

**REVISED COURSE STRUCTURE
(CBCS SYSTEM)**

**M.Sc.
(Environmental Sciences)**

July, 2017



**DEPARTMENT OF ENVIRONMENTAL
SCIENCES**

**CENTRAL UNIVERSITY OF HARYANA
MAHENDERGARH**

M.Sc. ENVIRONMENTAL SCIENCES (FOUR SEMESTERS)

SEMESTER I (Total Credits: 23)

S. No.	Course code	Course title	L	T	P	Credit
1.	SEES EVS 01 01 01 C 4004	Fundamentals of Ecology	4	0	0	4
2.	SEES EVS 01 01 02 C 4004	Natural Resource Conservation & Management	4	0	0	4
3.	SEES EVS 01 01 03 C 4004	Biodiversity Conservation	4	0	0	4
4.	SEES EVS 01 01 04 C 0055	Practical I (Ecology & Biodiversity)	0	0	10	5
5.	SEES EVS 01 01 01 DCEC 2002	Seminar Paper (compulsory)	2	0	0	2
6.	GE	<i>To be taken from other department</i>	4	0	0	4
7.		<i>Any one of the following two courses</i>				
	SEES EVS 01 01 01 GE 4004	Foundation course in Ecology and Environment	4	0	0	4
	SEES EVS 01 01 02 GE 4004	Environmental Health and Toxicology	4	0	0	4

SEMESTER II (Total Credits: 27)

S. No.	Course code	Course title	E	T	P	Credit
1.	SEES EVS 01 02 05 C 4004	Environmental Chemistry	4	0	0	4
2.	SEES EVS 01 02 06 C 4004	Environmental Policies and Laws	4	0	0	4
3.	SEES EVS 01 02 07 C 4004	Physical Environment	4	0	0	4
4.	SEES EVS 01 02 08 C 4004	Instrumentation Techniques	4	0	0	4
5.	SEES EVS 01 02 09 C 0055	Practical II (Environmental Monitoring & Analysis)	4	0	0	4
6.	SEES EVS 01 02 02 DCEC 4004	Environmental Microbiology	0	0	10	5
7	SEES EVS 01 02 03 GE 2002	Global Environmental Issues (compulsory)	2	0	0	2

SEMESTER III (Total Credits: 24)

S. No.	Course code	Course title	E	T	P	Credit
1.	SEES EVS 01 03 10 C 4004	Environmental Management and Impact Assessment	4	0	0	4
2.	SEES EVS 01 03 11 C 4004	Environmental Pollution and Control	4	0	0	4
3.	SEES EVS 01 03 12 C 0055	Practical III (Environmental Management)	0	0	10	5
4.	SEES EVS 01 03 13 C 2003	Summer Training (Report and Presentation)	2	0	0	3
5.	GE	<i>To be taken from other department</i>	4	0	0	4
6.		<i>Any one of the following two courses</i>	4	0	0	4
	SEES EVS 01 03 03 DCEC 4004	Water Quality Management				
	SEES EVS 01 03 04 DCEC 4004	Natural Disaster Management				

SEMESTER IV (Total Credits: 24)

S. No.	Course code	Course title	E	T	P	Credit
1.	SEES EVS 01 04 01 SEEC 002424*	Dissertation (Research work, Progress Seminar, Report and Viva voce)	0	0	48	24
	SEES EVS 01 04 01 SEEC 001616*		0	0	32	16
		<i>Any two of the following three courses</i>				
2.	SEES EVS 01 04 05 DCEC 4004	Environmental Biotechnology	4	0	0	4
	SEES EVS 01 04 06 DCEC 4004	Forest and Wildlife Ecology				

*A dissertation/ project work/field work carries 16 credits (along with two Discipline Centric Elective Courses (DCEC)); and a semester-long dissertation/project work/field work carries 24 credits.

SEEC: Skill Enhancement Elective Course (Compulsory and exclusively for Environmental Science students)

SEMESTER- I

FUNDAMENTALS OF ECOLOGY

Unit I: Introduction to Ecology

Definition, subdivision and scope, Basic concepts in ecology, Autecology and Synecology, Level of organization in Ecology, Environmental heterogeneity, Applied ecology, Environmental complexes, Interaction of ecological factors.

Unit II: Ecological factors

Light, temperature, precipitation (rainfall), humidity. Atmosphere: gases and wind, atmospheric gases, wind factor and fire factor, topographic and edaphic factors. Different environmental laws and limiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors). Biotic community, Interdependence in a community and community metabolism, Community ecology: structure, composition and development of community, species diversity in communities, Ecotones, Concept of edge effect, Ecological niche, Gause's Principle.

Unit III: Ecosystem

Introduction, kinds of ecosystem, structure and functions, abiotic and biotic component, Ecological energetics, Energy flow models, Food chain and Food web, Concepts of productivity and standing crops, Ecological Pyramids-types, Ecological succession, Ecological indicators, Ecological efficiencies, Biogeochemical cycles in ecosystems.

Unit IV: Population ecology

Population characteristics; density, natality, mortality, biotic potential, survivorship curves, age distribution, growth curves and models, r & k selection. Population interaction, Prey-Predator Relationship, Ecological Model

REFERENCES

1. Begon, M., Townsend, C.R. and Harper, J.L. (2005). Ecology: From Individuals to Ecosystems, 4th Edition, John Wiley & Sons.
2. Botkin, D. and Edward, K. (1997). Environmental Sciences, John Wiley & Sons, New York.
3. Chapman, J. L. and Reiss, M. J. (1998). Ecology: Principles and Applications. Cambridge University Press, UK.
4. Cunningham, W. P. and Cunningham, M. A. (2004). Principles of Environment Science. Enquiry and Applications. 2nd Edition. Tata McGraw Hill, New Delhi.
5. Dash, M.C. and Dash, S.P. (2009). Fundamentals of Ecology. McGraw Hill Education.
6. Odum, E.P. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning Publication.
7. Raven, P. H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th Edition. John Wiley & Sons., USA.
8. Sharma, P.D. (2000). Ecology & Environment, 7th Edition, Rastogi Publications, Meerut.
9. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
10. Smith, T.M. and Smith, R.L. (2015). Elements of Ecology. 9th Edition, Pearson Benjamin Cummings, USA.

