

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester I

Course Title: Basics in Environmental Sciences

Paper Code: EVS 501

L	T	P	Credits	Marks
4	1	0	4	100

Unit 1: Introduction

Connecting to the issue of environment; ecology of environment; components of environment and their interactions; human-environment interface, relationship dynamics and resource conflicts. Environmental Science – definition, principles and scope, multidisciplinary approach – chemistry, physics, biology, mathematics. Environmental ethics and role of education in solving environmental issues.

(12 Lectures)

Unit 2: Structure of the Environment

Atmosphere, Hydrosphere, Lithosphere and Biosphere - Definition, Structure and composition; Structure of Environment

(10 Lectures)

Unit 3: Global Environmental Issues

Green House Effect - Green house gases its sources, impacts, consequences and remedial measures; global warming. Global Climate change, World and Indian scenario, Acid Rain; Brown Haze, Photochemical smog, nuclear winter; Ozone depletion.

(16 Lectures)

Unit 4: Environmental disasters

Bhopal gas tragedy, Fukushima and Chernobyl disaster, love canal tragedy, Minimata bay, GM crops. Creation of UNEP and its role, World earth summits; Agenda 21, UNFCCC, Convention on Biodiversity and Convention on Climate Change, CoPs, Climate Change and Global Warming; IPPC and its reports

(18 Lectures)

Suggested Readings:

1. Ahluwalia, V.K. Environmental studies : Basic concepts, TERI, 2013.
2. Beheim, Einar (Ed.) Integrated watershed management : perspectives and problems, Springer, 2010.
3. Bhatt, S. Environment protection and sustainable development, APH Publishing Corporation, 2004.
4. Burchett, Stephen. Introduction to wildlife conservation in farming, Wiley- Blackwell, 2010.
5. Das, S.K. Watershed development and livelihoods: People's action in India, Routledge India, 2007.
6. Fa, John E. Zoo Conservation Biology (Ecology, Biodiversity and Conservation), Durrell Wildlife Conservation Trust, 2011.
7. Fatik B. Mandal. and Nepal C. Nandi. Biodiversity: concepts, conservation and biofuture, Asian Books, 2013.
8. Heathcote, Isobel W. Integrated watershed management : principles and practice (2nd Ed), John Wiley & Sons, 2009.
9. Prasad, Dr. Govind Conservation of natural Resources, Discovery Publishing, New Delhi, 2013
10. Srivastav, Sweta. Basics of Environmental Science, Anmol Publications Pvt Ltd, 2008

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Ecological Principles

Paper Code: EVS 502

L	T	P	Credits	Marks
4	1	0	4	100

Unit 1: Introduction to Ecology

Definition, principle and scope of ecology, major branches, history, origin and evolution of life, geological scale. Habitat and niche, adaptation, ecosystem, biotic and abiotic factors, food chain, food web, trophic level. Biogeography – classification and zones

(14 Lectures)

Unit 2: Ecosystem Dynamics

Concept and components of ecosystem, ecological pyramids, energy flows in different ecosystems, energy models, ecosystem productivity. Types and characteristics of ecosystem- terrestrial (forest, desert, grassland) and aquatic (pond, marine), wetlands, estuaries, natural and man-made ecosystems, forest types in India. Biogeochemical cycles – cycling of water, nutrients.

(14 Lectures)

Unit 3: Population and Community Ecology

Population characteristics, population interaction; prey-predator relationships, competition, exploitation, mutualism, Theories of population growth, population dynamics, regulation. Concept of metapopulation, demes and dispersal, niche- concept and types, keystone species, Flagship species and umbrella species; dominant species, ecotone, edge effect, ecotypes, plant indicators; ecological succession – types and mechanism, Theory of Island Biogeography, abundance and distribution of species; factors leading to commonness, rarity and vulnerability of extinction of species. Green data book.

