SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

M.Sc. ENVIRONMENTAL SCIENCE

(2022-23)

(2023-24)

Maharaja Ganga Singh University

Bikaner

Table of Contents

About the Department

Department of Environmental Science was established in 2011 imparting education at Post Graduate Level in area of Environmental Science. The course offered by department includes M.Sc., Ph.D. and PG Diploma in Geoinformatics &. Remote Sensing degrees. Admission for the programme is made through percentage basis every year. Department has five full time faculty members including two professors and three assistant professors (senior scale). The department has a well stocked library holding good number of reference and text books on core and allied subjects. It has a state of the art laboratory equipped with almost all required instruments and related paraphernalia.

Background

Considering the curricular reforms as instrumental for desired learning outcomes, all academic Department of Maharaja Ganga Singh University made a rigorous attempt to revise the curriculum of postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP". The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focusing on creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills 'for the development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the Policy by emphasizing upon- integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points, alignment of Vocational courses with the International Standard Classification of Occupations maintained by the International Labour Organization; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical, vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. The University has also developed consensus on adoption of Blended Learning with 10% component of online teaching and 90% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the Faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department was discussed in series of discussion sessions conducted at Department, Faculty and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of Masters Course, Learning Outcome Index, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and Appendices. The experts of

various Boards of Studies and Faculties contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Therefore, the curriculum may be reviewed annually so as to gradually include all relevant provisions of NEP-2020.

Programme Outcomes (PO)

Vision

To build responsive, responsible, sensitive, creative and thoughtful citizens with a comprehensive understanding of regional, national and international perspectives.

Mission

To strive towards the educational, cultural, economic, environmental and social advancement of the region and the nation at large by providing multidisciplinary liberal education involving arts, sciences, social sciences, education, law and commerce & Management and quality programmes which inculcate and enhance students' creative and innovative insights, equipping them with both professional and vocational skills, leading to Bachelors', Masters', Professional, Vocational and Doctorate Programmes.

Program Objectives:

1. To create and disseminate knowledge to the students about environmental problems at local, regional and global scale.
2. To provide practical training on modern instrumentation and analytical techniques for environmental analyses.
3. To sensitize students towards environmental concerns, issues, and impacts of climate change and related mitigation strategies.
4. To make the students to apply their knowledge for efficient environmental decision-making, management and sustainable development.
5. To prepare students for successful career in environmental departments, research institutes, industries, consultancy and NGOs, etc.

Programme Outcomes (PO)

The PG Courses of Faculty of Science will be able:

PO	Description
PO1	To acquaint students with recent knowledge and techniques in basic and applied sciences.
PO2	To develop understanding of biological and environmental basis of life.
PO3	To provide insight in to ethical implications of scientific research for environmental protection and good laboratory practices and bio safety.
PO4	To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to sciences.
PO5	To understand application of biotic material in food security for human wellbeing and sustainable development.
PO6	To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of sciences for self reliance.

Program Specific Outcome (PSO)

PSO	Description
PSO-1	To contribute to Environmental Sustainability and wise use of Natural Resources for benefit of society through education and research on environment with a multidisciplinary and professional approach
PSO-2	To provide knowledge on Ecology, Biodiversity Conservation, Remediation and Restoration.
PSO-3	To create awareness on Pollution, Climate Change, Ecotoxicology and their linkages to human health
PSO-4	To educate students on Environmental Impact Assessment, Monitoring and Policy frameworks
PSO-5	To give knowledge on concepts, tools and modern techniques for Environmental Analysis and Management
PSO-6	To educate students on Natural Resource Management and Sustainable Development.

Post Graduate Attributes

The graduate attributes of our students shall be aligned with those of our University in terms of touching "the life of every student through inculcating virtues of empathy, ethics, efficiency, respect for diversity, prudence and creativity with compassion". We wish to achieve this through rigorous teachings and research effort, which remains the basic tenet of our teaching-learning philosophy. The following are the University's graduate attributes which we emphasize.

- In depth Domain Knowledge
- Interdisciplinary Perspective
- Competence for Research and Innovation
- Analytical Competence
- Critical Thinking
- Problem Solving Competence
- Decision Making
- Information Technology Skills
- Ability to Work Independently
- Capacity for Creativity
- Contribute to Societal Well-being & Sustainability

Process of Course development involving various stakeholders at different stages:

1. Appointment of syllabus revision committee comprising 5 faculty members from the Department of Environmental Science.
2. Draft revised syllabus circulated among all the Department faculty members including the guest faculty.
3. Draft revised syllabus sent to more than 10 external experts including alumni and international reviewers.
4. Incorporation of suggestions/changes in the draft revised syllabus.
5. Draft revised syllabus sent to the Department course committee which included guest faculty.
6. Draft revised syllabus submitted to the Faculty of Science for consideration & approval.
7. Revised syllabus sent for statutory approvals in the University.

Structure of Programme

Semester Ist: Four Core Compulsory, One Foundation Course, One Practical Course

ESCC-101	Environmental Science Core Compulsory	Environment and Ecology
ESCC-102	Environmental Science Core Compulsory	Environmental Geosciences
ESCC-103	Environmental Science Core Compulsory	Environmental Chemistry
ESCC-104	Environmental Science Core Compulsory	Environmental Pollution
ESFC – 01	Environmental Science Foundation Course (Audit)	Elementary concepts of Environment
Practical		

Semester IInd: Four Core Compulsory, One Foundation Course, One Practical Course

ESCC -201	Environmental Science Core Compulsory	Environmental Monitoring
ESCC-202	Environmental Science Core Compulsory	Desert Ecology
ESCC-203	Environmental Science Core Compulsory	Environmental Legislation
ESCC-204	Environmental Science Core Compulsory	Environmental Toxicology
FC-02	Foundation Course (Audit)	Human Values
Practical		

emester IIIrd: Two Core Compulsory, One Core Elective, One Elective Open, One Practical Course

ESCC-301	Environmental Science Core Compulsory	Environmental Technology
ESCC-302	Environmental Science Core Compulsory	Environmental Impact Assessment-I
ESCE-303	Environmental Science Core Elective	(A) Population and Community Ecology **OR** (B) Biomes and Biogeography
ESEO-304	Environmental Science Elective Open	(A) Climate Science **OR** (B) Disaster Management
Practical		

Semester IVth: Two Core Compulsory, One Core Elective, One Elective Open, One Practical Course

ESCC-401	Environmental Science Core Compulsory	Natural Resource Management
ESCE-402	Environmental Science Core Elective	(A) Environmental Impact Assessment-II **OR** (B) Biodiversity and Conservation
ESEO-403	Environmental Science Elective Open	(A) Environmental Issues, Awareness and Monitoring **OR** (B) Waste Management
ESCC-404	Environmental Science Core Compulsory	Dissertation
Practical		

Learning outcome Index of the courses

(i) Programme outcome (PO) and programme Specific Outcome(PSO)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1	✓	✓	✓	✓	✓	✓
PO2		✓				
PO3					✓	
PO4	✓	✓		✓		✓
PO5			✓	✓		✓
PO6		✓			✓	

(ii) Programme Specific Outcome (PSO) and Core Courses

	ESCC 101	ESCC 102	ESCC 103	ESCC 104	ESCC 201	ESCC 202	ESCC 203	ESCC 204	ESCC 301	ESCC 302	ESCC 401	ESCC 404
PSO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PSO2	✓	✓	✓			✓			✓		✓	✓
PSO3		✓		✓				✓				✓
PSO4					✓		✓			✓		✓
PSO5			✓		✓				✓		✓	✓
PSO6				✓	✓						✓	✓

(iii) Programme Specific Outcome (PSO) and Elective Courses

	ESCE 303 A	ESCE 303 B	ESEO 304 A	ESEO 304 B	ESCE 402 A	ESCE 402 B	ESCO 403 A	ESEO 403 B
PSO1	✓	✓	✓	✓	✓	✓	✓	✓
PSO2	✓	✓				✓		✓
PSO3			✓				✓	
PSO4					✓			
PSO5				✓	✓	✓	✓	✓
PSO6				✓				✓