BIODIVERSITY CONSERVATION

Unit I: Introduction

Concepts and components of biodiversity, types of diversity (Microbial, Plant, Soil, Agro-biodiversity), Biodiversity as an important and valuable resource, human population growth and its implications on biodiversity, biodiversity indices, biodiversity losses

Unit II: Strategies for biodiversity conservation

In-situ conservation: sanctuaries, biospheres reserves, national parks, preservation plots. Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation of plant tissue culture; gene bank; pollen and spore bank, DNA bank. National and international programmes for biodiversity conservation

Unit III: Megadiversity zones and biodiversity hotspots

Concepts, distribution and importance of megadiversity zones, Biodiversity hotspots, National and global red data lists, Categories of species and their management, Restoration of biodiversity, Acceleration of ecological succession, Reintroduction of biota. Methods for monitoring biodiversity trends, IPRs, Patent protection and Biopiracy

Unit IV: Bioprospecting

Concept of bioprospecting, importance of biodiversity: aesthetic, cultural and ecosystem services, biodiversity informatics, International efforts and issues of sustainability. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC.

REFERENCES

1. Benny J. (2006). 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi.
2. Botkin, D. and Edward, K. (1997). Environmental Sciences, John Wiley & Sons, New York.
3. Chapman, J. L. and Reiss, M. J. (1998). Ecology: Principles and Applications. Cambridge University Press, UK.
4. Cunningham, W.P., Cooper, T.H. Gorhani, (2001). "Environmental Encyclopedia", Jaico Publication, House, Mumbai.
5. Gilbert M. Masters. (2004). 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education.
6. Laladhas, K.P., Nilayangod, Preetha, V. Oommen, Oommen (Eds.) (2017). Biodiversity for Sustainable Development. Springer International.
7. Miller Jr., G.T. (1997). Environmental Science: Working With the Earth. Wadsworth
8. Odum, E.P., Odum, H.T. & Andrews, J. (1971). Fundamentals of Ecology. Philadelphia: Saunders. Publishing Company, Belmont, California
9. Wager, K.D. (1998). "Environmental Management", W.B. Saunders CO., Philadelphia, USA.

NATURAL RESOURCE CONSERVATION AND MANAGEMENT

Unit I: Introduction and Mineral resources

Natural resources: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Mineral resources: use of minerals, Resources and reserves. Mineral exploration and extraction, Ocean as new area for exploration of mineral resources. Ocean ore and recycling of resources, Environmental impacts of mineral extraction

Unit II: Soil and water resource

Soil as a resource; soil profile; Soil erosion; Soil conservation and management strategies; Role of organic matter and its maintenance; soil nutrient deficiencies, Remedial measures and management techniques; Use and over-utilization of surface and ground water, Dams-benefits and problems. Integrated water resources management and Rain Water Harvesting.

Unit III: Energy resources

Energy sources, Prospects of alternate energy sources. Principal of generation of renewable energy: Solar energy (Photovoltaic and thermal conservation), Hydroelectric power, Tidal, Ocean thermal energy conversion (OTEC), Wind, Geothermal energy, Nuclear energy: fusion and fission, Magneto hydrodynamic power, bio-energy. Energy use pattern in different parts of world.

Unit IV: Forest resources

Forest vegetation: status, distribution and management, Major forest types and their characteristics, Use and over-exploitation, Deforestation, Timber extraction, mining, dams and their effects on forest and tribal people, Urban forestry.

REFERENCES

1. Boyle, G. (2004). Renewable Energy, 2nd Edition. Oxford University Press.
2. Jain, A. K. (1989). Forests in India, Vorha Publication, Allahabad.
3. Oliver, S. O. and Daniel, D. C. (1990). Natural Resource Conservation: Management for a Sustainable future. Prentice Hall International, New Jersey.
4. Rai, G. D. (1993). Non Conventional Energy Sources, Khanna Publishers, Delhi.
5. Raven, P.H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th ed. John Wiley & Sons., USA.
6. Tiwari, G.N. and Ghosal, M. K. (2005). Renewable Energy Resources: Basic Principles and Application, Narosa Publishing.
7. Twidell, I.J. and Tony, W. (2007). Renewable Energy Resources. Taylor and Francis Group.

PRACTICAL – I
Ecology & Biodiversity

A. To determine the following parameters of grassland vegetation

(Two exercise to be done in examination)

1. Minimum size and number of quadrat
2. Frequency of plant species
3. Density of plant species
4. Abundance of plant species
5. Importance Value Index (IVI)

B. Determination of Primary Productivity by following methods:

(One exercise to be given)

1. Harvest method
2. Light and dark bottle method.

C. Analysis of the following parameters:

1. Hardness
2. Transparency
3. Turbidity
4. Conductivity
5. Chlorophyll content estimation

D. Determine the following water parameters (Any two exercises)

1. DO
2. BOD
3. COD
4. Alkalinity
5. TDS

E. A visit to aquatic ecosystem and methods for water and plankton collection

SEMINAR (COMPULSORY)

Every student, who has been enrolled in M.Sc. (Environmental Sciences) programme, shall have to deliver a Seminar on a recent topic related to Environmental Science, as per the programme of the School of Earth, Environment and Space Studies. Seminar will be of 30-40 minutes duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board. The speaker has to submit an abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/list of sources.

