1
CO4	1	2	1	-	1	2	2	2	2	1	2	1	2
CO5	2	2	2	1	-	2	1	3	1	2	1	2	1
CO6	3	1	-	-	1	-	1	2	2	3	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESE306 (Elective-III)**				
Course Name	**: Biodiversity Conservation and Restoration Ecology**				
Semester	**: IIIrd sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To gain knowledge on the status and importance of biodiversity at national and global level, its exploitation and conservation including the legal framework.

Course Contents

Unit I. Introduction to Biodiversity **No. of Credits = 03**

1.1. Concept and values of biodiversity
1.2. Magnitude and distribution of biodiversity
1.3. Biodiversity at different levels (genetic, species and ecosystem)
1.4. Biodiversity and ecosystem services
1.5. Threats to biodiversity and its loss
1.6. Hotspots of biodiversity

Unit II. Biodiversity: Conservation and Management

2.1. Need for biodiversity conservation and management
2.2. Biodiversity and livelihood
2.3. WCS and IUCN threatened species categories
2.4. *In -situ* and *Ex-situ* conservation
2.5. Biodiversity Act, Biodiversity Rules and Regulations
2.6. International Biodiversity Law, CBD, Trade related Intellectual Property Rights, CITES, Ramsar Convention
2.7. International organizations involved in biodiversity management: IUCN, UNEP, UNESCO, WWF

Unit III. Restoration Ecology

3.1. Introduction concept and scope of Restoration Ecology
3.2. History of Restoration Ecology
3.3. Elements of ecological restoration
3.4. Restoration of degraded aquatic ecosystems: springs, rivers and wetlands.
3.5. Restoration of terrestrial ecosystem (forest, landscape, soil)
3.6. Restoration of mined areas with special reference to Doon Valley
3.7. Ecological restoration of ecosystem damaged by construction and widening of National Highways and roads

Unit IV. Management of Restoration Project

4.1. Setting goals
4.2. Planning
4.3. Action plan
4.4. Mined Closure Plan (Major/ minor minerals)
4.5. Adaptive management
4.6. Monitoring
4.7. Legal framework and international agreements
4.8. Indian guidelines for sustainable mining management
4.9. Case study: Integrated restoration management of severely degraded ecosystem

Suggested Reading:

1. Dhar, U. 1993 (Ed.). Himalayan Biodiversity: Conservation Straegies, Gyanodaya Prakashan, Nainital
2. Hunter, Jr, M.L. & Gibbs, J.P. 2006. Fundamentals of Conservation Biology. Wiley Blackwell.
3. Pullin, A Conservation Biology. Cambridge University Press, The Edinberg Building, Cambridge CB2ZRU, UK.
4. Primack, R.B. 2006. Essentials of Conservation Biology. Sinauer Associates, Inc.
5. Primack, R.B. 2008. A Primer of Conservation Biology. Sinauer Associates, Inc.
6. Singh, J.S., Singh, S.P. & Gupta, S.R. 2007. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Gain knowledge on the status and importance of biodiversity at national and global level, its exploitation and conservation
CO2	Evaluate the methods to assess the biodiversity of a region
CO3	Analyze various threats to our biodiversity and able to suggest measures for conservation strategies
CO4	Realize the significance of sustainable use of resources and conservation of biodiversity effectively and scientifically
CO5	Learn and understand the scope of restoration ecology, methods to restore the degraded lands with special reference to Doon Valley
CO6	Learn about the legal frameworks and international programmes and agreements related to biodiversity conservation and restoration ecology

\CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	2	1	2	3	2	2	2	1	2	2
CO2	2	2	1	2	-	1	1	2	1	3	2	2	1	1
CO3	1	2	2	2	1	2	2	2	2	1	1	1	2	2
CO4	2	1	1	2	1	2	1	1	1	2	2	2	1	1
CO5	2	1	2	1	-	1	2	2	2	2	2	1	2	2
CO6	3	-	1	2	1	-	2	3	-	3	2	1	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESE307 (Elective-IV)**				
Course Name	**: Environmental Toxicology**				
Semester	**: IIIrd sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To learn about the exposure of man and animal to potentially hazardous environmental factors of chemical, biological or physical nature and the effects caused by such exposure on health of man, animal and environment.

Course Contents **No. of Credits=03**

Unit I. Introduction to Environmental Toxicology

1.1 Definition, concept and scope of Environmental Toxicology
1.2 Common environmental toxicants
1.3 Heavy metals: Sources and their effects on life and environment
1.4 Pesticides: Types, uses and harmful effect of pesticides; brief note on biopesticides, persistent organic pesticides.
1.5 Mutagenic and carcinogenic chemicals, polyaromatic hydrocarbons, nitrosamines, organic solvents, alcohol, carbon tetrachloride, anaesthetic (chloroform, ether, xylocaine) tobacco chewing and smoking

Unit II. Toxicity Assessment

2.1 *In-vivo* and *in-vitro* toxicity assessment
2.2 Accute , subacute , sub chronic and chronic toxicity test
2.3 Skin and eye test, behavioural, neurotoxic, reproductive, mutagenic test, hypersensitivity and allergy.
2.4 LD_{50}, LC_{50}, EC_{50}, and IC_{50}
2.5 Factors affecting toxicity

Unit III. Systemic Toxicity

3.1 Absorption, translocation and excretion Xenobiotics: Membrane permeability and mechanism of chemical transfer, Absorption of xenobiotics, distribution of toxicants, storage depots, translocation of xenobiotics, membrane barriers, excretion of xenobiotics (major detoxifying glands)
3.2 Neuro toxicity, hepatotoxicity, immunotoxicity, cardio- vascular toxicity, respiratory disfunction and hypersensitivity

Unit IV. Biotransformation, Bioaccumulation and Biomagnification

4.1 Biotransformation: Principle, sites, biotransformation enzymes, biotransformation for gaseous toxicants
4.2 Bioaccumulation: Principle, sublethal and indirect effects of bioaccumulation
4.3 Biomagnification, bioconcentration
4.4 Bioremediation

Unit V. Environmental Health and Risk Assessment

5.1 Risk assessment
5.2 Risk assessment models

5.3 Risk assessment methods
5.4 Risk management

Suggested Reading:

1. Toxicants in the aquatic ecosystem, T. R. Crompton, John Wiley & Sons, NY.
2. Casarett & Doull's Toxicology, The basic Science of poisons, 2nd Den, Editors, J. Doull, C.D. Klaassen, M.O. Amdur, Macmillan Publishing Co. Inc., NY.
3. Statistics for environmental Biology and Toxicology, W. W. Piegorsh & A. J. Bailer.