Semester Wise Credit Distribution as per
CHOICE BASED CREDIT SYSTEM (CBCS)

Paper Code	Paper Name	Course	Lecture	Tutorial	Practical	Total Credits	Maximum Marks		Minimum Passing Marks
							Internal Marks	External Marks	
Semester-I									
Theory Papers									
ESCC-101	Environment and Ecology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCC-102	Environmental Geosciences	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCC-103	Environmental Chemistry	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCC-104	Environmental Pollution	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESFC-01	Elementary Concept in Environment	Foundation Course	2	2	1	5			
							40	160	
							Total Theory Marks	200	72 (36% aggregate)
Practical									
Practical		Core Compulsory					25	75	36 (36% aggregate)
						Total Credits	**25**	**Grand Total**	**300**	
Semester-II									
Theory Papers									
ESCC -201	Environmental Monitoring	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCC-202	Desert Ecology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCC-203	Environmental Legislation	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCC-204	Environmental Toxicology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FC-02	Human Values	Foundation Course	2	2	1	5			
							40	160	
							Total Theory Marks	200	72 (36% aggregate)
Practical									
Practical		Core Compulsory					25	75	36 (36% aggregate)
						Total Credits	**25**	**Grand Total**	**300**	
Semester-III									
Theory Papers									
ESCC-301	Environmental Technology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCC-302	Environmental Impact Assessment-I	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCE-303	(A) Population and Community Ecology **OR** (B) Biomes and Biogeography	Core Elective	3	1	1	5	10	40	13 (25 %)

ESEO-304	(A) Climate Science **OR** (B) Disaster Management	Elective Open	3	1	1	5	10	40	13 (25 %)
							40	160	
							Total Theory Marks	200	72 (36% aggregate)
Practical									
Practical		Core Compulsory					25	75	36 (36% aggregate)
		Total Credits				20	**Grand Total**	**300**	
Semester-IV									
ESCC-401	Natural Resource Management	Core Compulsory	3	1	1	5	10	40	13 (25 %)
ESCE-402	(A) Environmental Impact Assessment-II **OR** (B) Biodiversity and Conservation	Core Elective	3	1	1	5	10	40	13 (25 %)
ESEO-403	(A) Environmental Issues, Awareness and Monitoring **OR** (B) Waste Management	Elective Open	3	1	1	5	10	40	13 (25 %)
ESCC-404	Dissertation	Core Compulsory	0	4	1	5	20	80	36 (25 %)
							40	160	
							Total Theory Marks	200	72 (36% aggregate)
Practical									
Practical		Core Compulsory					25	75	36 (36% aggregate)
		Total Credits				**20**	**Grand Total**	**300**	

M.Sc. First Semester

Paper ESCC 101	**Environment and Ecology**
Paper ESCC 102	**Environmental Geoscience**
Paper ESCC 103	**Environmental Chemistry**
Paper ESCC 104	**Environmental Pollution**
Paper ESFC-01	**Elementary Concept in Environment Practical**

Course Title: Environment and Ecology
Course Code: ESCC 101

Time: 3 Hours **M.M. 40+10**

Unit I

Earth, man and environment. Environmental factors: Atmosphere, Hydrosphere, Lithosphere and Biosphere, and their interrelationships. Holistic concept, environmental complex, tolerances, ecological amplitude, limiting and inhibiting effects. Climatic factors: Pressure, temperature, RH, precipitation, radiation, wind. Edaphic factors: physical, chemical and biological characteristics.

Unit II

Ecology- Definition, principles, and scope. Human ecology and settlement. ECOsystems: Structure and functions. Abiotic and Biotic components, Energy flows, Food chains, Food web, Ecological pyramids. ECOsystem types- Aquatic (freshwater, marine) and terrestrial (grassland, forest) eCOsystems. Concept of Population and Community. Ecotones and their importance.

Unit III

Biogeochemical cycles and regulation, pools and fluxes, basic cycles: hydrologic, carbon, oxygen, nitrogen, phosphorus and sulphur cycles; Nutrient cycling in forest and aquatic eCOsystems.

Course Outcomes (COs)

CO1: Develop foundation on principles of Environmental Science and concept of structure and function of different compartments of the Environment.

CO2: Gain scientific perspective of the issues confronting our present day environment.

CO3: Enable to analyze the national and global environmental issues relating to atmosphere, water, soil and land use, biodiversity, and natural resources (global warming, climate change, mineral extraction and energy resources, environmental impact assessment and environmental audit).

Suggested Readings:

1. Basic ecology - E. P. Odum
2. Ecology and field biology - R.L. Smith
3. Ecology - P.D. Sharma
4. Fundamentals of ecology -E.P. Odum
5. Principles of ecology – Rickleff
6. Environmental Science – The natural environment and human impact (1998): A. R. W.
7. Jackson and J. M. Jackson, Longman
8. Environmental Science (2001) : S. C. Santra, New Central Book Agency (P) Ltd
9. Introduction to Environmental Science and Engineering (2nd Ed.) (2004): G. M. Masters, Pearson Education Pvt. Ltd.
10. Environmental Science (6th ed) (1997): Jr. G. T. Miller, Wadsworth Pub. Co.
11. Fundamentals of Environmental Science: G. S. Dhaliwal, G. S. Sangha and P. K. Raina,Kalyani Publication
12. General Climatology: Critichfield H. J.
13. Introduction to Weather and Climate : Trewartha

Course Title: Environmental Geoscience
Course Code: ESCC 102

Time: 3 Hours **M.M. 40+10**

Unit I

The earth systems and Biosphere: Conservation of matter in various geospheres-lithosphere, hydrosphere atmosphere and biosphere. Energy budget of the earth. Earth's thermal environment and seasons. General relationship between landscape, biomes and climate. Climates of India. Indian Monsoon. EI Nino. Droughts. Tropical cyclones and Western Disturbances.

Unit II

Earth's Processes and Geological Hazards: Earth's processes; concept of residence, time and rates of natural cycle. Catastrophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche. Prediction and perception of the hazards and adjustments to hazardous activities, Plate tectonics.

Unit III

Environmental Geochemistry: Concept of major, trace and REE. Classification of trace elements. Mobility of trace elements. Geochemical cycles. Biogeochemical factors in environmental health. Human use, trace elements and health. Possible effects of imbalance of some trace elements. Interface between climate and techniques geoindicators.

Course Outcomes (COs)

CO1: Lay foundation on basic geologic knowledge to maximize the utilization of all natural resources and minimize their degradation.

CO2: Empower with geological methods to minimize the destructive potential of natural processes and to sustain a healthy biosphere on earth.

CO3: Train on methods to identify common minerals & major rock types in hand specimens and under petrological microscope, and tools to analyze geomorphological basis of land use and interpret plate tectonics and hazard zonation maps.

Suggested Readings:

1. Environmental geology- Edward A. Keller
2. Physical geology - C.W. Montgomery.
3. Geology of India - National book trust series.

Course Title: Environmental Chemistry
Course Code: ESCC 103

Time: 3 Hours **M.M. 40+10**

Unit I

Fundamentals of Environmental Chemistry: Stoichiometry, Gibbs' energy, Chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

Unit II

Chemical composition of Air: Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere. Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical smog.

Unit III

Water Chemistry: Chemistry of water, concept of DO, BOD, COD, sedimentation, coagulation, filtration, Redox potential. Soil Chemistry**:** Inorganic and organic components of soil, Nitrogen pathways and NPK in soils.

Course Outcomes (COs)

CO1: Develop understanding on the chemistry of the lithosphere. Hydrosphere and atmosphere.

CO2: Gain understanding on the chemistry of various anthropogenic pollutants and basic analytical techniques.

