

**REVISED COURSE STRUCTURE
(CBCS SYSTEM)**

**M.Sc.
(Environmental Science)**

2016-17



**DEPARTMENT OF ENVIRONMENTAL SCIENCES
CENTRAL UNIVERSITY OF HARYANA, MAHENDERGARH**

M.SC. ENVIRONMENTAL SCIENCE (FOUR SEMESTERS)

Revised Programme Scheme

SEMESTER I

S.No.	Course code	Course title	L	T	P	Credit
1.	SEES EVS 1 1 01 C 4004	Fundamentals of Ecology	4	0	0	4
2.	SEES EVS 1 1 02 C 4004	Natural Resource Conservation & Management	4	0	0	4
3.	SEES EVS 1 1 03 C 4004	Biodiversity Conservation	4	0	0	4
4.	SEES EVS 1 1 04 C 00105	Practical I (Ecology & Biodiversity)	0	0	10	5
5.	GE	<i>To be taken from other department</i>	4	0	0	4
6.		<i>Any one of the following two courses</i>				
	SEES EVS 1 1 01 GE 4004	Foundation course in Ecology and Environment	4	0	0	4
	SEES EVS 1 1 02 GE 4004	Environmental Health and Toxicology	4	0	0	4

SEMESTER II

1.	SEES EVS 1 2 05 C 4004	Environmental Chemistry	4	0	0	4
2.	SEES EVS 1 2 06 C 4004	Environmental Policies and Laws	4	0	0	4
3.	SEES EVS 1 2 07 C 4004	Physical Environment	4	0	0	4
4.	SEES EVS 1 2 08 C 00105	Practical II (Environmental Monitoring & Analysis)	0	0	10	5
5.	SEES EVS 1 2 03 GE 4004	Global Environmental Issues (compulsory)	0	2	0	2
6.		<i>Any one of the following three courses</i>	4	0	0	4
	SEES EVS 1 2 01 DCEC 4004	Environmental Microbiology				
	SEES EVS 1 2 02 DCEC 4004	Forest and Wildlife Ecology				

SEMESTER III

1.	SEES EVS 1 3 10 C 4004	Environmental Management and Impact Assessment	4	0	0	4
2.	SEES EVS 1 3 11 C 4004	Environmental Pollution and Control	4	0	0	4
3.	SEES EVS 1 3 12 C 00105	Practical III (Environmental Management)	0	0	10	5
4.	SEES EVS 1 3 03 DCEC 4004	Seminar Paper (compulsory)	0	2	0	2
5.	SEES EVS 1 2 09 C 0002	Summer Training (Report and Presentation)	0	0	0	3
6.	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 1 3 04 DCEC 4004	Water Quality Management				
	SEES EVS 1 3 05 DCEC 4004	Natural Disaster Management				

SEMESTER IV

S.No.	Course code	Course title	L	T	D	Credit
1.	SEES EVS 1 4 01 SEEC 0066*	Dissertation (Research work, Progress Seminar, Report and Viva voce)	0	0	20	20
2.	SEES EVS 1 4 13 C 4004	Instrumental techniques	4	0	0	4
3.	SEES EVS 1 4 06 DCEC 4004	Environmental Biotechnology	4	0	0	4

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

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: Abiotic 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).

Unit III: Biotic 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 IV: 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 V: 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. Raven, P. H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th Edition. John Wiley & Sons., USA.
7. Sharma, P.D. (2000). Ecology & Environment, 7th Edition, Rastogi Publications, Meerut.
8. Singh, J.S., Singh, S.P. and Gupta, S.R. *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi, India. 2006.
9. Odum, E.P. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning Publication.

NATURAL RESOURCE CONSERVATION AND MANAGEMENT

Unit I: Introduction

Natural resources: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Concern on Productivity issues.

Unit II: Mineral resources

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 III: 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, floods, drought, conflicts over water, dams-benefits and problems. Integrated water resources management. Rain Water Harvesting. Wetland management. Coastal zone management-Concept, scope, issues and strategies.

Unit IV: Energy resources

Growing energy needs, Renewable and non-renewable energy sources, Prospects of alternate energy sources. Case studies. Solar radiation and its spectral characteristics, Principal of generation of solar energy (Photovoltaic and thermal conservation), hydroelectric power, tidal, ocean thermal energy conversion, wind, geothermal energy,. Nuclear energy: fusion and fission, Magneto hydrodynamic power, bio-energy, anaerobic digestion. Energy use pattern in different parts of world.

Unit V: Forest resources

Forest vegetation: status, distribution and management, Major forest types and their characteristics, Use and over-exploitation, Deforestation, Case studies. 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.