FOUNDATION COURSE IN ECOLOGY AND ENVIRONMENT

Unit I: Fundamentals of Ecology

Definition and subdivision of ecology, Autecology and Synecology, scope of ecology, Basic concepts in ecology, Terminologies in ecology, Organizational level of ecological systems.

Unit II: Environmental Factors

Definition of environmental factors, Types of environmental factors, Abiotic factors: Temperature, light, water, precipitation and wind. Shelford's law of Tolerance, Liebig's law of Minimum, Concept of limiting factors, Biotic factors.

Unit III: Ecosystem Ecology

Definition, Types of ecosystem, Terrestrial: forest and grassland, Aquatic: lotic and lentic, Structure of an ecosystem, Function of an ecosystem, Food chain: grazing and detritus and trophic level, Energy Flow Ecological pyramids: number biomass and energy.

Unit IV: Population and Community Dynamics

Definition, Characteristics of population: natality, mortality, Age distribution, dispersion, migration. Age structure of population, Ecological niche, Ecotone and Edge effect, Interactions between populations, Life history strategies (r and k species), Key stone species, flagship species. Definition of ecological succession, Characteristics of succession, General process, Significance of ecological succession, types of succession: xerosere and hydrosere, Concept of climax, IVI.

REFERENCES

1. Begon, M., Townsend, C.R. and Herper, J.L. (2005). Ecology: From Individuals to Ecosystems, 4TH Edition, John Wiley & Sons.
2. Botkin, D. and Edward, K. (1997). Environmental Sciences, John Wiley & Sons, New York.
3. Chapman, J. L. and Reiss, M. J. (1998). Ecology: Principles and Applications. Cambridge University Press, UK. Cunningham, W. P. and Cunningham, M. A. (2004).
4. Dash, M.C. and Dash, S.P. (2009). Fundamentals of Ecology. McGraw Hill Education.
5. Odum, E.P. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning Publication.
6. Principles of Environment Science. Enquiry and Applications. 2nd Edition. Tata McGraw Hill, New Delhi.
7. Raven, P. H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th Edition. John Wiley & Sons., USA.
8. Sharma, P.D. (2000). Ecology & Environment, 7th Edition, Rastogi Publications, Meerut.
9. Singh, J.S., Singh, S.P. and Gupta, S.R. *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi, India. 2006.
10. Smith, T.M. and Smith, R.L. (2015). Elements of Ecology. 9th Edition, Pearson Benjamin Cummings, USA.

ENVIRONMENTAL HEALTH AND TOXICOLOGY

Unit-I: Principles of toxicology

Environmental toxicology and its importance; Occurrence of Toxicants and their chronic and acute effects; Exposure, uptake, transportation, storage, metabolism and excretion of pollutants

Unit-II: Pollution and human health

Trace element deficiency and disorders; Occupational health hazards; Biogeochemical factors in environmental health; Epidemiological issues- Goiter, Fluorosis, Arsenic poisoning.

Unit-III: Biotransformation: Metabolism of Xenobiotics

Types and Mechanism of Biotransformation, Characteristics of Biotransformation, Consequence of Biotransformation: Biotransformation of Endogenous Substances, Activation of Xenobiotics, Factors Affecting Biotransformation, Induction, Genetic Polymorphisms.

Unit-IV: Genetic Toxicology

Carcinogenesis; Carcinogens, chemical carcinogenicity, mechanism of carcinogenicity, Oncogenes and tumour suppressor genes. Environmental carcinogenicity testing. Mutagenicity: Mutagens, Environmental mutagen testing- Bacterial mutagenesis assays, gene mutation chromosome damage assays, DNA damage and repair assays.

References

1. Ayres, J., (2009). Occupational industrial and environmental toxicology, 2nd edition
2. Chatterjee, P., Progress in predictive toxicology- Clayson, Munro, Shubik & Swenderg (eds.)
3. Landis, W., Sofield, R., Yu, M.H., Wayne G. Landis, Yu, S.M.H. Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes, Fourth Edition
4. Niesink, R., Hollinger, M.A., Vries, J.D. (1999). Toxicology: Principles and Applications.
5. Perk, Preventive and Social Medicine
6. Phillip. R.B. (2001).Ecosystems and human health: toxicology and environmental hazards. 2nd edition. Boca Raton: Lewis Publishers

SEMESTER-II

ENVIRONMENTAL CHEMISTRY

Unit I: Chemistry of water and aquatic system

Stoichiometry, Gibb's energy, chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water. The carbonate system; Chemistry of water, Properties of water and their significance, types, sources and consequences of water pollution, Physico chemical and bacteriological sampling and analysis of water quality. Water quality standards. Concept of DO, BOD, COD, sedimentation, coagulation, filtration, Redox potential, alkalinity, acidity, calcium and other metals in water, organic pollutants in sewage, soaps, oil and detergents, radionuclide in water

Unit II: Atmospheric chemistry

Particles, ions and radicals in the atmosphere. Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Oxygen and ozone chemistry. Chemistry of air pollutants, Photochemical smog. Methods of monitoring and control of air pollution- SO₂, NO_x, CO, SPM. Effects of pollutants on human beings, plants, animals and materials. Air quality Standards

Unit III: Soil and sediment geochemistry

Inorganic and organic components of soil, Weathering of rocks, rock forming minerals, Soil properties, acid-base and ion-exchange reaction in soil, Macro and micronutrients in soil, Nitrogen pathways and NPK in soils, Interior of the earth- minerals and rocks- earth processes- plate tectonics- sea floor spreading, mountain building, rock deformation.