CO3: Trains on chemical analysis of water and waste water, and the scientific principle of tools and techniques used for chemical analysis.

Suggested Readings:

1. Environmental Chemistry - G.S. Sodhi
2. Environmental Chemistry - Mannahan
3. Fundamentals of soil science - Henry D. Futh
4. Textbook of limnology - G.A. Cole
5. Environmental Chemistry - Sharma and Kaur

Course Title: Environmental Pollution
Course Code: ESCC 104

Time: 3 Hours **M.M. 40+10**

Unit I

Overview of Environmental Pollution-Definition, types of pollutants, causes, effects, monitoring, prevention and control of pollution. Environment Pollution Local, Regional, Global aspect

Air: Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Gas laws governing the behaviour of pollutants in the atmosphere. Methods of monitoring and control of air pollution .SO_2, NO_2, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate. Acid Rain. Air Quality Standards. Global warming.

Unit II

Water: Types, sources and consequences of water pollution. Physico-chemical and Bacteriological sampling and analysis of water quality. Sewage and waste water treatment and recycling. Water quality standards.

Marine: Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system, coastal management.

Soil: Physico-chemical and bacteriological sampling and analysis of soil quality. Industrial waste/effluents and heavy metals, their interactions with soil components. Soil microorganisms and their functions, degradation of different insecticides, fungicides and weedicides in soil. Different kinds of synthetic fertilizers (NPK) and their interactions with different components of soil. Soil Pollution Control.

Unit III

Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes (Hospital Wastes and Hazardous Wastes)

Sources of noise pollution, measurement of noise and Indices, effect of meteorological parameters on noise propagation. Noise exposure levels and standards. Noise control and abatement measures. Impact of noise on human health. Radioactive waste and radioactivity from nuclear reactors; Thermal Pollution.

Impacts of large-scale exploitation of Solar, Wind, Hydro and Ocean energy.

Course Outcomes (COs)

CO1: Examine the critical linkage between environmental pollution and human health.

CO2: Develop understanding on the mode of various diseases as triggered by the spread of contaminants in soil, water and air.

CO3: Analyze different types of pollution and the guidelines for their control in the context of public health.

CO4: Enable to estimate physic-chemical properties of water and evaluate hydrologic parameters; catchment delineation and water balance.

CO5: Trains on basic analytical methods to quantify water quality, analyze hydrographs and determine hydrological parameters.

Suggested Readings:

1. Air pollution and control - K.V.S.G. Murlikrishan
2. Industrial noise control - Bell & Bell
3. Environmental engineering -Peary
4. Introduction to environmental engineering and science - Gilbert Masters.

Course Title: Elementary Concepts in Environment
Course Code: ESFC – 01

UNIT I

Introduction to the interdisciplinary nature of environmental science and fundamental issues in environmental science, including climate change, pollution, sustainability.
Overview of critical Earth systems and their interrelationships: Aquatic, terrestrial and atmospheric systems. Earth's structure, composition, surface features. Earth's processes.

UNIT II

Four main motions of the Earth (rotation, revolution, precession and galactic rotation), Gaia theory of the Earth.
Earth's atmosphere and climate: Climate, Ice ages, Greenhouse effect, Global warming and climate change.

UNIT III

Introduction to the Earth's physical systems: Weathering and soil formation.
Biosphere: Biodiversity and conservation of terrestrial systems.
Introduction to water resources and marine resources.

Suggested Reading:

- Cunningham, W.P., Cunningham, M.A. & Saigo, B. (2004) Environmental Science, a Global Concern. (8th edition). McGraw-Hill (Boston)
- Montgomery, C. (2005) Environmental Geology. McGraw-Hill.
- Nebel, BJ & Wright, R. (2004) Environmental Science: Toward a Sustainable Future. Prentice-Hall.
- Park, C. (2001) The Environment: Principles and Applications. Routledge
- Tyler Miller G. (2005) Living in the Environment: Principles, Connections, and Solutions. Belmont, Calif.: Brooks/Cole (14th International student edition)
- Wright, R.T. (2005) Environmental Science - toward a Sustainable Future. (9th International Edition), Pearson Education International, Prentice Hall Publishers.

Practical

Time: 3 Hours **M.M. 75+25**

Study of Local Flora & Fauna:

1. Plant species diversity in a given area (one season data only)
2. Species-wise population count of birds in a wetland/ terrestrial habitat.
3. Qualitative and quantitative analysis of zooplankton, phytoplankton, periphyton and benthos.
4. List of bioproducts used by a community living inside or in the proximity of a protected area.
5. Study of Frequency, Abundance, density & IVI of give area.
6. Study of vegetation by using quardrat & line fransect methods.
7. Field study by using GPS & toposheet .
8. Field visit to institution/ industrial units.
9. Measurement of Noise level by using Noise level meter of residential, industrial & sensitive areas.
10. Estimation DO, BOD & COD of given water sample.

Monitoring of Water: Turbidity, pH, Dissolved oxygen, Free carbon dioxide, Alkalinity, Salinity, Sodium, Potassium, Calcium, Magnesium, Carbonates, Bicarbonates, Chlorides, Sulphates, Nitrate, Phosphate, Silica.

M.Sc. Second Semester

Paper ESCC 201	**Environmental Monitoring**
Paper ESCC 202	**Desert Ecology**
Paper ESCC 203	**Environmental Legislation**
Paper ESCC 204	**Environmental Toxicology**
Paper FC-02	**Human Values* (To be Incorporated)**
	Practical

Course Title: Environmental Monitoring
Course Code: ESCC 201

Time: 3 Hours **M.M. 40+10**

Unit I

Principles of Analytical Methods and their application in Environmental monitoring, with special reference to**:** Titrimetry, Gravimetry, Colourimetry, Spectrophotometry, Chromatography, Gas Chromatography, Atomic Absorption Spectrophotometry, GLC, HPLC, Electrophoresis, X-ray fluorescence, X-ray diffraction, Flame photometry.

Unit II

Systems analysis for Environmental problems. Environmental monitoring for Air, Water, Soil, Radiation and Microbiology: Common parameters, sampling procedures and analytical techniques. Sampling methodologies for Environment matrices, Environment modeling.

Unit III

Basic elements and tools of statistical analysis; Probability, sampling. Measurement and distribution of attributes; Distribution-Normal, t and x', Poisson and Binomial; Arithmetic, Geometric and Harmonic means; moments: matrices, simultaneous linear equations. Tests of hypothesis and significance.

Introduction to environmental system analysis; Approaches to development of models; linear simple and multiple regression models, validation and forecasting. Models of population growth and interactions-Lotka-Volterra model, Leslie's matrix model, point source stream pollution model, box model. Gaussian plume model.

Course Outcomes (COs)

CO1: Equip with various methods used in the collection and analyses of data for Environmental Studies.

CO2: Train on the theory and practice of biostatistical tools for analyzing the data and deriving meaningful conclusions.

CO3: Investigate the potential of simulation models to understand the complexity of environmental processes and enables to use environmental modeling, remote sensing and GIS in environmental studies.

CO4: Develop the concept of systems and sub-systems, monitoring.

CO5: Learn to model various environmental systems, particularly those dealing with ecology and eCOsystems and study of environmental pollution in monitoring air and water quality.

CO6: Empower with major approaches towards natural resource issues and enables to think creatively about conflict and concord in general, with special emphasis on the roles of ideas and institutions in environmental politics.

CO7: Trains on the computational techniques and simulation models to analyze environmental processes.

Suggested Readings:

1. Principles of Biophysical chemistry - Uppadahay- and Nath.
2. Analytical Techniques - S.K. Sahani
3. Dynamics of Environmental Bioprocesses-Modelling and simulation-Snape and Dunn.
4. Environmental Modelling – Jorgensen

Course Title: Desert Ecology
Course Code: ESCC 202

Time: 3 Hours **M.M. 40+10**

Unit I

Definition and types of deserts. Major deserts of the world- Distribution and characteristics. Causes of desertification. Arid climate.