BIODIVERSITY CONSERVATION

Unit I: Introduction

Concepts and components of biodiversity, Microbial diversity, Plant diversity, Agrobiodiversity, Soil biodiversity, Biodiversity as an important resource, human population growth and its implications on biodiversity, biodiversity indices, value of biodiversity, biodiversity losses.

Unit II: Strategies for biodiversity conservation:

In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, 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. Convention on biodiversity and Biodiversity Act, 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, Wildlife Protection Act, 1972.

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. Miller Jr., G.T. (1997). *Environmental Science: Working With the Earth*. Wadsworth Publishing Company, Belmont, California
7. Odum, E.P., Odum, H.T. & Andrews, J. (1971). *Fundamentals of Ecology*. Philadelphia: Saunders.
8. Wager, K.D. (1998). "Environmental Management", W.B. Saunders CO., Philadelphia, USA.

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 Ecology:

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.

Unit V: Community Dynamics:

Definition of ecological succession, Characteristics of succession, General process, Significance of ecological succession, types of succession: xerosere and hydrosere, Concept of climax, IVI.

REFERENCES

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

SEMESTER-I

PRACTICAL – I

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

SEMESTER- II

VIRONMENTAL CHEMISTRY

Unit I: Fundamentals of Environmental Chemistry

Stoichiometry, Gibb's energy, chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water. the carbonate system, radionuclides.

Unit II: Atmospheric chemistry

Chemical composition of Air: Chemical speciation. 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: Chemistry of water and aquatic 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 IV: Soil Chemistry

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, Physico-chemical and bacteriological sampling and analysis of soil quality, Soil pollution control, Industrial waste effluents and heavy metals, their interactions with soil components.

UNIT V: 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 DDT.

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.

BIOSTATISTICS, INSTRUMENTATION AND COMPUTER APPLICATION

Unit I: Fundamental of biostatistics

Measures of central tendencies: mean, median mode, Measure of dispersion: Range, standard deviation, variance, mean deviation, coefficient of variation, Probability distributions: binomial, Poisson and normal distribution, Statistical significance (Hypothesis testing, types of error, level of significance). Correlation analysis, Regression analysis, simple linear regression, Student's t distribution, Analysis of variance, χ^2 test.

Unit II: Microscopy

Microscopy: Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, confocal microscopy. Cytophotometry and flow cytometry, fixation and staining.

Unit III: Principles and applications of analytical methods

Titrimetry, Gravimetry, Colourimetry, Spectrophotometry (UV-Visible spectrophotometry, atomic absorption spectrophotometry, flame photometry), Chromatographic techniques (Paper chromatography, thin layer chromatography, Gas liquid chromatography, High pressure liquid chromatography, Ion exchange chromatography, Column chromatography, Gel filtration), Electrophoresis, X-ray diffraction.

Unit IV: Electrochemistry and dosimetry

Bio-sensors, pH meter, biochips, Radioactive techniques, Scintillation counter, refractometer, Potentiometry, Coulometry, Nephelometry and Turbidimetry

Unit V: Computer applications

History, development and types of computers; Computer hardware, software and peripheral devices, Basic working on DOS and Windows. IT tools, MS Windows and MS Office (MS word, MS Power point and MS Excel). Application of Computer in Environmental Modeling.

REFERENCES:

1. APHA (1998). Standards Methods for the examination of water and Waste water, 20th Edn, Washington DC.
2. Bailey, R.A. (1978). Chemistry of the Environment, Academic Press, New York 3.
3. Baird, C. (1999). Environmental Chemistry, W H Freeman & Co, New York
4. Khopkar, S.M. (1985). Basic Concepts of Analytical Chemistry. Wiley Eastern Ltd., New Delhi.
5. Manahan. S.E. (2001). Environmental Chemistry, Williard Grant Press, Boston, USA.
6. Manly. (2001). Statistics for environmental science and management, Chapman Hall / CRC.
7. Marr, L.L. & Cresser, M.S. (1983). Environmental Chemical Analysis, International Text Book Company (pub), New York.
8. Skoog, D.A. and Leary, J.J. (1992). Principles of Instrumental Analysis, 4th edn, Saunder's College Publishing, Fortworth.
9. Willard, H.H., Merritt, L.L, Deen, J.A. and Settle, F.A. (1986). Instrumental Methods of Analysis (Indian Reprnt), CBS Publishers and Distributers, New Dehi.
10. Zar, J.H. (1998). Biostatistical Analysis. Prentice Hall, N.J.