(14 Lectures)

Unit 4: Biodiversity

Definition, levels of biodiversity, measurements of biodiversity, values of biodiversity. Hot spots of biodiversity, Biodiversity hotspots of India, threats to biodiversity. Biological Invasion: concept; pathways, process, mechanism, impacts, examples of major invasive species in India. Speciation- types and process, Causes of species extinction. Endangered and threatened species, IUCN Categories of threatened species, Red data book, List of threatened flora and fauna in India. Biodiversity conservation; Ecotourism, responsible tourism, role of inter-governmental, government and non-government organizations, legal initiatives for wildlife and forest conservation, wetland conservation, ecosystem management at national and international level; Convention on Biodiversity.

(14 Lectures)

Suggested Readings:

1. Agren, Goran I. Terrestrial ecosystem ecology : Principles and applications, Swedish University of Agricultural Sciences, 2012
2. Day, John W., Kemp W. M., Alejandro Yáñez-Arancibia and Byron C. Crump. Estuarine Ecology (2nd Ed), Wiley-Blackwell Publishers, 2012.
3. Fa, John E. Zoo Conservation Biology (Ecology, Biodiversity and Conservation), Durrell Wildlife Conservation Trust, 2011.
4. Fatik B. Mandal. And Nepal C. Nandi. Biodiversity : concepts, conservation and biofuture, Asian Books, 2013.
5. Jorgensen, Sven Erik. Encyclopedia of Ecology. Vol 1-5. Elsevier Publishers. Netherlands. 2008.
6. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C. Biodiversity and Environmental Management. APH, New Delhi, 2009

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

7. Joshi, P.C. and Joshi, N. Biodiversity and conservation. APH Publishing Co-operation, New Delhi.2009.
8. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R.. *Invasive Plants and Forest Ecosystems*. CRC Press / Taylor and Francis. 2009.
9. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. and Brown, J.H. Biogeography (4th Ed). Sinauer Associates, 2010.
10. Odum, E.P., Barrick, M. and Barret, G.W. *Fundamentals of Ecology* (5th Ed). Thomson Brooks/Cole Publisher, California, 2005.
11. Pandey, B.N. and Jyoti, M.K. Ecology and Environment. APH Publishing Co-operation, New Delhi, 2012.
12. Professional. Forest & wildlife laws Professional books publishers,2014.
13. Rana, S.V.S. Essentials of ecology and environmental science (5th Ed), PHI Learning Pvt. Ltd, 2013.
14. Sharma, P.D. Ecology and Environment. Rastogi Publications. New Delhi, 2009.
15. Smith , T.M and Smith, R.L. Elements of ecology (8th Ed), Benjamin Cummings, 2012.
16. Vandermeer, John H., Riddle,B.R. and Brown, J.H. Population ecology : First principle (2nd Ed). Princeton University Press, 2013
17. William J. Mitsch, James G. Gosselink, Li Zhang, Christopher J. Anderson Wetland ecosystems, Wiley-Interscience, 1989.

Course Title: Natural Resource Management and Conservation

Paper Code: EVS 503

L	T	P	C	Marks
4	1	0	4	100

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Unit 1: Forest resources

Natural resources: Definition; Resource and Reserve; Classification of natural resources; natural resource degradation and conservation; Environmental impacts of resource depletion

Forest Resources: Forest cover of India and world; forest types, functions of forest – production and protection; Conservation of forests; forestry programmes – social forestry, farm forestry, urban forestry, community forestry; deforestation; Exploitation of forest resources; Afforestation; Dessertification; Forest policy.

(14 Lectures)

Unit 2: Water and Marine resources

Water Resources: Surface, ground water, marine and brackish water resources - assessment and utilization; Rivers and Lakes in India; hydrological cycle; Ground water depletion; Water logging and salinity; Water Conservation and management techniques; Rain water harvesting; Watershed management; Eutrophication; Restoration of Lakes; River cleaning, River action plans - Ganga and Yamuna action plan, Interlinking of rivers; conflicts over water.

Marine resources: Introduction to marine resources, Factors controlling abiotic resources and their distribution - polymetallic manganese nodules, phosphorites, hydrocarbons, beach placers evaporates, rare metals, corals, pearls and shells. Prospecting and mining of the ocean floor, Management of marine resources, demand, supply and production of marine resources. Policies and acts relating to ocean and land.