Uint II

Desert eCOsystem with special reference to the Indian desert: environment, flora, fauna. Desert adaptations among plants and animals. Drought and famine, migration. Aridity index. Endangered plant and animal species of the Indian desert and their conservation strategies.

Unit III

Resource management in deserts- traditional and modern approaches. Saline tracts of the Rajasthan desert. Impact of canal irrigation on the ecology of the Indian desert. Approaches for combating desertification. Dry land farming. Waterbodies in arid and semiarid lands and their management strategies.

Course Outcomes (COs)

CO1: Demonstrate emerging importance of the arid setting.

CO2: Explores the importance for policy, community mobilization, law and governance in desert areas.

CO3: Insight into some key challenges facing desert sustainability in the 21st century.

Suggested Readings:

Bothma, J. duP. Carnivore Ecology in Arid Lands. Springer-Verlag Berlin Heidelberg 1998.

Cloudsley-Thompson, J.L. 1984, Key Environments, Sahara Desert, Oxford Pregmon Press, London.

Epstein, E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley Publishers, New York.

Goodall, D.W. and Perry, R. 1981. Arid Zone ECOsystems. Vol.I Cambridge University Press, Cambridge

Goodall, D.W. and Perry, R. 1981. Arid Zone ECOsystems. Vol.II Cambridge University Press, Cambridge.

Gupta, R.K. and Prakash, I. 1975. Environmental Analysis of the Thar Desert. English Book Depot, Dehradun.

Kalwar, S. C. Arid Ecology. Pointer Publishers.1999.

Levit, J. 1972. Response of Plants to Environmental Stresses. Academic Press. New York.

McGinnies, W. G. 1968. Deserts of the World – An appraisal of Research into their Physical and Biological Environment. University of Arizona Press, Tucson.

McGinnies, W.G., Goldman, B.J. and Paylore, (Eds.) 1968. Deserts of the World. University of Arizona Press. Tucson.

Prakash, I. 2001. Ecology of Desert Environments. Scientific Publishers, Jodhpur.

Sen, D.N. 1978. Concepts of Indian Ecology. S. Nagin & Co. Jullundur.

Sen, D.N. 1982. Environment and Plant Life in Indian Desert. Geobios International, Jodhpur.

Course Title: Environmental Legislation
Course Code: ESCC 203

Time: 3 Hours **M.M. 40+10**

Unit I

Overview of the ISO 14000 family, Key aspects of the International Standard ISO 14001. Environmental Management Systems: Benefits, Principles and elements of successful environmental management. Comparison between EMAS, BS77560 and ISO 14001. Auditing of EMS. Occupational Health and safety Management System (OHSMS), OHSAS 18001.

Unit II

Provision in Constitution of India regarding Environment (Article 48A and 51G). Environmental (Protection) Act, 1986 and Rules 1986. Air (Prevention and Control of Pollution) Act, 1981 as amended by Amendment Act 1987 and Rule 1982. Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988 and Rules 1975.

Wildlife (Protection) Act, 1972 amended 1991. Indian Forest Act (Revised) 1982. Biological Diversity Act, 2002.

Unit III

Scheme of labelling of environmentally friendly products (Ecomark). Life Cycle Assessment. Ecological Footprinting. Public Liability Insurance Act, 1991 and Rules 1991. Bio-Medical Waste (Management and Handing) Rules- 1975; Hazardous Waste (Management and Handling) Rules- 1989. National Environmental Policy, NGT Act 2020.

Course Outcomes (COs)

CO1: Develop insights into the role of environmental laws for planetary housekeeping, protecting the planet and its people from activities that upsent the earth and its life sustaining capacities.

CO2: Enable to apply a range of regulatory instruments to preserve and protect the environment.

CO3: Demonstrate the strengths and weaknesses in law and its enforcement for developing strategies to overcome the same.

Suggested Readings:

1. Environmental administration & law - Paras Diwaa.
2. Environmental planning, policies & programs in India - K.D. Saxena.

Course Title: Environmental Toxicology

Course Code: ESCC 204

Time: 3 Hours **M.M. 40+10**

Unit I

Toxic Chemicals in the environment--Air, Water: Pesticides in water. Bio-chemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, O_3 and PAN Pesticides, Insecticides, MIC, carcinogens in the air.

Unit II

Occupational Health: Definition, Occupational Health Hazards, Common hazards: Pneumoconiosis. SiliCOsis, AnthraCOsis, Byssinosis, Bagassosis, Asbestosis, Farmers's Lung, Lead poisoning, Occupational Cancer, Occupational Dermatitis, and Radiation Hazards. Measures for health protection of workers and Role of WHO in Occupational Health. Occupational Health in India.

Unit III

History and scope of toxicology. Toxicology of aquatic and terrestrial environments. Acute and chronic toxicity. Toxicity testing in field and enclosure. Toxic dose: Approximate acute LD50 /LC50 of some representative chemical agents. The use of biomarkers in assessing the impact of environmental contaminants. Bioassay. Trophic level transfer of contaminants. Bioindicators of environmental quality.

Course Outcomes (COs)

CO1: Lay foundation for in-depth understanding on the sources, origins and effects of various toxic materials and heavy metals that adversely affect environmental health.

CO2: Develop perspective on the movement of toxicants in different compo9nents of environment, in different levels of biological organization and in trophic transfer across the food chain.

CO3: Demonstrates the relationship between types of contaminants and effect on human health.

CO 4: Trains on the methods used to assess the ecotoxicological impact and human health issues due to increase in the levels of contaminants in environment.

Suggested Readings:

1. Principles of Environmental Toxicology: I. C. Shaw and J. Chadwick; Taylor& Francis ltd
2. Basic Environmental Health (2001): Annalee Yassi, Tord Kjellstr"om, Theo de Kok, Tee Guidotti
3. Environmental Health: Monroe T. Morgan
4. Handbook of Environmental Health and Safety – principle and practices: H. Koren; Lewis
Publishers
5. C.Lu.Frank and Kacew.Sam (2002). Lu.s Basic toxicology: Fundamentals, target organs and
risk assessment;4th edition.Taylor and Francis, London.
6. Tambrell, J. (2002). Introduction to Toxicology. Taylor and Francis, London.

7. Rana, S.V.S. (2011). Environmental Pollution: Health and Toxicology. Narosa PublishingHouse, New Delhi.

Practical

Time: 3 Hours **M.M. 75+25**

Monitoring of Soil: Measurement of Bulk density, Specific gravity, Moisture content, Conductivity, pH, Alkalinity, Soluble ions, Nitrogen, Phosphorus, Sulphur.

Geographical data:

1. Meteorological records – Pressure, Temperature, Precipitation, Humidity, wind.
2. Drainage basin and network morphometry
3. Slope and aspect maps, Critical slope for specified activities, Profiles.
4. Climatic maps and diagrams: circular graph, climograph, water budget, wind roses (simple and compound)
5. Application of GPS in various environmental applications.
6. Estimation of Biodiversity by using various diversity indices.

Visit:

Visit to a terrestrial or aquatic location of ecological importance.

M.Sc. Third Semester

Paper ESCC 301	**Environmental Technology**
Paper ESCC 302	**Environmental Impact Assessment-I**
Paper ESCE 303	**(A) Population and Community**
	OR
	(B) Biomes and Biogeography
Paper ESEO 304	**(A) Climate Change**
	OR
	(B) Disaster Management
	Practical

Course Title: Environmental Technology
Course Code: ESCC 301

Time: 3 Hours **M.M. 40+10**

Unit I

Scope, Purpose and Objectives of Air Quality Monitoring Programme; Guidelines and Design of an air quality surveillance network; Period, frequency and duration of sampling; Principles and instruments for sampling and measurement of -(i) ambient air pollutants, and (ii) stack emissions (monitoring).