UNIT IV: Toxic chemicals in the environment

Organic compounds: Hydrocarbons, Chemistry of hydrocarbons, phenols, chlorofluorocarbons, pesticides, chemical fertilizers, environmental effects, effects on macro and microorganisms. Gasoline lubricants and greases, Pesticides: Classification, degradation, analysis, pollution due to pesticides and heavy metals

REFERENCES

1. De, A.K. (2001). Environmental Chemistry. Wiley Eastern Ltd, New Delhi
2. Field, F.W. & Haines, P.J. (2000). Environmental Analytical Chemistry, Blackwell Science Ltd. USA.
3. Karikalan, V.L. (2002). Environmental Engineering. Dhanpati Rai & Co. (P) Ltd., Delhi.
4. Manahan, S.E. (1991). Environmental Chemistry. Lewis Publishers, Chelsea, Michigan.
5. O' Neill, P. (1993). Environmental Chemistry. Chapman and Hall, London.
6. Rao, C.S. (1991). Environmental Pollution Control Engineering. Wiley Eastern, New Delhi.
7. Sharma, B.K. and Kaur H. (1998). Environmental Chemistry. Goel Publishing House, Meerut.
8. Sodhi, G.S. (2002). Fundamental concepts of Environmental Chemistry, Narosa Publishing House, New Delhi.

ENVIRONMENTAL POLICIES AND LAWS

Unit I: Introduction to Environmental Laws

Environment protection- Issues and Problems; International and national efforts for environment protection; General principles in Environmental law: Precautionary principle; Polluter pays principle; Sustainable development

Unit II: Global Environmental Awareness

Brief introduction to International conferences and conventions on environmental protection: Stockholm Conference, Earth Summit, World Summit on Sustainable Development, Ramsar convention, Vienna convention, Montreal Protocol, Kyoto Protocol; Constitutional provisions of Constitution of India regarding Environment (Article 48A, 51A(g) and 253); Ecomark.

Unit III: Water, Air and Biodiversity related Laws

The Water (Preventions and Control of Pollution) Act, 1974; Water Cess Act, 1977; Air (Prevention and Control of Pollution) Act, 1981; Environmental Protection Act, 1986; Motor Vehicle Act, 1988 (Environmental aspects only); Coastal Regulation Zone (CRZ) Notification, 1991; Noise Pollution (Regulation and Control) Rules, 2000; Wildlife (Protection) Act, 1972 and amendment, 2002; Forest Conservation Act, 1980; Biological Diversity Act, 2002; Forest Rights Act, 2006.

Unit IV: Hazardous Waste Management Rules

Manufacture, Use, Import, Export & Storage of Hazardous Microorganisms & Genetically Engineered cells Rules, 1989; Public Liability Insurance Act, 1991; Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016; Bio-Medical Waste Management Rules, 2016; e-waste (Management) Rules, 2016.

REFERENCES

1. Deshai, B. (1994). Environmental Law of India, Lencern Book, New Delhi.
2. Divan S. and Rosencranz A. (2005). Environmental Law and Policy in India, 2nded., Oxford, New Delhi
3. Leelakrishnan P. (2008). Environmental Law in India, 3rd ed., Lexis Nexis, India.
4. Mehta, C.S. (1991). Environmental Protection and the Law, Ashish Publishing House, New Delhi.
5. Nath B., Hens, L., Compton, P. and Devuyt, D. (1998). Environmental Management in Practice, Vol I, Routledge, London and New York.
6. Singh, G. (2005). Environmental law in India, Mc Millan, New Delhi.
7. Upadhyay S. and Upadhyay V. (2002). Hand Book on Environmental Law- Forest Laws, Wildlife Laws and the Environment; Vols. I, II and III, Lexis Nexis- Butterworths-India, New Delhi.

PHYSICAL ENVIRONMENT

Unit-I: Atmospheric Environment

Atmosphere: composition and vertical distribution of temperature, earth and sun relationship, heat budget, scales of meteorology, hydrostatic equilibrium, lapse rates, vertical stability of atmosphere, clouds (classification and formation), winds, wind roses, Coriolis force, global pressure belt system and monsoons.

Unit-II: Aquatic and Terrestrial Environment

Global water balance. Ice sheets and fluctuations of sea levels. Origin and composition of sea water. Hydrological cycle. Inland water bodies (lakes, streams, rivers, estuaries and wetlands). Rocks; Igneous, sedimentary and metamorphic rocks, weathering, erosion, transportation and deposition of earth's material through running water, wind, glaciers. The land use plan, soil surveys in relation to land use planning, methods of site selection and evaluation.

Unit III: Introduction to Remote Sensing and GIS

Fundamental concepts of remote sensing and GIS, EMR spectrum, Radiation laws, Elements of photographic systems, aerial photo interpretation. Spectral reflectance, vegetation, soil and water. Transmittance, Absorbance. Application of remote sensing and GIS in environmental management (Land use; Wastelands; Forest, Water resources, Wildlife habitat)

Unit-IV: Global climate change

History of climate change, Milankovitch's theory of climate change, greenhouse gases and their effects, role of humans, urban climatology, climatic feedback mechanisms, and possible impacts of global climate change.

REFERENCES

1. Conte, D.J., Thompson, D.J., Moses, L.L (1994). Earth Science : A holistic approach
2. Davis, R.A. (1991). Oceanography: An introduction to the Marine Environment 2nd edition. Publisher: William C Brown
3. Gross, M.G., Gross, E. (1995). Oceanography: A View of the Earth 7th edition.
4. Gross, M.G. (1996). Oceanography. Wallace, J., Hobbs, W.P. Atmospheric Science-An introductory survey. 2nd edition.
5. Lutgens, F.K. Tarbuck, E.J. Tasa, D.J. The atmosphere: An introduction to Meteorology. 13th edition.
6. Ritchie, G. Atmospheric Chemistry (from the surface to the stratosphere) 1st edition.
7. Rothschild, L.J. (2012). Evolution on Planet Earth: The Impact of the Physical Environment. San Diego, California, USA
8. Geography of the Physical Environment (2017). Springer International Publishing AG.