(14 Lectures)

Unit 3: Land and mineral resources

Land resources: Land degradation due to mining, exploration, industrialization, irrigation and natural disasters; Soil Erosion, Loss of soil fertility, Restoration of soil Fertility, Soil Conservation Methods; restoration of degraded land; Wasteland reclamation, Organic farming, green manuring, Wetland – definition, classification, functions, ecological importance and conservation.

Mineral resources: Mineral resources of India – Use and exploitation; mineral exploration, extraction; environmental impacts of extraction; Restoration of mining lands.

(14 Lectures)

Unit 4: Bioresources

Evolution strategies, adaptation, Vegetation, flora and fauna of India; Aquatic bioresource; Definition, Types and significance of biodiversity, values and threats, biodiversity conservation strategies; Bioprospecting. Biopiracy. REDD+; Conventions and protocols. Wild life resources and conservation measures

Human resources – population explosion, urbanization, industrialization, slums, poverty

(14 Lectures)

Suggested Readings:

1. Anderson, David A. (2013) Environmental economics and natural resource management, Taylor and Francis 4th Edition
2. Gurdev Singh (2007) Land resource management, Oxford publishers
3. Kathy Wilson Peacock. (2010) Natural resources and sustainable developments. Viva books.
4. Lynch, Daniel R. (2009) Sustainable natural resource management for scientists and engineers. Cambridge University Press
5. Jaidev, Somesh. (2010) Natural resources in 21st. century. Oxford Publishers
6. Mishra, S.P (2010) Essential Environmental Studies, Ane Books.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

7. Kudrow, Nikolas J (Ed) (2009) Conservation of natural resources, Nora Science, New York.
8. Kumar, H.D. (2001) Forest resources: Conservation and management. Affiliated East-West Press
9. Grigg, Neil S. (2009) Water resources management : Principles, regulations, and cases, McGraw Hill Professional
10. Beckman, Daniel W. (2013) Marine environmental biology and conservation. Jones and Barlett learning
11. Primak R.B (2014) Essentials of Conservation biology, Sinauer Publishers, 6th edition

Course Title: Environmental Chemistry

Paper Code: EVS 504

L	T	P	C	Marks
4	1	0	4	100

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Unit 1 : Chemistry for Environment

Fundamental of environmental chemistry: Mole Concept, Solution chemistry, solubility product, Solubility of gases, Phase change thermodynamics, Electrochemistry and redox reactions, Gibbs' free energy; Chemical potential; Activity and fugacity, Chemical kinetics and chemical equilibrium.

Sources of natural and artificial radiations: Dosimetry, types of dosimeters, radioactive substances, applications and handling of isotopes and other radionuclides in environment.

(14 Lectures)

Unit 2: Air & Water Chemistry

Atmospheric chemistry: Composition of air, Chemical speciation, particles, ion and radicals, Formation of particulate matter, Photochemical reactions in the atmosphere, Chemistry of air pollutants, Photochemical smog, Acid rain, Ozone chemistry, Greenhouse gases and Global warming, Thermal Pollution.

Aquatic chemistry: Structure and properties of water, Water quality parameters, Physicochemical concepts of color, odour, turbidity, pH, conductivity, DO, COD, BOD, alkalinity, carbonates, redox potential, Pourbiach diagram.

(14 Lectures)

Unit 3: Soil and Geochemistry

Chemistry of Soil: Physio-chemical composition of soil, humus, Inorganic and organic components of soil, nutrients (NPK) in soil, significance of C:N ratio, Cation exchange capacity (CEC), Reactions in soil solution, Ion exchange (Physiosorption), Ligand exchange (Chemisorption), Complexations, Chelation; Precipitation / dissolution.

Environmental geochemistry: Concept of major, trace and REE. Classification of trace elements, Mobility of trace elements, Geochemical cycles. Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, carbon Monoxide, O₃, PAN, MIC and other carcinogens

(14 Lectures)

Unit 4: Green Chemistry

Green chemistry and green technology: New trends in green chemistry, Basic principles, Atom economy concept and its environmental importance, Green reagents, Green solvents, Green technology: Microwave heating & pollution, Ultrasound technique, Industrial Ecology.