Dispersion of Pollutants: maximum mixing depth, lapse rate, stability conciliations, plume behaviour, calculation of effective stack height.

Unit II

General methods of control of Gaseous pollutants-scrubbers, condensers, control equipment for particulate matter-gravity settling chambers, cyclone, fabric filters, electrostatic precipitators, case study of thermal power plants. Control of Mobile Source Emissions. Automobile Exhausts.

Unit III

Water Pollution Control: Drinking Water Treatment Procedures, Flocculation, Settling, Filtration, reverse sand filter, cleaning, chlorination.

Methods of Cleaning Potable Water: Filtration, Electro-dialysis, principle & theory of chemical oxidation. Disinfection mechanism: Ozone, permanganate, chlorination. Reverse osmosis. Ultra filtration. Water quality standards.

EnvironmentaI Biotechnology: Fermentation, Vermiculture, Biogas, Biofertilizer, Bioremediation technologies.

Course Outcomes (COs)

CO1: Develop evolutionary perspective on the relationship between and evolution of technology and environment.

CO2: Develop in-depth understanding on the role and contribution of different types of economic and social mechanism in the contemporary societies shaping the structure and function environment.

CO3: Demonstrate the technological changes in the direction of sustainable development, which will help to achieve ecological and social justice.

Suggested Readings:

1.Air Pollution – Stern
2. Environmental Pollution Control Engineering: C. S. Rao
3. Environmental Chemistry: B.K. Sharma, and H. Kaur
4. Air pollution – threat and response: D. A. Lynn
5. Air pollution and Environmental Protection – Legislative policies, Judicial trend and Social
perceptions: N. Kumar; Mittal Publication

Course Title: Environmental Impact Assessment-I
Course Code: ESCC 302

Time: 3 Hours **M.M. 40+10**

Unit I

Introduction to environmental impact analysis. Environmental impact Statement and Environmental Management Plan. EIA guidelines 2006, Notifications of Government of India. Impact Assessment Methodologies, their strengths and weaknesses. Generalized approach to impact analysis. Procedure for reviewing Environmental impact analysis and statement.

Unit II

Guidelines and basic principles of Environmental auditing -Definition, functions, benefits and COsts of Environmental Auditing. Introduction to Environmental planning. Base line information and predictions (land, water, atmosphere, energy, etc.). Landuse policy for India. Urban planning for India. Rural planning and landuse pattern. Concept and strategies of' sustainable development. COst-Benefit analysis. Environmental Appraisal Accounting, Green Balance Sheet-SJA.

Unit III

Environmental Appraisal with particular reference to:

1. Mining Projects
2. Industrial Projects
3. Thermal Power Projects
4. River Valley, Multipurpose, Irrigation and H.E. Projects
5. Infrastructure Development and Miscellaneous Projects
6. Nuclear Power Projects

Course Outcomes (COs)

CO1: Lay foundation on the concept and components of environmental impact assessment.
CO2: Enable to practice EIA that examines the environmental consequences of development actions, in advance.
CO3: Investigate the agenda of all environmental agencies as a result of introduction of legislations in various countries.
CO 4: Develop skill to evaluate the issues and problems in environmental assessment from the perspective of process and methods, and goals of EIA.

Suggested Readings:

1. Environmental Impact Assessment- John Glasson.
2. Methods of Environmental Impact Assessment - Morris and the rivel.
3. Environmental Imapct Assessment - L. W. Canter.
4. Chemical principles of Environmental pollution - Lalloway and Ayers.
5. Industrial Environment - Assessment and strategy - S.K. Aggarwal
6. Kulkarni, V.S., Kaul, S.N. and Trivedi, R.K. (2002). A Handbook of Environmental Impact Assessment. Scientific Publishers, India.

Course Title: Population and Community Ecology
Course Code: ESCE 303 (A)

Time: 3 Hours **M.M. 40+10**

Unit I

Concepts and Scope Environmental Biology. Impact of environment at cellular level. Eco-physiological adaptations in plants and animals for stressed environments. Biosphere as an eCOsystem, its ecological processes and life support systems. Anthropogenic impact on the biosphere and its life support systems (including flora, fauna, soil, climate, atmosphere, terrestrial and aquatic eCOsystems). Role of biological processes in remedial measures and restoration.

Unit II

Population Ecology: Factors determining population. Factors leading to the commonness, rarity and vulnerability of extinction of a species. Population Dynamics:

Patterns of survival, age distribution, dispersal and rates of change. Attributes of K-selected and r-selected species. Population Growth. Common approaches in population density measurement.

Unit III

Community Ecology: Concept and types of communities. Interspecific and intraspecific interactions. Concepts of niche and keystone species. Role of nutrients, water and energy in determining community. Succession, development, climax and stability of eCOsystems.

Course Outcomes (COs)

CO1: Lay Explain Intraspecific and Interspecific interactions.

CO2: Explain the application of stage and age structured population dynamics.

CO3: Apply the riche concept and evaluate the importance of species composition and diversity for population and community dynamics.

CO4: Explain the importance of spatial scale for interactions within and between populations.

CO5: Assess the importance of interactions in food webs for the development of populations and communities.

CO6: Develop a comprehensive historical perspective on the interactions between human societies in relationship to eCOsystems in ancient to modern societies.

CO7: Gain knowledge on the present day environmental dilemmas, and the conflicts and choices that have their roots in the past.

CO8: Examine the ways in which environmental changes, often the result of humans actions, have caused historical trends in human societies.

Suggested Readings:

Brown, J.H. and Lomolino, M.V (1998). Biogeography. Sinauer Associates Inc., Sunderland,Massachusetts.

2. Cox, C. B. and Moore, P.D. (2000). Biogeography – An Ecological and Evolutionary Approach. Blackwell Scientific Ltd. pp. 298. London.

3. Fahrig, L., and K. Freemark. (1994). Landscape-scale effects of toxic events for ecological risk assessment. In J. Cairns and B.R. Niederlehner (eds.), Ecological Toxicity Testing, Scale, Complexity, and Relevance. Lewis Publishers, Boca Raton, FL.

4. Weinstein, D.A., and H.H. Shugart. (1983). Ecological modeling of landscape dynamics. In H.A. Mooney and M. Godron (eds.), Disturbance and ECOsystems. Springer-Verlag, NewYork.

Course Title: Biomes and Biogeography

Course Code: ESCE 303 (B)

Time: 3 Hours **M.M. 40+10**

Unit I

Biomes:

Climatic and edaphic factors of terrestrial biomes. Heinrich Walter's Biome Climate Diagrams.

Classification of land biomes with their soil, climate and vegetation characteristics. Their natural history, wildlife, geography and human influences.

Mountain Biome: Replication of latitudinal changes in the altitudes of high mountains.

Terrestrial biomes, eCOsystem diversity, forest and vegetation types in India.

Unit II

Freshwater and Marine biomes:

Challenges and adaptations of life in aquatic biomes (freshwater: lentic and lotic; marine).

Freshwater Biomes (Rivers, streams, lakes, ponds) and their natural history.

Marine Biomes (including mangroves, coral islands, kelp forests, saltwater marshes, seashores, estuaries) and their natural history.

Estuaries, their characteristics and biota.

Wetlands- definitions, types, ecological functions and resources.

Unit III

Biogeography: India & World:

Major biogeographic (zoogeographic and phytogeographic) regions of the world and India, extent, characteristics and species composition.

Continental Drift: Its causes and consequences for distribution of life on earth.

India's biogeographical history, current geographical position and their impact on biodiversity.

India's forests and vegetation types. Protected Area Network.

Course Outcomes (COs)

CO1: Explain Biome concept.

CO2: Explain Biogiography.

CO3: Developing link between eCOsystem functionality & Biogeography.

CO 4: Understanding on drivers of vegetation patterns at large spatial scales based on biodeographical zones.

Suggested Readings:

Brown, J.H. and Lomolino, M.V (1998). Biogeography. Sinauer Associates Inc., Sunderland,Massachusetts.