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Learn about the exposure of man and animal to potentially hazardous environmental factors of chemical, biological or physical nature and the effects caused by such exposure on health of man, animal and environment
CO2	Analyse and interpret exposure measurements and critically evaluate different advanced exposure assessment methods
CO3	Appreciate the advantages and disadvantages of toxicological and epidemiological studies for deriving dose-response relationships
CO4	Design strategies for study of dose-response relations
CO5	Evaluate frequently used methods for health effect measurements
CO6	Apply methods for combining information from different studies to derive a dose-response relationship (meta-analysis)

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	2	1	1	2	2	3	2	1	2	2
CO2	1	2	2	2	1	2	2	3	2	2	1	2	3	1
CO3	2	1	1	1	2	1	1	2	1	2	2	1	2	2
CO4	2	1	2	2	1	2	2	2	2	1	2	2	1	1
CO5	2	2	1	1	-	-	2	3	-	2	1	1	-	1
CO6	3	-	-	2	1	-	12	3	1	3	2	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESL 308**				
Course Name	**: Lab Course-II**				
Semester	**: IIIrd sem**				
		L	**T**	**P**	**C**
		0	**0**	**3**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVES: To gain knowledge about geosciences and disaster management, toxicology, biodiversity conservation and restoration ecology as well as atmospheric models and their relation to climate change.

Course Content **No. of Credits=03**

Section A: Climatology and Environmental Modelling

Exercise 1. Measurement of dry and wet bulb temperature

Exercise 2. Recording of wind speed and direction

Exercise 3. Preparation of wind roses with the given data

Exercise 4. Recording of diurnal variations in temperature

Exercise 5. Modelling of impact of global warming on glaciers

Section B: Environmental Geosciences and Disaster Management

Exercise 1. Study of sediments and soil

Exercise 2. Soil surveys in relation to land use planning

Exercise 3. Understanding the Earth's interior with the help of a diagram

Exercise 4. Role of various agencies in Himalayas for disaster management in the Himalaya

Exercise 5. Inventory of landslide prone areas of Uttarakhand.

Exercise 6. Assessment of genesis, impact and management of any eco-disaster.

Exercise 7. Preparation of report on environmental risk assessment of any developmental project

Section C: Environmental Toxicology

Exercise 1. Assessment of toxicity on an organism (fish or tadpole) through dose response relation (LC50/LC50)

Exercise 2. Bioremediation experiment with the help of water hyacinth

Exercise 3. Assessment of impact of high temperature on organisms (control experiment)

Exercise 4. Study of risk assessment model through flow chart

Exercise 5. Case study of biomagnification in any food chain

Exercise 6. Quantitative analysis of heavy metals in environmental samples. Lead, Cadmium, Mercury, Chromium and Arsenic in air, water and soil samples

Section D: Biodiversity Conservation and Restoration Ecology

Exercise 1. To study the restoration of limestone mined area, Doon valley

Exercise 2. To study restoration and management plan for river sand mined area of any river

Exercise 3. Preparation of an inventory of WCS/IUCN categories of animal and plant species of any National Park/ Sanctuary

Exercise 4. Preparation of inventory of endangered and extinct species of plants/animals of India Exercise 5. Assessment of threats to biodiversity of a given region

Course Outcomes (COs):

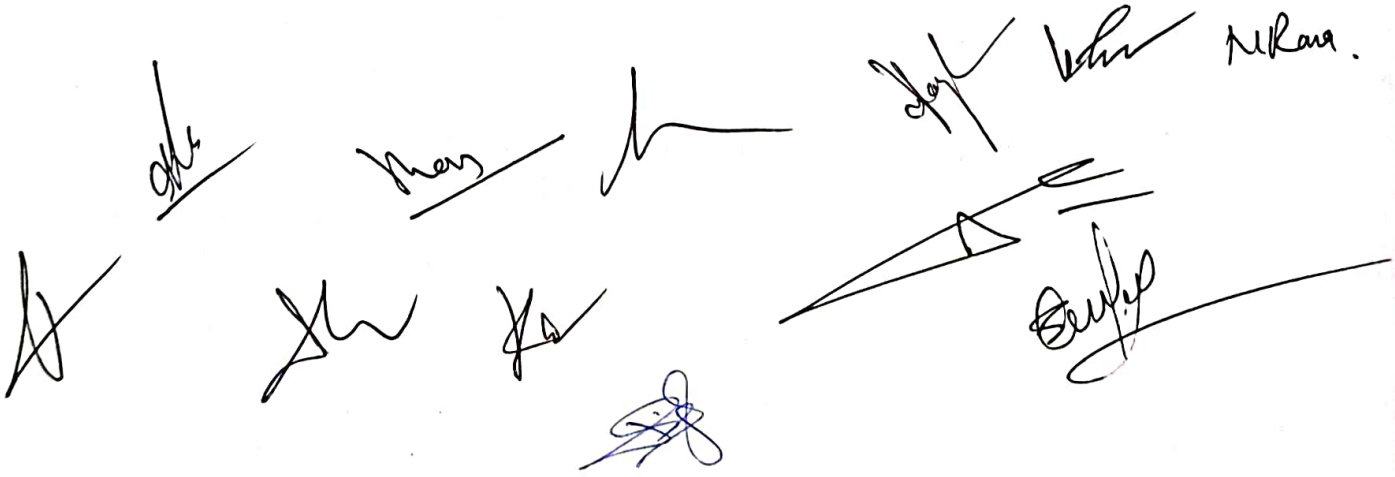
Upon successful completion of the course a student will be able to

CO1	Gain knowledge about atmospheric models and their relation to climate change
CO2	Evaluate the relation between earth's processes and hazards, role of various agencies in disaster management in the Himalayan region
CO3	Evaluate frequently used methods for health effect measurements
CO4	Design strategies for study of dose-response relations
CO5	Learn about the inventory preparation of endangered and extinct species of plants/animals of India and analyse the threats to them
CO6	Analyse the impact of contaminants and pollutants on life and property and thereby, their remediation

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	2	1	2	1	2	2	2	3	2	1	2
CO2	2	1	2	1	2	1	2	2	2	2	2	1	2	1
CO3	1	2	-	2	-	2	1	1	1	1	1	2	1	2
CO4	2	2	1	-	1	1	2	2	2	2	1	2	2	1
CO5	1	1	-	1	2	2	1	1	1	2	2	1	2	2
CO6	1	2	2	-	-	-	2	3	-	3	1	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	**: MESS 309**				
Course Name	**: History and Philosophy of Sciences**				
Semester	**: IIIrd sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop an understanding of the history and philosophy of sciences and its relevance in today's scenario to arouse integrity and ethical awareness in all aspects.