INSTRUMENTATION TECHNIQUES

Unit I: Analytical Approach

Defining of problem and designing of analytical method; Sampling: Types and methods for solid, liquid and gaseous matrix; Sample storage; Sample preparation; Measurement and assessing of data; Method validation and documentation

Unit II: Principles and Applications of Analytical Techniques

Titrimetry; Gravimetry; Colourimetry; Spectrophotometry (UV-Visible Spectrophotometry, Atomic Absorption Spectrophotometry, Flame photometry); Plasma emission spectroscopy (Induced Coupled Plasma Mass Spectrometer); X-Ray Spectroscopy (X-Ray Fluorescence, X-Ray Diffraction); Scintillation counter; Refractometry, Nephelometry and Turbidimetry

Unit III: Chromatographic Techniques

Chromatographic techniques (Paper Chromatography, Thin Layer Chromatography, Gas Liquid Chromatography, High Pressure Liquid Chromatography, Ion-exchange Chromatography, Column Chromatography); Electrophoresis

Unit IV: Microscopy and Electro-analytical Techniques

Optical Microscopy (Light, Bright field, Darkfield, Phase Contrast, Fluorescence, Confocal); Electron Microscopy (Scanning and Transmission Electron Microscopy); Flow Cytometry; Electro analytical methods (Potentiometry, Coulometry)

REFERENCES

1. APHA (1998). Standards Methods for the examination of water and Waste water, 20th Edn, Washington DC.
2. Douglas A. Skoog, F. James Holler, Stanley R. Crouch (2018). Principles of Instrumental Analysis. Cengage Learning Publisher.
3. Khopkar, S.M. (1985). Basic Concepts of Analytical Chemistry. Wiley Eastern Ltd., New Delhi.
4. Marr, L.L. & Cresser, M.S. (1983). Environmental Chemical Analysis, International Text Book Company (pub), New York.
5. Robinson, J. W., Frame, E. M. S., & Frame, G. M. (2014). Undergraduate instrumental analysis. CRC Press, New York
6. Rouessac, F. and Rouessac, A. (2007). Chemical Analysis: Modern Instrumentation Methods and Techniques 2nd Edition. Wiley.
7. Skoog, D.A. and Leary, J.J. (1992). Principles of Instrumental Analysis, 4th edn, Saunder's College Publishing, Fortworth.
8. Willard, H.H., Merritt, L.L, Deen, J.A. and Settle, F.A. (1986). Instrumental Methods of Analysis (Indian Reprint), CBS Publishers and Distributers, New Delhi.
9. Zar, J.H. (1998). Biostatistical Analysis. Prentice Hall, N.J.

PRACTICAL – II
Environmental Monitoring & Analysis

A. Determine the following air pollutants (Two exercises to be given)

1. PM₁₀ 2. PM_{2.5} 3. NO_x 4. SO₂ 5. CO 6. O₃ 7. NH₃

B. Estimation of alkali metals in various samples by flame-photometry

C. To calculate the lambda max of the given compound by UV-Vis spectrophotometer.

D. Microbial studies:

Media preparation, Sterilization, inoculation, Cultivation

E. Experiments to perform: (Two exercise to be given)

1. Preparation of nutrient broth
2. Isolation and enumeration of soil bacteria and fungi
3. Inoculation of polluted water sample
4. Grams staining of *Lacto bacilli*
5. Faecal coliform

F. Determination of microbiological quality of water

- a. Standard Plate Count
- b. Standard Coliform Test
- c. MPN Test
- d. Fecal Coliform test
- e. Enumeration of Fecal Streptococci
- f. Membrane Filtration Technique

ENVIRONMENTAL MICROBIOLOGY

Unit-I: General and Aquatic Microbiology

Classification, characteristics, occurrence and distribution of microorganisms. Microbial cultivation and growth. Microbial mats, Bio-films, Role of Microorganisms in Wastewater and Water Treatment; Bioassay tests for toxicity evaluation, Pathogens and Indicator microorganisms; Eutrophication of water bodies.

Unit-II: Soil microbiology

General characteristics and activities of microorganisms in surface soil, Mineralization and Immobilization of soil nutrients, Microbial degradation of cellulose, hemicelluloses and lignin. Microbes in Agriculture- Biological nitrogen fixation, bio-fertilizers, Mycorrhiza and their environmental significance. Microbe mediated C, N and S transformations.

Unit-III: Food microbiology

Food borne infections: bacterial (Clostridium, Salmonella, Shigella, Staphylococcus), Mycotoxins in food with reference to Aspergillus species. Genetically modified foods. Microbes in food production. Applications of microbial enzymes in food industry.

Unit-IV: Applied Environmental Microbiology:

Bioremediation: principle and mechanisms, types and environmental applications. Specific Processes: Biodegradation of pesticides and hydrocarbons, Bio-hydrometallurgy, Microbial Enhanced Oil Recovery, Biodegradable Plastics, Biosurfactants. Release of genetically engineered microbes and environmental risk.

REFERENCES

1. Gaudy, A.F. & E.T. (1980). Microbiological Methods for Environmental Scientists and Engineers, McGraw Hill.
2. Grainer, J.M. & Lynch, J.M. (1984). Microbial Methods for Environmental Biotechnology: Academic Press.
3. Madigan, M.T. & Martinko, J.M. (2006). Brock Biology of Microorganisms. Pearson Prentice Hall.
4. Maier, R.M., Pepper, I.L. & Gerba, C.P. (2000). Environmental Microbiology, Academic Press.
5. Parihar, P. & Parihar, L. (2008). Advances in Applied Microbiology. 1st Ed., Agrobios (India).
6. Pelezar, M.J. Jr., Chan, E.C.S and Kreig, N.R (1993). Microbiology, Tata McGraw Hill, Delhi.
7. Purohit, S.S. (2010). Microbiology Fundamentals and Applications, 6th Ed., Agrobios.
8. Stainer, R.Y., Adelberg, E.A. & Ingraham, J.L. (1977). General Microbiology, Macmillan Press.