ENVIRONMENTAL METEOROLOGY

Unit I : Introduction to Meteorology

Earth as a planet- Motion of the earth, Seasons, Laws of black body radiation, Solar constant, Albedo. Air masses-source, modification and classification, Heat balance of the earth atmosphere system. General circulation and wind systems.

Unit II: Atmospheric processes

Atmospheric structure and composition, Wind speed, direction and their vertical profiles, spatial scales (micro, meso, synoptic and global scales), wind roses. , atmospheric stability: characteristics and classes, Plume behavior, mixing height-boundary layer definition, temperature inversions, factors affecting on dispersion of air pollutants, micrometeorological instruments. Clouds-their formation and classification. Artificial modification of Clouds.

UNIT III: Climatology

Elements of weather and climate, Climatic controls, Elementary ideas about weather systems; Climatic variability and climate change; Climatic classifications; Climates of Indian region.

Unit IV: Introduction to Remote Sensing

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

Unit V: Interaction of electromagnetic radiation (EMR) and remote sensing:

With earth surface: reflection, transmission, spectral signatures. With the atmosphere: scattering, absorption, refraction, Types of remote sensing, Characteristics of remote sensing, Platforms and orbits: ground based, air borne, space borne, Orbits: geostationary satellites and polar-orbiting satellites, Geographical Information System(GIS): Basic principles, Raster and vector data, Map projection. Global Positioning System (GPS): Basic principles, Applications to environmental studies. Ecological Niche Modeling: Application in environmental studies

REFERENCES:

1. Alley, E. R. (1998). Air Pollution Control Hand-book, Mc-Graw Hill, New Delhi.
2. Byers, H. R., (1974). General Meteorology, McGraw-Hill, New York.
3. Lutgen, F.K. and Tarbuck, E.J. (2001). The Atmosphere: An Introduction to Meteorology, 10th edition, Prentice Hall.
4. Master, Gillbert M. (2000). Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi.
5. Miller, A. and Thompson, J.C. (1975). Elements of Meteorology. 2nd Edition. Columbus.
6. Peter, H., Raven, P.H. and Berg, L.R. (2005). Environment, 5th Edition. John Wiley & Sons Inc., New York.
7. Trivedi, R.K. and Goel, P.K. (1995). An Introduction to Air Pollution, Techno Science Publications, Jaipur
8. Wallace, J.M. and Hobbs P.V. (1977). Atmospheric Science -An introductory survey: Academic Press.

ENVIRONMENTAL MICROBIOLOGY

Unit-I: General Microbiology

Classification, characteristics, occurrence and distribution of microorganisms. Diversity of microorganisms Microbial cultivation and growth. Biological interactions of microbes with plants and animals.

Unit-II: Aquatic Microbiology

Planktonic, Benthic, 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-III: 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-IV: Food microbiology

Foodborne 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-V: Applied Environmental Microbiology:

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

REFERENCES:

1. Gaudy, A.F. & Guady, 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. Peleazar, M.J. Jr., Chan, E.C.S and Kreig, N.R (1993). Microbiology, Tata Mc Graw 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.

SEMESTER-II

PRACTICAL – II

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

1. NO_x
2. SO_x
3. CO₂
4. RSPM
5. SPM

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

GLOBAL ENVIRONMENTAL ISSUES

UNIT-I: Introduction

Stockholm conference, Creation of UNEP and its role, World earth summits; Agenda 21, UNFCCC, Convention on Biodiversity, Convention on Climate Change, CoPs, Convention on Conservation of Antarctic Marine Living Resource. Vienna Convention (1985), Montreal Protocol (1987), CDM.

UNIT-II: Environmental movements:

Global and national movements of Significance impact: RAMSAR Convention- 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-III: Climate change:

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

UNIT-IV: Nuclear issues:

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

UNIT-V: 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.

ENVIRONMENTAL POLICIES AND LAWS

Unit I: Introduction to Environmental Laws

Environment protection- Issues and Problems, International and national efforts for environment protection. National Environmental Policy of India, Constitutional provisions of Constitution of India regarding Environment (Article 48, 51A and 253) and Panchayat Raj System, Doctrine Principles of State Policy, Stockholm conference; Rio Conference, Rio+5 and the Rio+10, etc. General principles in Environmental law: Precautionary principle; Polluter pays principle; Sustainable development.

Unit II: Water, Air, and Marine Laws

National Water Policy; The Water (Preventions and Control of Pollution) Act, 1974; The Water Rules, 1975; Water Cess Act, 1977; Environmental Protection Act, 1986; Pollution Control Boards, Marine laws of India; Coastal zone regulations; Legal framework on Air pollution, Air (Prevention and Control of Pollution) Act, 1981, The Air Rules, 1982.