Course Content

No. of Credits=03

Unit 1: Introduction to History of Science

1.1. What is Science?
1.2. A brief history of Science
1.3. Origin of Science in ancient times (Mesopotamia, Indus Valley Civilization)
1.4. Science in the middle ages
1.5. Science and technology in ancient India (Mathematics, Astronomy, Medicine, Metallurgy)
1.6. Origin and evolution of Environmental Sciences

Unit 2: Indian Scientific Heritage

2.1. Invention of zero
2.2. Value of π
2.3. Pythagoras theorem of Bodhayan
2.4. Revolution of Earth and Sun
2.5. Law of Gravity of Bhashkaracharya
2.6. Indian scholars and their contributions to Science: *Charak, Susruta, Aryabhata, Varahmihira, Kanād, Parashar, Nagarjun*

Unit 3: Philosophy of Science

3.1. What is philosophy of science?
3.2. Ancient Indian, Greek, European and American philosophers and their contribution to science
3.3. Scientific Revolutions
3.4. Religion *versus* Science
3.5. Myths and Pseudoscience
3.6. Laws of Nature
3.7. Discovery *versus* Confirmation

Unit 4: Modern Science

4.1. Renaissance and Age of Enlightenment (Kepler, Copernicus, Galileo, *etc.*)
4.2. Biology, abiogenesis and evolution (Lamarck, Darwin, Mendel, Crick/Watson)
4.3. Classical Physics, including theory of relativity (Newton, Leibniz, Maxwell, Einstein)
4.4. New Physics (Thermodynamics, Quantum Physics & String theory: Boltzmann, Planck, Schrödinger)
4.5. Emerging areas of Modern Science

Course Outcomes

CO1	Possess a broad knowledge and understanding of the discipline
CO2	Develop an awareness of the relationship between HPS and other disciplines, especially the sciences
CO3	Evaluate integrity and ethical awareness in all aspects of the programme's learning activities
CO4	Analyze a wide range of life skills including: life-long learning; excellent communication; effective collaboration in small and large groups; and a high-level of organization
CO5	Create sustained and critical arguments using appropriate knowledge and methods, culminating in independent and self-directed research
CO6	Apply HPS knowledge to real-world practice, including the development of policy and the provision of informed comment about science, society and technology

Suggested Reading:

1. Fernandez, Brena. (2008). Studies in History and Philosophy of Science (Book Review). 20-23.
2. James Ladyman (2001). Understanding Philosophy of Science. Publisher: Routledge; 1st edition, 304p ISBN-13: 978- 0415221573

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	2	1	2	1	2	2	2	3	2	1	2
CO2	2	1	2	1	2	1	2	2	2	2	2	1	2	1
CO3	1	2	-	2	-	2	1	1	1	1	1	2	1	2
CO4	2	2	1	-	1	1	2	2	2	2	1	2	2	1
CO5	1	1	-	1	2	2	1	1	1	2	2	1	2	2
CO6	1	2	2	-	-	-	2	3	-	3	1	2	1	1

Course code	**: MESS 310**			
Course Name	**: Himalayan Wildlife**			
Semester	**: III[rd] sem**			
	L	**T**	**P**	**C**
	3	**0**	**3**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

No. of Credits=3

COURSE OBJECTIVE: To gain knowledge about the different aspects of Himalayan wildlife diversity and its Conservation.

Course Content

Unit I. An Introduction to the Himalaya

1.1 Physiography- location, expansion and importance
1.2 Origin and evolution of the Himalaya
1.3 Himalayan Environment
1.4 Natural resources of the Himalaya
1.5 Fragility of the mountain ecosystem

Unit II. Wildlife of the Himalaya

2.1 Unique characteristics and importance of the wildlife
2.2 Himalayan biodiversity
2.3 Endemism
2.4 Depletion of Himalayan wildlife

Unit III. Manifestation of Himalayan Wildlife

3.1 Himalayan wild Mammals
3.2 Himalayan wild Birds
3.3 Himalayan Reptiles and Amphibians
3.4 Himalayan Fish
3.5 Himalayan Butterflies
3.6 Rare and Endangered Himalayan wild flora

Unit IV. Conservation and Management

4.1 Administrative and legislative measures for protection of wildlife
4.2 Protected areas (National parks, sanctuaries, biosphere reserves) in the Himalaya
4.3 Tiger Project, Project Elephant, Project Rhino, Project Snow Leopard
4.4 Man-Wildlife Conflict: agriculture-wildlife conflict
4.5 Wildlife Protection Act 1972 and successive amendments
4.6 Problems in implementation of the Wildlife Protection Act

Suggested Reading:

1. Kendeigh : Animal ecology, Prentice Hall 1961.
2. Odum: Fundamentals of ecology, Saunders Co. Publ., 1993 Indian ed.
3. Odum : Basic ecology, Saunders Co. Publ., 1993 Indian ed.
4. Krebs: Ecology (4th ed.) Harper Collins College Publisher
5. Negi: An Introduction to Wildlife Management, 1983.
6. Majupuria T C: Wildlife Wealth of India Tecprress Service, Bangkok, 1986.
7. Saharia: Wild life of India Nataraj Publishers, Dehradun.

8. Negi: Himalayan Wildlife: Habitat and Conservation, 1992. Indus Publishing Company, New Delhi.
9. Sharma: High Altitude Wildlife of India Oxford & IBH Publishing Co. Pvt. Ltd.1994.

Course Outcome

CO1	To gain knowledge about the different aspects of Himalayan wildlife diversity and its conservation
CO2	To learn about the Himalayan origin and evolution, physiography, biodiversity, and approaches towards the protection of its wildlife
CO3	To understand the exclusivity and fragility of Himalayan ecosystem and its wildlife, with special focus to its rare, endangered and endemic species
CO4	To become aware about significance of Himalayan ecosystem as a home to variety of wild faunal species, and its rare and endangered wild flora
CO5	To analyze the different administrative and legislative measures and practices adopted for wildlife conservation like Protected Areas, Project Tiger, Project Elephant etc.
CO6	To formulate efficient solutions for the problems faced in the protection of wildlife like man-wildlife conflict, depletion of wildlife etc.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	2	1	3	2	3	3	2	1	2
CO2	2	1	2	1	2	1	2	2	2	2	2	1	2	1
CO3	1	2	-	2	-	2	1	1	1	1	1	2	1	2
CO4	2	2	1	-	1	1	2	2	2	2	1	2	2	1
CO5	1	1	-	1	2	2	1	1	1	2	2	1	2	2
CO6	3	2	2	-	-	-	2	3	-	3	1	2	1	1

Course code	**: MESC401**			
Course Name	**: Environment Management: EIA and Environmental Auditing**			
Semester	**: IVth sem**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: Learn the importance and scope of Environmental Impact Assessment and Realize the need for EMP.