(14 Lectures)

Suggested readings:

1. Baird, C. and Cann, M. (2008). *Environmental chemistry*, 2008, W.H. Freeman, USA
2. Manahan, S. E. (2008). *Fundamentals of environmental chemistry*, 3rd Edition, CRC Press, USA
3. Connell D. W. (2005). *Basic concepts of environmental chemistry* 2nd Edition, Crc Press, USA
4. Girard J. (2010). *Principles of environmental chemistry* 2nd Edition, James & Barlett Publishers, USA.
5. Harrison R M (2007). *Principles of environmental chemistry*, RSC Publishing, UK
6. Hillel, D. (2007). *Soil in the environment: crucible of terrestrial life*, 1st edition, Academic Press, USA.
7. Lancaster M.(2002). *Green chemistry: an introductory text*, RSC Publishing, UK.
8. Manahan, S. E. (2006). *Green chemistry and the ten commandments of sustainability*, 2nd Edition, Chem Char Inc. Publishers, USA
9. Manahan, S. E. (2010). *Water chemistry: green science and technology of nature's most renewable resource*, CRC Press, USA

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

10. Clark J. H. and Macquarrie, D. J. (2002). *Handbook of green chemistry and technology*, Wiley-Blackwell, UK.

L	T	P	Credit	Marks
---	---	---	--------	-------

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

0	0	0	2	50
---	---	---	---	----

Course Title: EVS Lab I (Ecological Principles – Practical)

Paper Code: EVS.505

1. To study and enlist various biotic and abiotic components of pond and forest ecosystem.
2. To determine minimum quadrat size for studying vegetation in a grassland.
3. To calculate density, frequency and abundance of plant species in grassland using quadrat method.
4. To determine basal area and dominance of species.
5. To calculate Importance value index (IVI) of species.
6. To calculate index of diversity, richness, evenness and dominance of species
7. To study ecology of some more exotic invasive weeds.
8. To estimate chlorophyll content of plant leaves.
9. To study percent cellular respiration.
10. To estimate carbohydrate content in given plant sample.
11. To estimate protein content in the given sample.

Course Title: EVS Lab II (Environmental Chemistry – Practical)

Paper Code: EVS.506

L	T	P	Credit	Marks
0	0	0	2	50

1. Determination of chloride ions in soil and water.
2. Complexometric titration for determination of hardness (Total, Ca, permanent and temporary).
3. Gravimetric method: TSS and TDS.
4. Sulphate determination by gravimetry.
5. Flocculation studies of wastewater samples.
6. Determination of sulphide by iodometric titration.
7. Determination of the active chlorine in bleaching powder.
8. To estimate total organic content and total organic carbon in soil sample.
9. Adsorption study – Iodine value determination of charcoal.
10. TCLP extract preparation

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Computer Applications

Paper Code*:

L	T	P	Credit	Marks
2	0	0	2	50

Unit 1: Fundamentals of Computers

Block Diagram of Computer, Hardware Components, Introduction to computer network and World Wide Web.

(7 Lectures)

Unit 2

Sharing Data over Network, Computer Configuration, Memory Hierarchy, Software Structure. Introduction to MS Paint, Notepad and Word.

(7 Lectures)

Unit 3:

Introduction to Word Processing and Microsoft Office, Creating and Saving Documents, Text Formatting, Tables, Document Review Option, Mail Merge, Inserting Table of Contents, Reference Management.

(7 Lectures)

Unit 4:

Spreadsheet applications, Presentation applications, Internet browsers and Image processing applications.

(7 Lectures)

Suggested readings:

1. Gookin, D. (2007). MS Word for Dummies. Wiley.
2. Harvey, G. (2007). MS Excel for Dummies. Wiley
3. Sinha, P.K., Computer Fundamentals, BPB Publications

*** Course code will be provided by Centre for Computer Science**

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester II

Course Title: Environmental Geosciences and Meteorology

Paper Code: EVS.507

L	T	P	Credit	Marks
4	0	0	4	100

Unit 1 : Earth processes

Structure and Composition of the Earth; Plate tectonics; Formation of oceans and landmasses; Mountain Building; Mass Movements; Vulcanicity; Seismicity; Formation of lakes, rivers and streams; Wind; Glacial processes; Weathering and Erosion; Mass movement; Geological Time Scale.