Unit III: Forest, Wildlife and Biodiversity Related Laws

Evolution and Jurisprudence of Forest and Wildlife laws; Forest Conservation Act, 1980; Indian Forest Act, 1927; Forest Rights Act, 2006. Wildlife (Protection) Act, 1972 and their amendments; Statutory framework on Biodiversity: Biological Diversity Act, 2002; Strategies for conservation—Project Tiger, Elephant, Rhino, Snow leopard.

Unit IV: Hazardous Substances and Activities

Regulation for management of Hazardous Waste (management and Handling) Rules, 1989; Basal Convention, Manufacture, Use, Import, Export & Storage of Hazardous Microorganisms & Genetically Engineered cells Rules, 1989; Public Liability Insurance Act, 1991; National Environmental Tribunal Act, 1995; Biomedical Waste Rules, 1998. Noise Pollution Rules, 2000; Motor Vehicle Act, 1988.

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, 2 ed., 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.

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.

SEMESTER-III

ENVIRONMENTAL BIOTECHNOLOGY

Unit 1: Basic Techniques in genetic engineering: Basic Concept, Brief account of the structure and functions of DNA and RNA, Recombinant DNA Technology, Tools in rDNA Technology. Gene identification and isolation; Environmental genomics/metagenomics-a general account,

Unit 2: Introduction of cloned genes into new hosts using plasmid and phage vector systems, DNA ligation, and Transformation, Gene transfer methods in bacteria and plants. Genetically Modified Organism (GMOs) and their impact on the environment. Biodegradation of Petroleum constituents. Xenobiotics: Persistence and biomagnification of xenobiotic molecules.

Unit 3: Applications of natural and genetically engineered micro-organisms from extreme environment like thermophiles, alkalophiles, acidophiles and halophiles in waste treatment of different industries and methane production from agro industrial wastes. Production of enzymes like cellulase, proteases amylases; alcohol and acetic acid production.

Unit 4: Biofertilizer and Biopesticides: Nitrogen fixing organisms, Biochemistry of nitrogenase, genetics of nitrogen fixation, regulation of *nif* gene expression, symbiotic nitrogen fixation, application and future prospects of using biofertilizers in agriculture. Introduction to biopesticides, Biological Insecticides, Properties of *Bacillus thuringiensis*, Microbial Pesticides, Biochemical Pesticides Plant-Incorporated Protectants (PIPs), Applications of Biopesticides.

Unit 5: Solid Waste Management using vermicomposting: Resource recovery or reclamation, organic waste processing, biocomposting, aerobic and anaerobic composting, vermiculture and vermicomposting, vermiculture and protein production, vermiwash, benefits, economics and marketing.

REFERENCES

1. Alexander, M. (1999). Biodegradation and Bioremediation, 2nd edition , Academic Press.
2. Fulekar, M.H. (2010). Environmental Biotechnology - Theory and Application –: CRC Press. Science Publisher, USA.
3. Manahan, S.E. (1997). Environmental Science and Technology. Boca Raton. FL: Lewis Publishers, New York.
4. Purohit, S.S.and Mathur, S.K. (1990).Fundamentals of Biotechnology, Agro Botanical Publishers, New Delhi India.
5. Rittman, B. and McCarty, P. L. (2000). Environmental Biotechnology: Principles and Applications. 2nd Edition. Tata McGraw-Hill, USA.
6. Thakur, I.S. (2006). Environmental Biotechnology: Basic Concepts and Applications. I.K International Publishing House Pvt Ltd.
7. **Wainwright, M.** (1999). An Introduction to Environmental Biotechnology. Springer US Publisher.
8. **Gupta, P.K. (2010). Elements of biotechnology. 2nd edition. Rastogi publications.**

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. Waste water 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 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 (Management and Handling) Rules, 2000

Unit-V: Hazardous Waste Management

Classification of Hazardous wastes, Physico-chemical, properties of hazardous waste needed in management, Hazardous waste control and treatment, Different methods of disposal and management of hazardous wastes, Hazardous Waste (Management and Handling) Rules, 1989 and Amendments, 2000.

REFERENCES

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

ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT

Unit I: Introduction to EIA

Origin and development of EIA, concept and aims, Relationship of EIA to sustainable development, Methods and Processes, Strategic Environmental Assessment (SEA) – principles & potential, EIA guidelines 1994, notification of the Government of India, 2006; Environmental Impact Assessment (EIA) as a tool in environmental management, need for EIA.