Course Content **No. of Credits=03**

Unit I. Environmental Impact Assessment (EIA)

1.1. Concept, scope and objectives of EIA
1.2. Evolution of EIA and its development
1.3. Developmental projects under EIA
1.4. Protocol for environmental impact statement (EIS)
1.5. EIA Laws and Policy: An overview
1.6. EIA guidelines 1994: Notifications of Government of India
1.7. EIA Notification 2006 and subsequent modifications

Unit II: Methods of Impact Analysis

21. Procedure of EIA
22. Screening, scoping and baseline data collection for EIA
23. Impact prediction on air, water, land, biota, socio-economic environment
24. Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided)
25. Concept of Cumulative Environmental Impact Assessment (CEIA)
26. Case studies of EIA: River valley projects, mining, road construction, industries

Unit-III: Statuary Clearance Procedure and Public Consultation

3.1. Expert Appraisal Committee (EAC)
3.2. Environmental Clearance, Wildlife Clearance and Forest Clearance
3.3. Permission for carrying out survey and investigation
3.4. State Expert Appraisal Committee (SEAC) and State EIA Authority (SEIAA)
3.5. Concept and objectives of Public Consultation
3.6. Techniques and consultation approach for public Consultation

Unit IV. Post-Project Monitoring and Environmental Auditing

4.1. Principles and guidelines of environmental auditing
4.2. General Audit: Methodology and basic structure of environmental auditing
4.3. Preparation and submission of audit report to the regulatory bodies 4.4. ISO 14000 series: ISO 9001, 9002

Unit V. Environmental Management and Management Plan

5.1. Concept, objectives and scope of environmental management.
5.2. Environmental management in terms of developmental projects
5.3. Guidelines for EMP

5.4. Development of EMP- air, water, groundwater, noise, land and biodiversity
5.5. Rehabilitation and resettlement
5.6. Compensatory afforestation
5.7. Green belt development
5.8. EMP of any development project (case study)

Suggested Reading:

1. Canter, Larry W. Environment Impact Assessment. McGraw-Hill.
2. Rau, G.J. and C.D. Weeten. 1980. Environmental Impact Analysis Handbook. McGraw Hill.

Reference Book:

1. Glasson, John, Rikki Therievel and Andrew Chadwick. 1996. Introduction to Environmental Impact Assessment, 2nd edition UCL Press.
2. Kulkarni, Vijay and T.V. Ramchandra. Date Environmental Management. Capital Publishing.
3. Mhaskar, A.K. Environmental Audits. Enviro Media Publications.
4. Eccleston, Charles H. 2011. Environmental Impact Assessment: A Guide to Best Professional
5. Practices. CRC Press.
6. Morris, Peter and RikiTherivel. 2009. Methods of Environmental Impact Assessment (Natural and Built Environment Series). Routledge

Course Outcomes (COs):

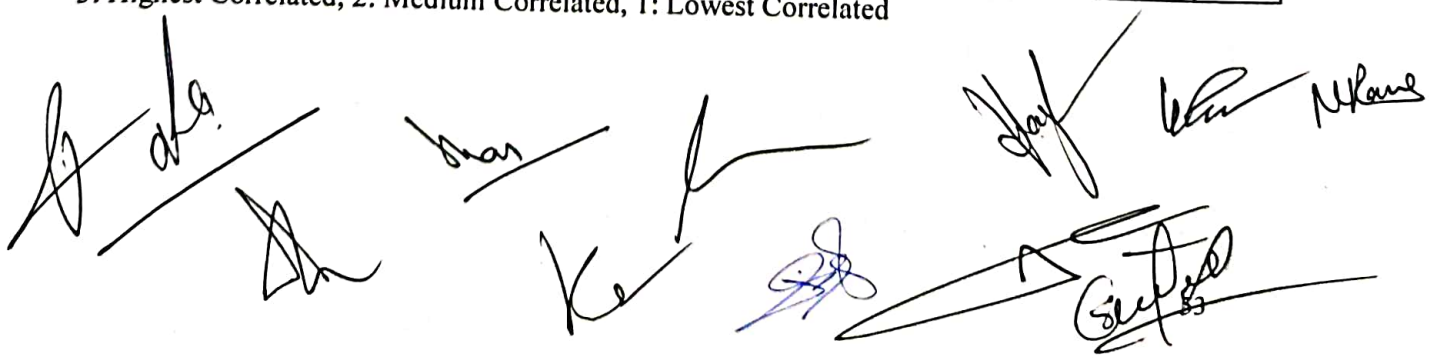
Upon successful completion of the course a student will be able to

CO1	Learn the importance and scope of Environmental Impact Assessment in today's scenario
CO2	Analyse the likely impacts of the proposed project on individual, society and environment
CO3	Analyse the various indicators to assess the state of health, economy and standard of life either prospering or deteriorating
CO4	Evaluate different methodologies of EIA and conditions under which a particular method can be adopted
CO5	Learn and demonstrate the need and methodology required for the process of environmental auditing
CO6	Realize the need for EMP and learn the process of environment management

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	2	2	1	2	2	1	2	1	2
CO2	2	1	2	1	-	2	1	2	1	2	2	1	2	2
CO3	1	1	-	2	-	1	2	2	2	1	2	1	2	1
CO4	2	2	2	-	1	1	2	1	1	2	1	2	1	2
CO5	1	1	-	2	-	-	2	3	-	3	2	1	1	1
CO6	3	2	1	1	1	1	2	2	1	3	2	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	**: MESC402**				
Course Name	**: Environmental Laws, Ethics and Policies**				
Semester	**: IVth sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Hours: 45

COURSE OBJECTIVE: To develop an understanding with the laws, policies and institutions in the field of environment at national and global level.

Course Content

No. of Credits =03

Unit I. National and International Efforts for Environmental Protection

1.1. Provision of environmental issues and problems in National and International Agenda
1.2. Environmental protection in the Indian Constitution (Article 48A, Article 51A (g)
1.3. International efforts (Stockholm Conference, Montreal Protocol, Kyoto Protocol and otherclimate related agreements, Ramsar Convention, CITES)

Unit II. National Environmental Laws-1

2.1 Indian Forest Act 1927; The Forest Conservation Act 1980 and Rules 1981and successive amendments
2.2 Wildlife Protection Act 1972 and subsequent amendments
2.3 Water (Prevention and Control of Pollution) Act 1974and Rules 1975 and subsequent amendments
2.4 Air (Prevention and Control of Pollution) Act 1978 and Rules 1982and successive amendments
2.5 The Environmental (Protection) Act 1986 and Rules 1986 and successive amendments

Unit III. National Laws –II

3.1 National Environmental Tribunal Act 1995; National Green Tribunal (NGT)
3.2 Public Liability Insurance Act 1991
3.3 Biomedical Waste (Management and Handling) Rules 1998 and successive amendments
3.4 Hazardous Waste (Management and Handling) Rules 1989
3.5 Biological Diversity Act 2002 and Rules 2004, and successive amendments

Unit –IV. National Policies and Ethics

4.1. Forest Policy
4.2. Environmental Policy
4.3. Water Policy
4.4 Definition and concept of environmental ethics
4.5 Resource consumption patterns and need for equitable utilization
4.6 Anthropocentrism, stewardship, biocentrism, ecocentrism, cosmocentrism,
4.7 Conservation ethics, traditional value system in India

Suggested Reading:

1. Anonymous (1997). The Indian Forest act, 1927 along with forest conservation act, 1980. Natraj
2. Publisher's Dehradun

3. Guha, R. (1989). The Unquiet woods. Oxford University Press. Guha, R. (Ed.). (1994). Social ecology. Oxford University Press Martell, L. (1994).
4. Ecology and society: an introduction. Polity press, Cambridge, U.K. Hayward, I.M. (1995).
5. Ecological thought: An introduction. Polity press, Cambridge.