2. Cox, C. B. and Moore, P.D. (2000). Biogeography – An Ecological and Evolutionary Approach. Blackwell Scientific Ltd. pp. 298. London.

3. Fahrig, L., and K. Freemark. (1994). Landscape-scale effects of toxic events for ecological risk assessment. In J. Cairns and B.R. Niederlehner (eds.), Ecological Toxicity Testing, Scale, Complexity, and Relevance. Lewis Publishers, Boca Raton, FL.

4. Weinstein, D.A., and H.H. Shugart. (1983). Ecological modeling of landscape dynamics. In H.A. Mooney and M. Godron (eds.), Disturbance and ECOsystems. Springer-Verlag, NewYork.

Course Title: Climate Science

Course Code: ESEO 304 (A)

Time: 3 Hours **M.M. 40+10**

Unit I

Introduction to Climate Change Science: Climate, Weather, Earth's Climate System. Greenhouse Effect. Greenhouse gases and their main sources. Monitoring of Climate, Climate archives, climate data and models. Climate change on different timescales over the past.

Unit II

Modern Climate change since industrial revolution: Anthropogenic Drivers of Climate Change. Observed Trends and Projected Trends of Climate change. Role of aerosols, black carbon and hydrocarbons in climate change. Impacts of Climate Change: food security, energy security, water security, human health and diseases, climate resilient agriculture, climate refugees.

Unit III

The Climate Change Policy Framework: Provisions of the United Nations Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol. Climate Change Adaptation. National Action Plan on Climate Change, Climate Change Mitigation and Low Carbon Development: Strategic Frameworks and Policy Approaches. Climate Change Finance. Carbon sequestration and carbon credits.

Course Outcomes (COs)

CO1: Understand & explain the physical basis of the natural greenhouse effect and global climate change.

CO2: Explain the role of greenhouse gases in Earth's energy budget & climate system.

CO3: Describe the strengths & weakness of existing climate related policies.

CO4: Understand climate change mitigation & adaption practices.

Suggested Readings:

Brohe, Arnaud, Nick Eyre, and Nicholas Howarth. 2009. Carbon Markets: An International Business Guide (Environmental Market Insights). Routledge.

Labatt, Sonia, and Robert R. White. 2007. Carbon Finance: The Financial Implications of Climate Change (Wiley Finance). Wiley Finance.

Esty, Daniel C., and Andrew Winston. 2009. Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage. Wiley.

Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.

Burroughs, W.J. Climate Change: A Multidisciplinary Approach. 2nd ed. Cambridge University Press. 2007.

Chasek, P. S. The Global Environment in the Twenty-First Century - Prospects for International Co-operation. Indian Reprint by Manas Publications, New Delhi. 2004.

Claussen, E. ed. Climate Change: Scenario, Strategies and Solutions. Arlington VA. 2001.
Dash, S. K. Climate Change-An Indian Perspective. Centre for Environment Education and Cambridge University Press Pvt. Ltd., New Delhi. 2007.
Dodds, F. (ed.). Earth Summit. 2002. A New Deal. Earthscan Publications Ltd., UK. 2002.
Enger, E.D. and Smith, B. F. Environmental Science: A Study of Interrelationships. 11th ed. McGraw Hill Inc., USA. 2006.
Hardy, John T. Climate Change: Causes, Effects, Solutions. Wiley & Sons, USA. 2003.
Harris, F. Global Environmental Issues. Wiley & Sons, Inc., USA. 2004.
Harvey L. D. D. Global Warming: The Hard Science. NY: Prentice-Hall.2000.
Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
Speth, J. C. Global Environmental Challenges – Transitions to a Sustainable World. Orient Longman Pvt. Ltd., New Delhi. 2004.
UNEP. Global Environmental Outlook 3: Past, Present and Future. Earthscan Publications. 2002.

Course Title: Disaster Management
Course Code: ESEO 304 (B)

Time: 3 Hours **M.M. 40+10**

Unit I

Concepts of Hazard, Vulnerability, Risks, Natural Disasters (earthquake, Cyclone, Floods, Volcanoes), and Man Made Disaster (Armed conflicts and civil strip, Technological disasters, Human Settlement, Slow Disasters (famine, drought, epidemics) and Rapid Onset Disasters (Air Crash, tidal waves, Tsunami) Risks, Difference between Accidents and Disasters, Simple and Complex Disasters.

Unit II

Disaster Cycle, Phases of Disaster. Disaster Risk Reduction Strategies, Early warning Systems.

Components of Disaster Relief-(Water, food, sanitation, shelter, Health and Waste Management). Principles of Disaster Epidemiology, Environment health hygiene and sanitation issues during disasters. United Nation International Strategy for Disaster Risk Reduction (UNISDR).

Unit III

India's Hazard and Vulnerability Profile, Disaster Management Indian scenario. Disaster Management Act 2005 and Policy guidelines. Cases Studies: Bhopal Gas Disaster, Gujarat Earth Quake, Orissa Super-cyclone, south India Tsunami, Bihar floods. Best practices in disaster management, Case Studies of drought in Rajasthan, India and World.

Course Outcomes (COs)

CO1: Gain insights into various environmental hazards, their causes, nature preparedness and assessment of loss.

CO2: Empower to develop model hazards and learn methods of disaster management.

CO3: Trains on preparation of hazard zonation map of India for landslides, earthquakes, floods; methods to estimate earthquake-loss using remote sensing and GIS, and prepare master plan for any environmental hazard mitigation.

Suggested Readings:

Disaster Reduction: Living in harmony with nature Kurowa, Julio
Human Development Report 2005: Internation co-operation at a cross roads: Aid, trade and security in an unequal world Watkins, K
Know risk Jeggle, Terry
World disaster report: Focus on information in disasters Jonathan, Walter
Advances in natural technological hazards research: International perspectives on natural disasters Occurrences, mitigation and consequences De Chano LM, Lidstone J & Stoltman Joseph M

Practical

Time: 3 Hours **M.M. 75+25**

Geoinformatics:

1. Introduction of the GIS software.
2. Georeferencing
3. Base layer preparation / Digitization
4. Preparation of Geodatabase.
5. Mosaicing.
6. Classification of Satellite Image.

Solid Waste Analysis

1. Physical composition (by weight)
2. Moisture content
4. pH and Conductivity

Environmental Statistics

1. Grouping of data and preparation of frequency distribution. Histogram and frequency polygon.
2. Calculating mean, median and mode for grouped and ungrouped data.
3. Calculating variance, standard deviation and coefficient of variation for grouped and ungrouped data.
4. Fitting simple linear regression. Plotting scatter diagram and regression line.
5. Computing correlation coefficient and testing its significance for grouped and ungrouped data.
6. Comparison between means of two independent samples. Paired t-test.
7. Analysis of variance one way classification.
8. Analysis of variance: two-way classification.

M.Sc. Fourth Semester

Paper ESCC 401	**Natural Resources and Management**
Paper ESCE 402	**(A) Environmental Impact Assessment-II**
	OR
	(B) Biodiversity and Conservation
Paper ESEO 403	**(A) Environmental Issues, Awareness and Monitoring**
	OR
	(B) Waste Management
Paper ESCC 404	**Dissertations**
	Practical

Course Title: Natural Resources and Management
Course Code: Paper ESCC 401

Time: 3 Hours **M.M. 40+10**

Unit I

Principles of Remote sensing and their application in Environmental Sciences. Application of GIS in Environmental Management. Landuse Planning: The landuse plan. Soil surveys in relation to landuse planning. Methods of site selection and evaluation.

Unit II

Sun as source of energy, solar radiation and its spectral characteristics. Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas. Principles of generation of hydroelectric power, tidal, Ocean Thermal Energy Conversion, wind, geothermal energy; solar collectors, photovoltaic, solar ponds; nuclear energy- fission and fusion; magnetohydrodynamic power, bio-energy-energy from biomass and biogas, anaerobic digestion; energy use pattern in different parts of the world.