Unit II: EIA Methodology

Types of Projects requiring Environmental Clearance, Project screening, Scoping, Base-line study, Impact identification, Prediction and assessment of impacts, Cost Benefit Analysis. Mitigation measures. Public participation, review and decision making, Checklist for EIA, Generic structure of EIA Document, Procedure of Public hearing, 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

Unit V: Introduction to Environmental Planning

Baseline information and predictions (Land, water, atmosphere, energy etc.), Restoration and rehabilitation technologies.

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.

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; disposal standards of MINAS. .

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- Forest fires, Biological warfare, Anthrax.

Unit–II Earthquakes and Landslides

Earthquakes - Types and Distribution of earthquakes, Prediction and control of earthquakes, Tsunami - Hazards associated with tsunamis, Tsunami prediction and warning systems. Factors causing landslides, Different kinds of mass movements, Factors that affect mass movement, prediction of mass movement, Landslides and their effects, Precursor events before the occurrence of landslides, Prevention and mitigation of mass movements.

Unit-III Volcanoes

Volcanoes-Distribution of volcanoes, eruption processes, Kinds of volcanic eruptions, Factors controlling volcanic eruptions, Products of volcanic eruptions, Hazards associated with volcanoes.

Unit-IV Floods and Drought

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- V Weather related Hazards

Effects of cyclones, genesis of a cyclone, Behaviour 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, lightening.

SEMESTER-III

PRACTICAL-III

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.

SEMINAR (Compulsory)

Maximum marks:

50

Every student, who has been enrolled in M.Sc. (Environmental Science) course, 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 45-minute 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 write 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 from where the material for presentation has been collected.

SEMESTER-IV

INSTRUMENTATION TECHNIQUES

Unit I: Sampling and Preservation

Types of Sampling and their methods, Methods of air, water, soil and plant sampling, Physical and chemical analysis of air, water, soil and plant samples.

Unit II: Microscopy

Microscopy: Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, confocal microscopy. Cytophotometry and flow cytometry, fixation and staining.

Unit III: Principles and applications of analytical methods

Titrimetry, Gravimetry, Colourimetry, Spectrophotometry (UV-Visible spectrophotometry, atomic absorption spectrophotometry, flame photometry), Electrophoresis, X-ray diffraction.

Unit IV: Chromatography

Chromatographic techniques (Paper chromatography, thin layer chromatography, Gas liquid chromatography, High pressure liquid chromatography, Ion exchange chromatography, Column chromatography, Gel filtration)

Unit V: Electrochemistry and Dosimetry

Bio-sensors, pH meter, biochips, Radioactive techniques, Scintillation counter, refractometer, Potentiometry, Coulometry, Nephelometry and Turbidimetry

REFERENCES:

1. APHA (1998). Standards Methods for the examination of water and Waste water, 20th Edn, Washington DC.
2. Bailey, R.A. (1978). Chemistry of the Environment, Academic Press, New York 3.
3. Baird, C. (1999). Environmental Chemistry, W H Freeman & Co, New York
4. Khopkar, S.M. (1985). Basic Concepts of Analytical Chemistry. Wiley Eastern Ltd., New Delhi.
5. Manahan. S.E. (2001). Environmental Chemistry, Williard Grant Press, Boston, USA.
6. Manly. (2001). Statistics for environmental science and management, Chapman Hall / CRC.
7. Marr, L.L. & Cresser, M.S. (1983). Environmental Chemical Analysis, International Text Book Company (pub), New York.
8. Skoog, D.A. and Leary, J.J. (1992). Principles of Instrumental Analysis, 4th edn, Saunder's College Publishing, Fortworth.
9. Willard, H.H., Merritt, L.L, Deen, J.A. and Settle, F.A. (1986). Instrumental Methods of Analysis (Indian Reprnt), CBS Publishers and Distributers, New Dehi.
10. Zar, J.H. (1998). Biostatistical Analysis. Prentice Hall, N.J.

ENVIRONMENTAL BIOTECHNOLOGY

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6. Thakur, I.S. (2006). Environmental Biotechnology: Basic Concepts and Applications. I.K International Publishing House Pvt Ltd.
7. Wainwright, M. (1999). An Introduction to Environmental Biotechnology. Springer US Publisher.
8. Gupta, P.K. (2010). Elements of biotechnology. 2nd edition. Rastogi publications.

PROJECT DISSERTATION

Every student will be required to undertake a research project based on any of the areas of Environmental Science. The project report will be submitted in the form of dissertation duly certified by the Dean of School of Earth, Environmental and Space Studies. The project will be presented for evaluation at the end of semester by