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Develop an understanding with the laws, policies and institutions in the field of environment at national and global level
CO2	Develop skills needed for interpreting laws, policies and judicial understanding in a holistic perspective
CO3	Realize the importance of public participation through Right to information, Public Interest Litigation and other remedies in preserving and protecting environment
CO4	Analyse the role of international/ national environmental institutions, NGOs, civil society and community involvement in promoting the cause of environment
CO5	Comprehend the statutory and regulatory mechanisms pertaining to environment in India
CO6	Learn about the human right to environment and constitutional framework governing environment in select countries, including India and find solutions to global environmental problems

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	2	1	2	2	2	1	2	2	1
CO2	1	2	2	1	2	1	2	1	1	2	2	-	1	2
CO3	2	1	1	2	-	-	2	2	2	2	1	1	2	2
CO4	1	2	2	1	1	-	2	2	1	2	1	1	2	1
CO5	1	-	1	-	-	1	1	2	-	1	-	1	-	1
CO6	3	1	1	2	2	1	3	3	1	3	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESL403**			
Course Name	**: Lab Course I**			
Semester /Year	**: IVth Sem**			
L	**T**	**P**	**C**	
0	**0**	**4**	**4**	

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 60**

COURSE OBJECTIVE: To develop an understanding of the EIA process and salient features of the environmental acts.

Couse Content **No. of Credits=4**

Exercise 1. Presentation of EIA through flowchart
Exercise 2. Presentation of case study of EIA of any developmental project Exercise 3. Presentation of procedure of environmental auditing through flow chart
Exercise 4. To prepare an audit report for submission to the regulatory body Exercise 5. Presentation of environmental clearance (EC) through flow chart Exercise 6. Presentation of forest clearance (FC) through flow chart
Exercise 7. Presentation of wildlife clearance (WC) through flowchart
Exercise 8. Presentation of salient features of Wildlife Protection Act 1972
Exercise 9. Presentation of salient features of Water (Prevention and Control of Pollution) Act 1974 Exercise 10. Presentation of salient features of the Air (Prevention and Control of Pollution) Act 1981
Exercise 11. Presentation of salient features of The Environmental (Protection) Act and Rules 1986 Exercise 12. Presentation of salient features of The Indian Forest Act 1927

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Learn and understand the importance of EIA and the process followed in India
CO2	Gain in depth knowledge of WPA 1972, Indian Forest Act 1927, Air Act 1981, Water act 1974 and EPA 1986
CO3	Analyse the process of environmental auditing
CO4	Evaluate different methodologies of EIA and analyse the need and process of environment management
CO5	Demonstrate a sound understanding of different types of environmental clearance
CO6	Generate information about EIA process of different developmental activities with the help of practical case studies

CO-PO Mapping

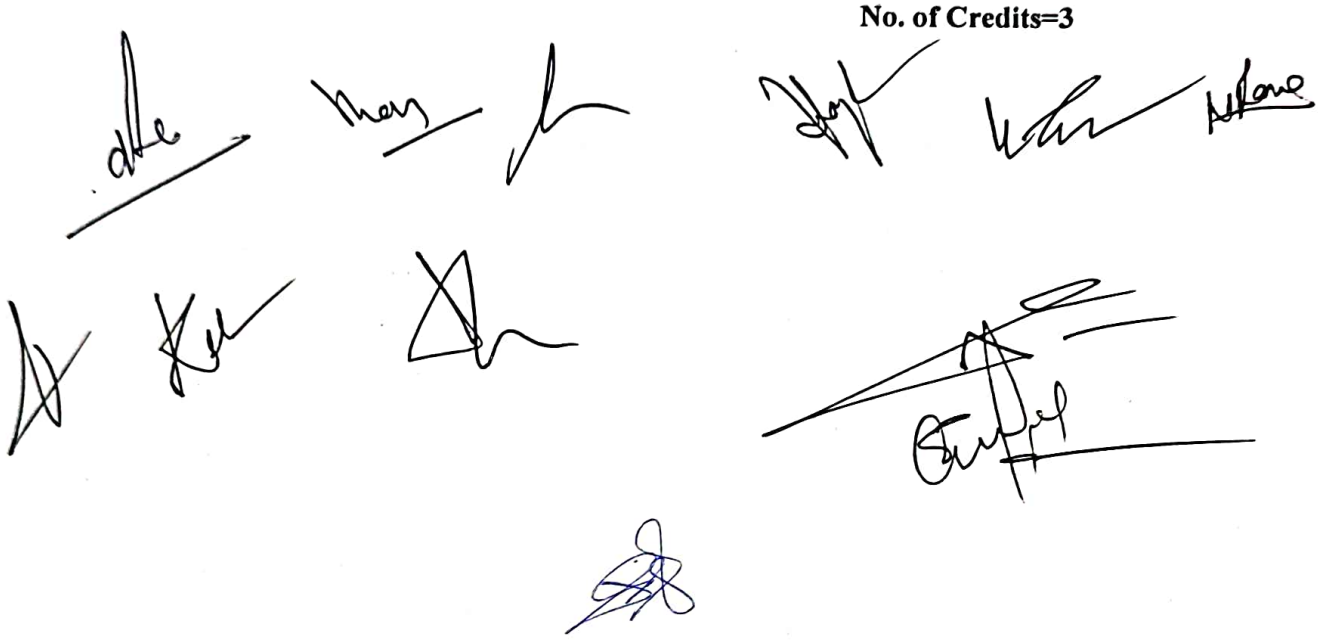
Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	3	2	2	2	3	2	3	3
CO2	3	2	3	2	2	2	3	2	3	3	2	2
CO3	2	2	2	2	2	3	2	2	2	2	2	3
CO4	2	2	3	2	3	2	3	2	3	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MESE 404**			
Course Name	**: Thesis/Dissertation**			
Semester /Year	**: IVth Sem**			
	L	**T**	**P**	**C**
	0	**0**	**3**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

No. of Credits=3



Course code	**: MESE405**				
Course Name	**: Mountain Ecology**				
Semester	**: IVth Sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop and understanding of the mountain ecology and learn the strategies to conserve and manage mountains at National and international level.