GLOBAL ENVIRONMENTAL ISSUES

UNIT-I: Environmental Issues and Movements

Creation of UNEP and its role, UNFCCC, Convention on Climate Change, CoPs, CDM, Convention on Conservation of Antarctic Marine Living Resource, Global and national movements of Significance impact: Green Belt movement, Green Peace, Chipko movement, Narmada Bachao Andolan, *Urja gram*, *Beej Bachao Andolan*, Silent valley- Doon valley and related issues / case studies

UNIT-II: Climate change

Sea level Change- primary and secondary impacts- Adapting to Sea level changes. Global Warming and Greenhouse gases- Global and national scenario. National Action Plan on Climate Change (NAPCC), Intergovernmental Panel for Climate Change (IPCC), Climate Change and Biodiversity loss.

UNIT-III: Nuclear issues

Nuclear issues, Nuclear power, Nuclear weapons, Nuclear and radiation accidents, Nuclear safety, High-level radioactive waste management.

UNIT-IV: Contemporary issues

Green Buildings, Genetic pollution, Genetically modified food controversies, Intensive farming Monoculture, Health and Diseases- Epidemics and Famines.

REFERENCES

1. Asthana, D.K. and Asthana, M. (2003). Environment: Problems and Solutions, , S. Chand & Co., New Delhi
2. Burroughs, W.J. (2007). Climate Change: A Multidisciplinary Approach. 2nd Edition. Cambridge University Press.
3. Cunningham, W. P. and Cunningham, M. A. (2004) Principles of Environment Science. Enquiry and Applications. 2nd Edition, Tata McGraw Hill, New Delhi.
4. Divan, S. and Rosencranz, A. (2001). Environmental Law and Policy in India: Cases, Materials and Statutes, Oxford University Press, New Delhi.
5. Goel P. K and Sharma K. P. (1996). Environmental Guidelines and Standards in India, Techno Science Publications, Jaipur.
6. Harris, F. (2004). Global Environmental Issues. Wiley & Sons, Inc., USA.
7. McCormick, J. Reclaiming paradise: The Global Environmental Movement
8. Singh, J.S., Singh, S.P. and Gupta, S.R. (2006). Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India.

SEMESTER-III

ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT

Unit I: Introduction to EIA and Environmental Planning

Origin, aims and needs of EIA, EIA guidelines 1994, EIA notification and amendments; Environmental Impact Assessment (EIA) as a tool in environmental management, EMS, ISO 14001. Baseline information and predictions (Land, water, atmosphere, energy etc.), Restoration and rehabilitation technologies.

Unit II: EIA Methodology

Types of Projects requiring Environmental Clearance, Types of EIA, Project screening, Scoping, Base-line study, Impact identification, Prediction and assessment of impacts, Mitigation measures. Public participation, review and decision making, Generic structure of EIA Document, Composition of EAC, SEAC, Benefits and future of EIA.

Unit III: Environmental Audit

Introduction, concepts, steps, methodology. Environmental Auditing: Procedure, Matrix methods and Batelle method of auditing, National Environmental Policies and guidelines for environmental audit in India, Environmental impact statement

Unit IV: Case Studies

Environmental Impact Assessment of major developmental projects – river valley projects, mining projects, thermal power plants, transport (rail, road highway), oil refineries and petrochemicals. Prediction and assessment of impacts on the biological, cultural and socio-economic environments

REFERENCES

1. Glasson, J. Therivel, R. and Chadwick, A. (2006). Introduction to Environmental Impact Assessment. Routledge, London.
2. Jain, R.K., Urban L.V. and Stacey, G.S. (1981). Environmental Impact Analysis: A New Dimension in Decision Making. Van Nostrand Reinhold Company, New York.
3. Kreske, D.L. (1996). Environmental Impact Statement: A practical guide for agencies, citizens and consultants. John Wiley and Sons Inc., New York.
4. Kulkarni, V.S., Kaul, S.N. and Trivedi, R.K. (2002). A Handbook of Environmental Impact Assessment. Scientific Publishers, India.
5. Petts, J. (2005). Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK.
6. Reddy, M.A. (2010). Textbook of Environmental Science & Technology, BS Publications.
7. Singh, P.P. and Sharma, S. (2004). Environment and Pollution Education. Deep and Deep Publication Pvt. Ltd, New Delhi.

ENVIRONMENTAL POLLUTION AND CONTROL

Unit-I: Waste water management

Primary treatment methods– screening, grit removal, primary sedimentation, secondary treatment methods, Activated sludge process, Trickling filters, Rotating biological contactors, Oxidation ponds and Lagoons. Advance waste water treatment, removal of nutrients and solids. Wastewaters reuse and sludge disposal, MINAS

Unit-II: Air Pollution control

Control methods for particulates-gravitational settling chambers, Centrifugal collectors, Wet collectors, Fabric filters, electro static precipitators. Control methods for gaseous pollutants-adsorption, absorption, condensation, combustion. High Volume Air Sampler, Major air pollutants in India.

Unit-III: Noise Pollution Control

Basics of sound, Sound propagation, Measurement of noise and indices, Effect of meteorological parameters on noise propagation. Noise control and abatement measures, Noise exposure levels and standards, Impact of noise on human health.

Unit-IV: Solid and Hazardous Waste Management

Sources, Chemical composition and Classification of solid wastes, Solid waste management options: Sanitary Landfill, Recycling, Composting, Incineration, Energy recovery options from organic wastes. Hospital waste management; Fly ash management, Municipal Solid waste. Classification of Hazardous wastes, Physico-chemical, Hazardous waste control and treatment, Different methods of disposal and management of hazardous wastes.