Unit III

Water Resources and Environment: Global Water Balance. Ice sheets and fluctuations of sea levels. Types of water. Origin and composition of seawater. Hydrological cycle. Factors influencing the surface water. Resources of oceans.

Mineral Resources and Environment: Resources and Reserves. Minerals and Population. Oceans as new areas for exploration of mineral resources. Environmental impact of exploitation, processing and smelting of minerals.

Course Outcomes (COs)

CO1: Demonstrate the human dimension of development and environment.
CO2: Gain insight on management of natural resources.
CO3: Train in tools and methodologies of ecological and environmental economics.
CO4: Empower with the integrated use of economics & ecology in decision making & law making process.
CO5: Acquire ideas and tools developed in other branches of economics to make significant contribution to valuation techniques, design of policy instruments for pollution control and management of commons.
CO6: Enables to use the COst-benefit analysis and instruments for pollution control and management of commons.
CO7: Analyze contemporary conflicts, struggles and policy choices around natural resources.
CO8: Develop critical thinking on who controls the environment and how, and who degrades nature and why.
CO9: Develop perspective on major approaches towards natural resource issues and enable to think creatively about conflict and concord in general, with special emphasis on the roles of ideas and institutions in environmental politics.
CO10: Learn skills to analyze case studies on big dams and endangered fauna, industrial pollution and global warming, the role of gender and empire.

Suggested Readings:

Living in the environmental - T.J. Miller.
Natural resource conservation - Owen & Chiras.
Encyclopaedia Energy - I & II.
Natural resources conservation -Oliver Ss. Owen.
Ecology of Natural resources – Ramade
Environmental Science- Cunningham Saigo

Restoration of degraded lands- J.S. Singh
Introduction to Environmental remote sensing – Curtis
Principles of Remote sensing - Lily and Kliffer.
Remote sensing of the Environment – Jenson

Course Title: Environmental Impact Assessment-II
Course Code: Paper ESCE 402(A)

Unit I

Reporting: - Features & purpose of EIA Reports, Main elements of EIA Report, Shortcoming encountered in preparing EIA reports. Review of EIA Quality:- Role & purpose of the Review process, Aspects for consideration, EIA Review- Types of Procedures, Steps involved in EIA Review, EIA review criteria, EIA review methods, Four steps approaches for EIA review. Environmental Management plan Or Impact management Plan.

Unit II

Decision Making: - concepts and its importance, responsibilities f decision makers in EIA process, Decision Making Process. Implementation & Follow up:- Need & purpose, Its components, Guiding Principles and elements, Aspects and Issues needs to be considered in EIA implementation & follow up.

Unit III

EIA Project Management: - its concepts, Role of Project Manager, Characteristics & Attributes of an interdisciplinary of EIA team, Project Managers Responsibilities. Social Impact Assessment:- concept, role & purpose of SIA, Benefits of SIA, Steps & principles of SIA, Methods used for predicting Social Impacts.

Course Outcomes (COs)

CO1: Lay foundation on the concept and components of environmental impact assessment.
CO2: Enable to practice EIA that examines the environmental consequences of development actions, in advance.
CO3: Investigate the agenda of all environmental agencies as a result of introduction of legislations in various countries.
CO 4: Develop skill to evaluate the issues and problems in environmental assessment from the perspective of process and methods, and goals of EIA.

Suggested Readings:

Canter, Larry W. Environment Impact Assessment. McGraw-Hill.
Rau, G.J. and C.D. Weeten. 1980. Environmental Impact Analysis Handbook. McGraw Hill.
Glasson, John, Rikki Therievel and Andrew Chadwic. 1996. Introduction to Environmental Impact Assessment, 2nd edition UCL Press.
Kulkarni, Vijay and T.V. Ramchandra. Date Environmental Management. Capital Publishing.
Mhaskar, A.K. Environmental Audits.Enviro Media Publications. Eccleston, Charles H. 2011. Environmental Impact Assessment: A Guide to Best Professional Practices. CRC Press.
Morris, Peter and RikiTherivel. 2009. Methods of Environmental Impact Assessment (Natural and Built Environment Series). Routledge.

Course Title: Biodiversity and Conservation
Course Code: ESCE 402 (B)

Time: 3 Hours **M.M. 40+10**

Unit I

Definition, classification and importance of Biodiversity; Causes of biodiversity reduction and strategies for biodiversity conservation. Endangered and Threatened Species (Flora and fauna) of India and Rajasthan, Hotspots of Biodiversity. Strategies of biodiversity conservation in India and the world (in situ and ex situ).

1. Magnitude and distribution of Biodiversity (global and Indian) and its characterization.
2. Rapid assessment of biodiversity and its valuation, skill, trained personnel and resources needed for the task.

3. Evaluating nature, scale and intensity of the threats to biodiversity.

Unit II

1. Role of plants in natural eCOsystems and life support system (terrestrial, freshwater and marine)
2. Importance of traditional cultivars and wild species in agriculture.
3. Role of plants in modern and traditional medicine.
4. Value of plants in scientific research and technological inventions.
5. Value of microbes in medicinal, scientific and technological research solutions and inventions.
6. Vegetation zones of India and Rajasthan.

Unit III

1. Role of animals in conservation of natural eCOsystems.
2. Role of wild and domesticated fauna in human nutrition.
3. Importance of animal species (terrestrial and marine) in medicine.
4. Important wild animals of India and their distribution, Sanctuaries and National parks, Red data book. Gene pool.
5. Ecotourism in wilderness and protected area network.

Course Outcomes (COs)

CO1: Demonstration importance of diversity at different levels of biological organization.

CO2: Lay foundation on basis concept of ecological and biological processes that ensures long-term stability of eCOsystems.

CO3: Train on the methods for measurement of species diversity and molecular diversity.

CO 4: Analyze the values of biodiversity and scientific approaches for conservation that can lead to sustainable development.

Suggested Readings:

Global Biodiversity - W.R. L. IUCN
Ecology of natural resource - Ramade
Ecology - P.D. Sharma
Conservation Ecology- G.W.Cox.

Course Title: Environmental Issues, Awareness and Monitoring
Course Code: ESEO 403 (A)

Unit I

Environmental Issues: Environmental Ethics and Global imperatives.

Global Environmental problems: Ozone depletion, global warming and climatic change, Greenhouse gases, Acid rains, Oil spills, Rain water harvesting and Groundwater recharge. Eutrophication and restoration of lakes. Wetlands conservation.

Nuclear fallout, Nuclear and radiation accidents, Nuclear safety , Electronic waste. Intensive farming, Overgrazing, Soil conservation, Soil erosion, Soil salination,

Unit II

Current Environmental issue in Indian Context: Narmada Dam, Tehri Dam, Almetti Dam, Soil Erosion. Formation and reclamation of Usar, Alkaline and Saline Soil. Waste lands and their reclamation, Floods and Drought.

Environmental priorities in India and sustainable development. Environmental education and awareness, role of governmental and non-governmental organizations.Environmental issues with war, Genetically modified food controversies, Overpopulation, Gender Imbalance. Epidemiological issues (e.g., Goitre, Fluorosis, Arsenic),

Unit III

Environmental Conservation Practices: Traditional Practices, Modern Practices. Environmental Monitoring: Air, Water, Soil, Monitoring of Natural Resources and Biodiversity.

Introduction of Geographical Information System (GIS): Definition, Components of GIS and Application of GIS in various fields

Course Outcomes (COs)

CO1: Gain insights into the politics of environmental issues at the national and international levels.

CO2: Debate on environmental policies and regulations and environmental movements in India.

CO3: Empowers with the methods of communication to the masses and consumers for environmental issues.
CO4: Develop global perspective on the scenario of environmental education and communication at the national and international levels.
CO5: Lay foundation of environmental communication, education and interpretations to achieve the goal of sustainable development, protection of environment, and conservation of biodiversity and eCOsystem.
CO6: Develop perspective on important environmental issues that have become a matter of global policy making, international negotiations and trade disputes.
CO7: Develop critical thinking on the links between environment, property regimes, trade and information economics.