Course Contents **No. of Credits=03**

Unit I. Introduction

1.1 Definition, importance and scope of Mountain Ecology
1.2 Specificity of mountain ecosystems
1.3 Environmental importance of mountains

Unit II. Mountain Ecosystem

2.1 Structure and its components
2.2 Geological formations of mountains
2.3 Vulnerability of mountain ecosystems
2.4 Environmental degradation in mountains

Unit III. Environmental Hazards in the Mountains

3.1 Landslides, soil erosion and sedimentation
3.2 Cloud bursts
3.3 Flash floods and river blockades
3.4 Avalanches and Glaciers Lake Outburst Floods (GLOF)
3.5 Earthquakes
3.6 Forest fires

Unit IV. Conservation and Management of Natural Resources of Mountains

4.1 Natural resources of mountains (Forest, Water, Wildlife and Minerals)
4.2 Sustainable exploitation of natural resources
4.3 Traditional wisdom for management of natural resources
4.4 National and international efforts for management of mountains

Unit: V. Mountains and People

5.1 Indigenous people of mountains
5.2 Livelihood of mountain people
5.3 Migration of mountain people
5.4 Livelihood security of mountain people

Suggested Reading:

1. Mani, M.S. (1974). Biogeography of India,1st Edn. Springer.
2. Geology of India D N Wadia Tata-McGraw Hill Publishing Co. New Delhi
3. Biogeography of India M S Mani Dr W Junk b v Publishers, The Hague
4. Garhwal Himalaya - Nature, Culture & Society Kandari, O. P. and Gusain, O. P., (Eds.)
5. Transmedia, Srinagar, Uttaranchal, India.

Course Outcomes (COs):

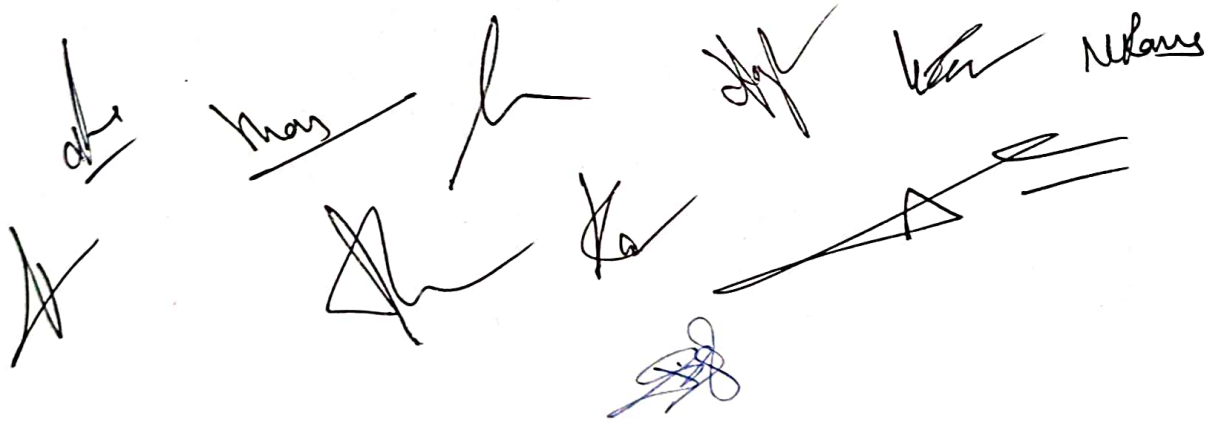
Upon successful completion of the course, a student will be able to

CO1	Learn about Mountain Ecology with special reference to the Himalayan Environment and Development; Mountain ranges of the world UN Agenda 2030, Mountain in SDGs2030
CO2	Develop an understanding of the Biological Diversity, Climate setting, Physical setting, Socio-ecological settings, Forests & forestry, Water Resources
CO3	Comprehend the Cultural Diversity, Landscapes, communities and Livelihoods, Traditional knowledge system, Transhumant, pastoralism and collectors, Urbanization, tourism and its impact
CO4	Analyse the mountain ecology, its vulnerability to hazards and its impact on life and property
CO5	Learn the strategies to conserve and manage mountains at National and international level
CO6	Analyse Sustainable Future, Environmental Issues Disasters and Climate Change, Political and governance issues, Economic, Cultural and Environmental needs (SDGs vis-à-vis Himalaya)

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	2	2	-	1	2	2	1	2	2	1
CO2	1	1	2	1	2	1	2	2	1	3	2	2	2	2
CO3	2	2	1	2	1	2	1	1	2	2	1	1	1	1
CO4	2	1	2	1	2	1	3	3	-	1	2	2	2	1
CO5	2	2	1	2	1	1	2	2	1	2	1	-	2	2
CO6	3	1	2	1	2	2	2	3	-	3	2	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	**: MESE406**			
Course Name	**: Wildlife Conservation and Management**			
Semester	**: IVth Sem**			
L	**T**	**P**	**C**	
3	**0**	**0**	**3**	

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To learn about the various contemporary aspects of wildlife monitoring analyse laws and acts related to wildlife and learn about ethics in the field of wildlife conservation.

Course Contents **No. of Credits=3**

Unit I. An Introduction to Wildlife conservation

1.6 Introduction to conservation biology
1.7 Conservation and sustainable development
1.8 Conservation *vs* preservation
1.9 Patterns and process of biodiversity, losses and threats to biodiversity
1.10 Biogeographic classification
1.11 Biological consequences of habitat loss

Unit II. Importance of Mountain ecosystem

2.5 Unique characteristics and importance (ecotone and edge effects)
2.6 Fragility and endemism of mountain ecosystem
2.7 Threats and conservation importance

Unit III. Importance of Indian Himalayan Region (IHR)

3.1 Origin, Physiography and evolution
3.2 Importance (sensitivity, endemism and uniqueness)
3.3 Biodiversity (Flora and Fauna) of IHR
3.4 Threatened wild flora and fauna of IHR

Unit IV. Conservation and Management

4.7 Administrative and legislative measures for protection of wildlife in India
4.8 Wildlife (Protection) Act 1972 and successive amendments: Problems in implementation
4.9 Protected areas (National Parks, Sanctuaries, Biosphere Reserves, Conservation Reserves, Community Reserves and Ramsar sites).
4.10 Major wildlife conservation projects of India (Tiger Project, Project Elephant Project Snow Leopard etc.)
4.11 Man-Wildlife Conflict: Cause, Impact and Mitigation Measures

Suggested books and readings:

- Odum, E. P. (1953) Fundamentals of Ecology.
- Giles, R. H. (1984), Wildlife Management Techniques, Natraj Publishers, Dehradun.
- Gopal, R. (1992), Fundamental of Wildlife management Justice Home Allahabad.
- Hosetti, B. B. (1997), Concepts in Wildlife Management, Chawla Press, Delhi.
- Sutherland, William J., ed. Ecological census techniques: a handbook. Cambridge University Press, 2006.

- Protected Areas Network(http://www.wiienvis.nic.in/Database/Protected_Areas_854.aspx)
- IUCN Red List of Threatened Species (https://www.iucn.org/resources/conservation-tools/iucn-red-list- threatened-species).
- Indian Mammals, A Field Guide by Vivek Memon.
- Birds of Indian Subcontinent by Carol Inskipp, Richard Grimmett, and Tim Inskipp.
- Biogeographic classification of India - Rodgers and Panwar, Wildlife institute of India.