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2. De, A.K. (1990). Environmental Chemistry, 2nd edition. Wiley Eastern Ltd. New Delhi.
3. Gilbert M. (2007). An Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi.
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5. Krishnan Kannan Ed. (1994). Fundamentals of Environmental Pollution, S. Chand & Company Ltd., Ramnagar, New Delhi.
6. Manahan S.E. (2000). Fundamentals of Environmental Chemistry, Boca Raton: CRC Press.
7. Metcalf & Eddy, (1995). Waste Water Engineering, Tata Mc-Graw Hill Publishers, 3rd Edition.
8. Rao, C.S. (2001). Environmental Pollution Control Engineering, New Age International Publication, New Delhi
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10. Trivedi, R. K. and Goel, P. K. (1995). An Introduction to Air Pollution, Techno Science Publications, Jaipur.

PRACTICAL-III
Environmental Management

A. To record the following parameters by weather monitoring station

(Two exercise to be given)

1. Atmospheric Pressure
2. Rain fall
3. Ambient Temperature
4. Wind Speed and Direction
5. Wind Chill and Temperature
6. Humidity and Dew point

B. Analysis of Heavy metals in given samples by Atomic Absorption Spectrophotometer.

1. Al
2. Cd
3. Cr
4. Cu
5. Fe
6. Hg
7. Ni
8. Pb

C. Waste Water Analysis

Experiment related to physicochemical properties of waste water

D. Soil Analysis

Sampling and Collection of soil sample, Determination of physical and chemical properties of soil: CEC, pH, moisture content, Soil water holding capacity, organic matter content, Nitrogen, Phosphate phosphorus, Calcium Carbonate content

E. Measurement of noise in industrial, residential and commercial zones within the university premises.

F. Field visit to river/lake and/or wastewater treatment plants.

SUMMER TRAINING

Every student, who has been enrolled in M.Sc. (Environmental Sciences) programme, shall have to attend summer training for the period of 04-06 weeks in different organizations related to environment and prepare a report and also deliver a presentation of summer training work as per the programme of the School of Earth, Environment and Space Studies. Presentation will be of 20-25 minutes duration during which the presentation will be followed by questions session by the audience comprising of faculty and students of the departments. Every student shall be required to submit the topic of his/her training to the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board.

WATER QUALITY MANAGEMENT

UNIT I: Introduction

Linking water quality & health; impurities in water, their significance and estimation techniques; water borne diseases; standards of potable water. Impact of water pollutants on environment; self-purification of waste in streams; zones of purification; eutrophication.

UNIT II: Water treatment

Aeration and types of aerators; purpose and mechanism of flocculation; coagulants used in water treatment; factors influencing coagulation; estimation of coagulant dose; types of flash mixers and flocculators; sedimentation; sedimentation tanks; filtration; types and design of filters; operational issues in filtration; chemical and non-chemical methods of disinfection; factors effecting efficiency of filtration; chick's law, tertiary treatment methods for removal of colour, salinity, hardness, fluorides, Arsenic, iron and manganese (using adsorption, RO; Electro-dialysis; ion-exchange; chemical; and distillation techniques).

UNIT III: Wastewater treatment

Physical treatment methods-screen chamber; grit separators; primary and secondary settling tanks. Biological treatment: Biology of sewage treatment; BOD growth curve and analysis; estimation of BOD rate constant; types of biological treatment processes; process description and design principals; removal of nitrogen and phosphorus. Sludge stabilization and dewatering systems; Low cost sewage treatment technologies-septic tanks; reed bed; oxidation ponds and lagoons.

UNIT IV: Water resources and quality management in India

Water availability; water stress index; status and trend of surface and groundwater; issues and policy interventions; pollution of rivers, lakes and ground water; GAP and National River Action Programme; role of national and international agencies in water health and sanitation.

REFERENCES

1. Benefield, L.D. and Randoll (1988). Biological Treatment Processes, Prentice Hall Inc., New York
2. Birde, G.S. and Birde, J.S. (2004). Water Supply and Sanitary Engineering, 7th ed., New Delhi, Dhanpat Rai Publishing.
3. Chatterjee, A.K. (2010). Water Supply, Waste Disposal and Environmental Engineering, 8th ed., New Delhi, Khanna Publisher.
4. Gurnham, C.F. (2004). Principle of Industrial Waste Treatment. John Wiley & Sons Inc, New York.
5. Hammer, M.J. and Hammer Jr, M.J. (2000). Water and Wastewater Technology. 3rd ed. Prentice Hall of India.
6. Kumar, R and Singh, R.N. (2006).Municipal Water and Wastewater Treatment. Capitol Pub. Co., New Delhi.
7. Metcalf & Eddy Inc. Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering Treatment and Reuse 4th ed. Tata McGraw-Hill Publishing Company Limited, New Delhi.

NATURAL DISASTER MANAGEMENT

Unit-I Introduction to Hazards

Hazard Classification – Natural hazards and Technological hazards, Effects of hazards, Vulnerability and susceptibility of hazards, Assessing hazards and risks, Hazard prediction and warning, A brief introduction to biological hazards- Biological warfare, Anthrax.

Unit–II Earthquakes and Landslides and Volcanoes

Earthquakes - Types and Distribution of earthquakes, Prediction and control of earthquakes, Tsunami, mass movements; types, affecting factors, prediction, prevention & control and effect of mass movements. Volcanoes-Distribution, types, eruption processes, Factors, Products.

Unit-III Water related hazards

Different kinds of floods, Factors leading to floods, Factors affecting floods, Floods and their associated hazards, Flood control measures, Prediction of floods. Factors leading to drought, drought consequences, strategies for drought mitigation, Desertification – Factors causing desertification, famine, El Nino and their effects.

Unit- IV Weather related Hazards

Effects of cyclones, genesis of a cyclone, Behavior of a cyclone and their forecast, Factors affecting cyclone hazards, Structure of a tropical cyclone, Size of tropical cyclones, Cyclone risk and mitigation strategies, Storm surge, Hurricane, cyclones and tornadoes, thunderstorms, lightning.