Suggested Readings:

Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.
Cunningham, W. P. and Cunningham, M. A. Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi. 2004.
Rajagopalan, R. Environmental Studies: From crisis to cure, Oxford University Press, New Delhi, 2008.
Richards, I. S.Principles and Practice of Toxicology in Public Health. Jones and Bartlett Publishers, London. 2008.
Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
UNEP. Global Environment Outlook 3. Geneva: UNEP, Global Resource Information Division. 2003.
World Commission on Environment and Development (WCED): Our Common Future, Oxford University Press, London. 1987.

Course Title: Waste Management
Course Code: ESEO 403 (B)

Unit-I

Generation and characteristics of waste: Sources, types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes. Proximate and ultimate analysis of solid wastes.

Unit-II

Waste collection, storage and transport: Methods of municipal solid waste collection, On site storage methods, transfer station and transportation methods, Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste

Unit-III

Industrial waste, Hazardous waste, Electronic waste, Biomedical waste- characteristics, treatment and disposal. Plastic waste disposal, Fly ash: Sources, composition & utilization. Municipal solid waste in Indian conditions.

Course Outcomes (COs)

CO1: Describe the components of solid waste management.
CO2: Explain solid waste collection systems, waste transportation & processing techniques.
CO3: Examine the waste treatment technologies.

Suggested Readings:

1. Solid Waste Management CPCB. New Delhi.

2. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.

3. Basic Environmental Technology - J.A. Nathanson

Course Title: Dissertation
Course Code: Paper ESCC 404

M.M.-50

The student will select a topic of research in consultation with his/her supervisor/guide to do a research work or carry out a case study on any topic related to environmental sciences.
The student shall prepare a report of his/her work carried out. The external examiner will evaluate the work carried out and shall award the marks accordingly.

Course Outcomes (COs)

CO1: Plan and engage in an independent investigation of a chosen research topic relevant to environment and society.
CO2: Systematically identity relevant concepts, methodologies, techniques and conclusions..
CO3: Able to do critical review.
CO 4: Communicate research concepts & contexts effectively both orally and in writing.

Suggested Readings:

Work on the Dissertation topic initiated in Semester III with seminar presentation is to be completed with report submission by the end of semester IV.

1. Bucchi, M. and B. Trench, editors. 2008. Handbook of Public Communication of Science and Technology. Routledge.

2. Bella Mody 2001 Designing Messages for Development Communication –An Audience participation-based approach. SAGE Publications.

3. Robert, A.D. and G. Barbara. 2006. How to Write and Publish a Scientific Paper, 6th Edition. Cambridge University Press.

4. Soraya, M.C. and A.S. Cynthia. 2001. Proposal Writing. Sage Publications.

5. Gregory, J. and S. Miller. 1998. Science in Public: Communication, Culture and Credibility. Plenum.

6. Holliman, R., et al., editors. 2009. Investigating Science Communication in the Information Age: Implications for Public Engagement and Popular Media. Oxford University Press.

7. Nelkin, D. 1995. Selling Science: How the Press Covers Science & Technology, 2nd Edition. WH Freeman.

8. Hoffmann, Angelika H. 2009. Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford.

9. Field, Anthony. 2003. How to Design and Report Experiments. Sage Publications.

10. Glass, David. 2006. Experimental Design for Biologists. Cold Spring Harbor Laboratory Press.

11. Underwood, A.J. 1997. Experiments in Ecology: Their Logical Design and Interpretation Using Analysis of Variance. Cambridge.

Practical

Time: 3 Hours **M.M. 75+25**

Environmental Monitoring

1. Determination of particle size using respirable dust sampler.
2. Determination of PM 2.5 using fine particle sampler.
3. Respirable Suspended Particulate Matter (RSPM) by Respirable suspended particulate matter sampler (RDS APM 460)
4. Dust retaining capacity of plants.
5. Measurement of noise.
6. Estimation of BOD
7. Estimation of COD
8. Estimation of Chlorophyll
9. Estimation of Total, organic and inorganic carbon
10. GPS – Application in field
11. Estimation of Biodiversity
12. Site visit to degraded landscapes/habitats- terrestrial and aquatic.
13. Visit to restored/ managed habitats & study of their practices.
14. Field use of contour Marker for alignment of contour lines on the ground.
15. Visit to watershed area, to study different characteristics of watershed preferably in rainy season.

Advanced Instrumental Techniques:

1. Flame photometery
2. UV-Visible Spectrophotometry
3. Atomic Absorption Spectrophotometry

Case Study: Related to Pollution Monitoring, Treatment and Control; Environmental Impact Assessment; Resource recycling and reclamation; Biodiversity and its conservation.

Teaching Learning Process

- Lectures
- Discussions
- Simulations
- Role Playing
- Participative Learning
- Interactive Sessions
- Seminars
- Research-based Learning/Dissertation or Project Work
- Technology-embedded Learning

Blended Learning

Herbarium preparation, field research report, Participation in seminars/conferences, celebration of events related to environment, Script/play on environmental issues, social responsibility and community participation.

Assessment and Evaluation

- Continuous Comprehensive Evaluation at regular intervals to find out each course-level learning outcome i.e. Assignment, Test, Quiz, Seminars.
- Formative Assessment on the basis of activities of a learner throughout the program instead of one-time assessment, followed by Internal Assessment.
- Individual Assignments i.e. Case Study, Practical Record, Dissertation.
- Seminar Presentation, Field/Excursion report writing

Distribution of Credit

Semester	**I**	**II**	**III**	**IV**	**Total**
Credit	25	25	25	25	100

Academic Year	**Semester**	**Core Compulsory**	**Core Elective**	**Open Elective**	**Foundation**
Credit Distribution	I and II	80%	-	-	20%
	III and IV	40%	40%	20%	-

1 Credit = 10 Marks

Evaluation (Calculation of Score)

Credits & Marks (Theory)
Course Credit = 5
Total Marks = 50

Credits & Marks (Practical)
Course Credit = 10
Total Marks = 100

Grading

Grade Points	**Description**	**% of Marks**	**Division**	**Grade**
10	Outstanding	90-100	First	O
9	Excellent	80-89	First	A+
8	Very Good	70-79	First	A
7	Good	60-69	First	B+
6	Above Average	50-59	Second	B
5	Average	40-49	Third	C
4	Pass	36-39	Pass	P
0	Fail	Below 36	Fail	F
0	Absent	-	-	Ab

Performance Evaluation (Calculation)

(i) Semester Grade Point Average (SGPA)

SGPA (Si) = Σ (Ci X Gi) / Σ Ci
Where Gi = Grade
Ci = Credit of Course

(ii) Cumulative Grade Point Average (CGPA)

CGPA = Sum of Credits X SGPA of Entire Program/ Sum of Credits up to the end of program

(iii) Conversion of CGPA into Percentage

Percentage % = 9.5 X CGPA (Adopted from CBSE pattern where 9.5 means that percentage should not greater than 95%)

OR

* Conversion of CGPA into Percentage is subject matter of examinations section of the university.

Key-Words

LOCF = Learning Outcome Course Frame work.
NEP 2020 = New Education Policy – 2020
CBCS = Choice Based Credit System
PO = Program Outcome
PSO = Program Specific Outcome
CCE = Comprehensive Continuous Evaluation

Reference

- https://www.education.gov.in/en/nep-new
- The draft subject specific LOCF templates available on UGC website. https://www.ugc.ac.in/ugc_notices.aspx?id=MjY5OQ==
- Draft Blended Mode of Teaching and Learning: Concept Note available on UGC website. https://www.ugc.ac.in/pdfnews/6100340_Concept-Note-Blended-Mode-of-Teaching-and-Learning.pdf