Course Outcomes (COs):

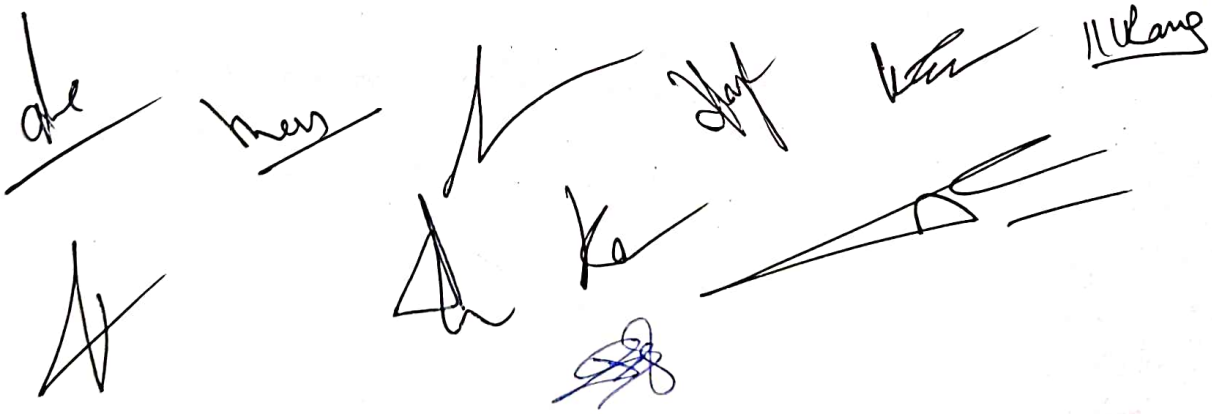
Upon successful completion of the course, a student will be able to

CO1	Learn about historical aspects of Wildlife conservation in India and India's conservation present day conservation priorities
CO2	Ability to undertake situation analysis for conservation
CO3	Learn about the various contemporary aspects of wildlife monitoring including application of modern and emerging tools and techniques related to this
CO4	Analyse laws and acts related to wildlife and learn about ethics in the field of wildlife conservation
CO5	Definitely provide an avenue to build a career in the field of wildlife conservation both in academic and non-academic sector
CO6	Provide a wholesome and professional understanding about the Indian wildlife and its conservation scenario

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	2	2	2	3	3	2	2	1	1	1	1
CO2	2	2	1	1	2	2	2	2	1	3	2	2	2	2
CO3	1	2	2	2	-	1	1	2	2	2	2	1	2	1
CO4	2	1	2	-	2	2	1	1	1	2	1	2	1	2
CO5	2	1	1	2	1	2	2	2	2	3	2	1	2	1
CO6	2	2	-	1	2	1	2	3	1	2	1	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	**: MESE407**				
Course Name	**: Climate Change and Sustainable Development**				
Semester	**: IVth Sem**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To learn about the fundamentals of Climate change and Sustainable Development and understand the importance of SDGs in the present scenario.

Course Contents **No. of Credits=3**

Unit I. Climate Change and Sustainability: Broad Overview

1. Introduction to Climate Change and Sustainable Development
2. Relationship between Climate Change and Sustainable Development
3. Importance of Sustainability in the changing climate

Unit II. Art and Science of Climate Change

1. Climate Dynamics & Drivers
2. Climate Change Mitigation
3. Climate Change Impacts and Adaptation
4. International and National Policies and legislations for Climate Change
5. Long-term Planning for Climate Change

Unit III. Principles and Concepts of Sustainable Development

1. Introduction of Sustainable Development
2. Sustainable Development Goals (SDGs): Local to Global Relevance
3. Climate Change and Sustainable Development
4. Sustainability and Livelihoods
5. Environmental Social and Governance (ESG) and Sustainability

Unit IV. Climate Change and Sustainable Development: IHR Perspective

1. Climate change and IHR
2. Major Missions and Programs related to Climate Change and IHR
3. Sustainable Development and IHR

Suggested books and readings:

1. Brinkmann R (2021). Introduction to Sustainability.
2. Harvey D (2000). Climate and Global Climate Change, Prentice Hall.
3. Elizabeth K (2006). Field Notes from a Catastrophe: Man, Nature, and Climate Change

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Learn about the fundamentals of Climate change and Sustainability.
CO2	Gain knowledge about the different components of climate change (mitigation and adaptation)
CO3	Understand the importance of SDGs in the present scenario.
CO4	Learn about numerous environmental laws and policies regarding the Climate Change
CO5	Learn about the impact of climate change on the IHR.
CO6	It will prepare students for the emerging sector of climate change and sustainability/

Course code	**: MESE408**			
Course Name	**: Solid Waste Management**			
Semester	**: IVth Sem**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop a critical understanding of the prevailing issue of waste generation and the need of its safe treatment and disposal to safeguard the surrounding environment.

Course Contents **No. of Credits=3**

Unit-I: Municipal Solid Waste

Solid wastes: Sources, classification, characteristics of solid waste, Waste generation rates, Collection and storage of municipal solid wastes, transfer stations, waste processing - volume and size reduction, source reduction, recycling, waste minimization.

Unit-II: Waste Treatment and Disposal

Waste processing technologies, Incineration, Combustion, Stabilization, Solidification, chemical fixation, encapsulation, Composting, Vermicomposting, Energy from waste – Bio- gasification - Anaerobic digestion, pyrolysis, refuse derived fuels; Landfill bioreactors, Burning, open dumping - problems, Landfill – site selection, Sanitary and secured structure, design, construction, operation and closure. Waste prevention and recycling at home, 5 Rs of waste management.

Unit-III: Hazardous Waste Management

Hazardous waste: Definition, sources, classification, collection, segregation, characterization, Treatment and disposal. Radioactive wastes: Definition, sources, classification, collection, segregation, Treatment and disposal. E waste: Definition, sources, classification, collection, segregation, Treatment and disposal. Biomedical wastes: Definition, sources, classification, collection, segregation, Treatment and disposal.

Unit-IV: Waste Management Legislation

Solid Waste (Management and Handling) Rules, 2000, 2016 and further amendments, Biomedical Waste (Management and Handling) Rules, 2016; Plastic Waste Management Rules 2016, 2022. E-Waste Management Rules, 2016, 2022. Bio-Medical Waste Management Rules, 2016 and amendments. Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and further amendments; Construction and Demolition Waste Management Rules. Schemes and programs of Government- Swachchh Bharat Abhiyaan.

REFERENCE BOOKS:

1. Solid Waste Management Manual CPCB, New Delhi.

2. Ecotechnology for Pollution Control and Environmental Management by Trivedy R.K. and Arvind
Kumar.
3. Williams, Paul T. (2013) Waste treatment and disposal, John Wiley Publishers.
4. Johri, Rakesh (Ed.), (2009) E-waste: Implications, regulations and management in India and
Current global best practices, TERI press.
5. Letcher, Trevor M. (Ed.) (2011) Waste: A handbook for management, Academic Press London.
6. Sahai, Sushma (2009) Bio- medical waste management, APH Publishing.
7. Rosenfeld, Paul E., (2011) Risks of hazardous wastes, Elsevier London.