REFERENCES

1. Abbott, Patrick L. 2004. Natural disasters. 4th ed. Boston, McGraw-Hill Higher Education. Alexander, David. 2000. Confronting catastrophe: new perspectives on natural disasters. New York, Oxford University Press.
2. Allison, I. S. and Palmer, D. F. 1980. Geology, the science of a changing Earth. VII Edition. McGraw-Hill Inc.
3. Cesare Emiliani 1992. Planet Earth - Cosmology, geology and the evolution of life and the environment. Cambridge University press U.K.
4. Robinson, A.G. 2002. Earthshock: hurricanes, volcanoes, earthquakes, tornadoes, and other forces of nature. Rev. Ed. New York,
5. Thames & Hudson, 2002. Smith, Keith. 2002. Environmental hazards: assessing risk and reducing disaster. 3rd ed. London, New York, Routledge.

SEMESTER-IV

PROJECT DISSERTATION

Every student will be required to undertake a research project based on any of the areas of Environmental Sciences. The project report will be submitted in the form of dissertation duly certified by the Head of the Department. The project will be presented for evaluation at the end of semester by the internal and external examiners.

ENVIRONMENTAL BIOTECHNOLOGY

Unit I: Basic techniques in genetic engineering

Brief account of the structure and functions of DNA and RNA, Restriction Endonucleases, DNA Ligase, Southern blotting and hybridization, Recombinant DNA Technology, Gene identification and isolation; Genomic library, use of reverse-transcriptase, cDNA library, Environmental Genomics/Metagenomics.

Unit II: Cloning

Cloning Vectors, (Plasmid, Cosmic, Phasmid, Bacterial Artificial Chromosome, Yeast Artificial Chromosome), Introduction of genes into new hosts using plasmid and phage vector. Gene transfer methods in bacteria and plants, PCR, Chemical synthesis of DNA, DNA ligation, Genetically Modified Organism (GMOs) and their impact on the environment. Xenobiotics compound: persistence and biomagnification

Unit III: Fermentation technology

Basics of Bioreactor, Use of natural and genetically engineered micro-organisms from extreme environment like thermophiles, alkalophiles, acidophiles and halophiles in industrial applications. Production of enzymes like cellulase, proteases amylases and acetic acid production, Renewable and alternative sources of energy; production of bio-hydrogen, biodiesel, bioethanol etc.

Unit IV: Biofertilizers and biopesticides

Biofertilizers application and future prospects, Biopesticides, Properties of *Bacillus thuringiensis*, Symbiotic Nitrogen fixation, Biochemistry of nitrogenase, Genetics of nitrogen fixation, regulation of *nif* gene expression, Plant-Incorporated Protectants (PIPs). Bioremediation of agricultural and industrial waste containing heavy metals and dyes using microbes.

REFERENCES

1. Alexander, M. (1999). Biodegradation and Bioremediation, 2nd edition, Academic Press.
2. Brown T. A. (2012) Gene Cloning and DNA Analysis: An Introduction 6th Edition, Wiley.
3. Fulekar, M.H. (2010). Environmental Biotechnology - Theory and Application –: CRC Press. Science Publisher, USA.
4. Gupta, P.K. (2010). Elements of Biotechnology. 2nd edition. Rastogi Publications.
5. Kumar, R., Sharma, A.K., Ahluwalia, S.S. (2017). Advances in Environmental Biotechnology. Springer Nature, Singapore.
6. Manahan, S.E. (1997). Environmental Science and Technology. Boca Raton. FL: Lewis Publishers, New York.
7. Purohit, S.S. and Mathur, S.K. (1990). Fundamentals of Biotechnology, Agro Botanical Publishers, New Delhi India.
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9. Thakur, I.S. (2006). Environmental Biotechnology: Basic Concepts and Applications. I.K International Publishing House Pvt Ltd.
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FOREST AND WILDLIFE ECOLOGY

Unit-I: Forest

Types and composition of forests of India, Structural organization of forest ecosystems, Primary production in different ecosystems and methods of measurement of primary production, Social forestry: Objectives, scope and necessity, Agroforestry, Extension forestry, *Eucalyptus* dilemma, people's participation, Roles on NGOs.

Unit-II: Silvicultural practices

Silvicultural principles and practices, Impact of deforestation and shifting cultivation on forest ecosystems. Forest management: Objectives and principles, Techniques, Sustainable yield relation, Biodiversity and Forest.

Unit-III: Values of wild life

Concept of wildlife, Role of wildlife in nature, Factors influencing wildlife management such as habitats, population, behavior, food-habits, health, etc., Common flora and fauna of India. Tools for data collection and analysis. Preservation of Breeding Stock; Artificial stocking; Habitat Improvement, Game Farming.

Unit-IV: Wildlife protection

Indian wildlife IUCN Categories, National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Ecological basis of wild life conservation and management, Special projects for endangered species (Project tiger, Gir lion Sanctuary Project, Crocodile breeding project, sea turtle conservation), International trade of wildlife, Animal cruelty: causes and prevention, Wild life and range management, Management of Fire, Role of NGO's in wildlife and forest life and range management, Role of local communities in wildlife management.

REFERENCES

1. Gibbs, J.P., Malcolm, L.H. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management, 2nd Edition, Wiley-Blackwell.
2. Jain, A. K. (1989). Forests in India, Vorha Publication, Allahabad.
3. Oliver, S. O. and Daniel, D. C. (1990). Natural Resource Conservation : Management for a Sustainable future. Prentice Hall International, New Jersey.
4. Raven, P. H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th Edition. John Wiley & Sons., USA.
5. Sharma, P.D. (2000). Ecology & Environment, 7th Edition, Rastogi Publications, Meerut.
6. Sondhi, S. (2012). Protected Animals of India. The Energy and Resources Institute, TERI.
7. Subramanian (2000). A Text book in Environmental Sciences: Narosa Publishing House, New Delhi.