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Understand various concepts related to solid waste management process
CO2	Acquire the knowledge related to the municipal and hazardous waste composition, management strategies and mitigation measures
CO3	Apply steps in solid waste management - waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of solid waste transport, treatment and disposal techniques
CO4	Evaluate the solid and hazardous waste management process in India according to the existing legal framework
CO5	Create innovative methods for final disposal of solid waste in daily life using 5 Rs: refuse, reuse, reduce, repurpose and recycle
CO6	Demonstrate a critical understanding of the prevailing issue of waste generation and the need of its safe treatment and disposal to safeguard the surrounding environment

Course code	**: MESL409**			
Course Name	**: Lab Course II**			
Semester	**: IVth Sem**			
	L	**T**	**P**	**C**
	0	**0**	**3**	**3**

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To develop practical knowledge about biodiversity conservation, resource management and traditional practices with special reference mountain ecology.

Course Contents **No. of Credits=3**

- Exercise 1. Analysis of various components (producer, consumer, decomposer) of ecosystems- lake, pond, river, forest in a mountainous terrain
- Exercise 2. Determination of minimum quadrat size for vegetational analysis
- Exercise 3. Calculation of Importance Value Index (IVI) for different plant species in a grassland ecosystem/forest patch in the Himalayan region
- Exercise 4. Determination of biological diversity (Shannon Wiener diversity index) in aquatic/ terrestrial habitats in the IHR
- Exercise 5. Development of food web with the help of various food chains available in an ecosystem (grassland/river/ pond ecosystem) in the Himalayan region
- Exercise 6. Documentation of forest types in the IHR
- Exercise 7. Documentation of Indigenous practices and traditional knowledge in a village ecosystem in the IHR
- Exercise 8. Documentation of traditional soil and crop management practices in a village ecosystem in the IHR
- Exercise 9. Analysis of soil and water quality of the available resources in a village ecosystem in the IHR
- Exercise 10. Documentation of Himalayan (local) birds and their feeding habits in the IHR
- Exercise 11. Preparation of report on any Sacred groove/Sacred Lake/Environmental hazard
- Exercise 12. Maintenance of Herbarium for high altitude medicinal plants/economically important plants.
- Exercise 13. Preparation of a report on Threatened wild flora and fauna of the IHR
- Exercise 14. Preparation of case study on Man-Wildlife Conflict in the IHR
- Exercise 15. Field visit to a National Park/Biosphere Reserve/Wild life Reserve etc.

Course Outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	To gain practical knowledge about ecosystem components in mountain regions with special reference to Indian Himalayan Region (IHR)
CO2	To assess the different components of mountain ecology (like documentation of birds and their feeding habits, vegetational analysis, food chains and food webs etc.)
CO3	To calculate the biodiversity in IHR by using different indices such as Shannon Wiener diversity index, DBDI, IVI etc.)
CO4	To evaluate the soil and water quality of available resources in a village ecosystem in IHR
CO5	To demonstrate a practical knowledge about the different problems of mountain ecosystems such as environmental hazards, man-wildlife conflicts, biodiversity loss and threatened species etc.
CO6	To prepare the inventory of the traditional knowledge and crop management practices in village ecosystems in IHR

Course code	**: MESS410**			
Course Name	**: Traditional Ecological Knowledge**			
Semester	**: IVth Sem**			
L	**T**	**P**	**C**	
3	**0**	**0**	**3**	

L - Lecture T – Tutorial P – Practical C – Credit **Hours: 45**

COURSE OBJECTIVE: To understand the importance of various dimensions of traditional knowledge and its relevance for resource management.

Course Contents **No. of Credits=3**

Unit I. Definition, concept, and scope of TEK

1.1. Traditional ecological knowledge as a science
1.2. TEK in different forms (stories, legends, folklore, rituals, folk songs, and dictums)
1.3. Traditional technology of subsistence (artifacts, crafts *etc.*)

Unit II. Cultural, Sacred, Myth, Rituals and Beliefs

2.1. Basic concept of society, culture and religion
2.2. Nature, aims and objectives of comparative religion (caste, community and their culture).
2.3. Basic feature of religion and principal sets of religion
2.4. Myths, rituals and beliefs associated with TEK in Hinduism.
2.5. Myths, rituals and beliefs associated with TEK in Buddhism
2.6. Myths, rituals and beliefs associated with TEK in Islam
2.7. Myths, rituals and beliefs associated with TEK in Christianity
2.8. TEK in Indian Himalayan states

Unit III. TEK and Natural Resources Management

3.1. TEK for forest conservation,
3.2. TEK for water harvesting,
3.3. TEK for wildlife case study
3.4. TEK for conservation of biodiversity
3.5. TEK related with medicinal plants
3.6. TEK related with agriculture and cattle rearing
3.7. TEK related with horticulture

Unit IV. Knowledge Transfer: Old Concepts and Barriers

4.1. Old concepts and barriers in transferring indigenous traditional knowledge
4.2. Old myths in transferring traditional knowledge
4.3. God and man
4.4. Ways of prayers, rituals in different communities

Unit V. Documentation and Preservation of TEK

5.1. Need for Documentation and Preservation
5.2. International laws and policy of TEK
5.3. Laws and policy in India for TEK

5.4. Reposition of TEK by CSIR, Govt. of India

Suggested Reading:

1. Nelson, M., & Shilling, D. (Eds.). (2018). *Traditional Ecological Knowledge: Learning from Indigenous Practices for Environmental Sustainability* (New Directions in Sustainability and Society). Cambridge: Cambridge University Press. doi:10.1017/9781108552998.
2. Neelendra K. Joshi and Dr. Vir Singh. 2010. Traditional Ecological Knowledge of Mountain People: Foundation for Sustainable Development in the Hindu Kush Himalayan, Daya Publ. House, New Delhi, 232p

Course Outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Understand the salience of various dimensions of knowledge and its relevance for resource management
CO2	Appreciate the need to go beyond binaries and articulate the need for greater synergies between two knowledge systems and bridging the science-management divide
CO3	Be familiar with the concept and need for use of traditional knowledge for adaptive management
CO4	Be aware of traditional practices of soil, forest, water management in South Asia, especially India and also understand why these practices did not sustain, i.e., an insight into the institutional processes that are key to understanding management issues
CO5	Learn and apply the value of traditional knowledge in the field of medicine
CO6	Analyse the importance of international laws and policies and IPR in traditional knowledge

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	2	1	2	2	3	2	3	3	2	2	2
CO2	2	2	1	-	1	1	2	2	2	2	3	2	2	1
CO3	1	2	1	2	1	1	3	3	1	3	2	2	1	1
CO4	2	1	1	2	-	1	2	2	2	2	2	2	2	2
CO5	2	1	-	1	2	1	2	2	2	1	2	2	2	2
CO6	3	1	2	2	1	2	1	3	1	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

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