(14 Lectures)

Unit 2: Meteorology

Fundamentals of meteorology, Scales of meteorology, Parameters of meteorology- pressure, wind, temperature, humidity, radiation; Radiation Budget of Earth; Application of meteorological principles to transport and diffusion of pollutants, Topographic effects.

(14 Lectures)

Unit 3: Climatology

The boundary layer; Radiations: Radiation laws, short wave and long wave radiations; Albedo; Emissivity; Inversion; Local microclimate; Greenhouse effect; Radiation balance; Precipitation; Atmospheric movements; Distribution of radiation; Rotation of earth- Coriolis acceleration, angular momentum; General meridional circulations: Hadley cells; Middle latitudes; Circulation of water and energy in atmosphere; Weather, and Climate in India; El Nino, La Nina, seasons and monsoons; Climatic classification schemes; Biogeographical regions of the world; Climate change-Emissions and Global warming, impact on sea level in south Asian region; Environmental disruptions and their implications .

(14 Lectures)

Unit 4: Oceanography

Sea water properties; Chemistry of seawater; Wind driven circulations in upper oceans; Waves, Tides and Currents; Upwelling and El Nino; Deep Ocean Circulations; Marine Resources; Marine flora and fauna- Benthic and Pelagic Communities; Marine Pollution; Global Warming and Oceans - Greenhouse effect, Ocean warming, Sea level rise, Acidification, Carbon sequestration.

(14 Lectures)

Suggested readings:

1. Huddart, D. and Stott, T. (2010). *Earth Environments*, Wiley-Blackwell, UK
2. Grotzinger, J., Jordan, T.H., Press, F. and Siever, R. (2007). *Understanding earth*, W.H. Freeman and company, New York
3. Butz, S.D. (2008). *Science of earth systems. Second edition*. Thomson Delmar Learning, U.S.A.
4. Chandrabhanu, T.K. and Bhatnagar, V. (2009). *Earth science and technology*, Campus books, New Delhi
5. Bennet, M.R. and Doyle, P. (1997). *Environmental geology*, Wiley, UK
6. McConnell, R.L. and Abel, D.C. (2014). *Environmental geology today*, Jones and Bartlett Learning, USA
7. Jordan, T.H. and Grotzinger, J. (2008). *The essential earth*, W.H. Freeman and company, New York
8. Park, G. (2010). *Introducing geology, 2nd edition*, Dunedin, Scotland

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

9. Varadarajan, S. (2009). *A-Z Earth sciences*, Centrum Press, New Delhi
10. Thompson, G.R. and Turk, J. (2007). *Earth Science and environment*, Thomson Brooks/Cole, USA
11. Kelley, A. and Knowles, K.M. (2012). *Crystallography and crystal defects*, Wiley, UK
12. Mukherjee, S. (2011). *Applied Mineralogy*, Capital publishing company, New Delhi
13. Sarkar, A.N. (2010). *Global Climate change: Beyond Copenhegen*, Pentagon Earth Press, New Delhi
14. Ruddiman, W.F. (2008). *Earth's climate*, W.H. Freeman and company, New York
15. Rohli, R.V. and Vegg, A.J. (2012). *Climatology, 2nd edition*, Jones and Barnett learning, USA
16. Dessler, A.E. (2012). *Introduction to modern climate change*, Cambridge university press
17. Cowie, J. (2007). *Climate change: Biological and human aspects*, Cambridge university press, UK
18. Awasthi, A. (2012). *Indian climatology*, APH publishing corporation, New Delhi
19. Silver, J. (2008). *Global warming and climate change*, McGraw Hill
20. Desster, A.E. (2012). *Introduction to modern climate change*, Cambridge university press, UK
21. Padmanabhamurthy, B. (2009). *Environmental meteorology*, I.K. International Publishing house Pvt. Ltd., New Delhi
22. Lovejoy, S. and Schertzer, D. (2013). *The weather and climate*, Cambridge university press, USA
23. Salby, M.L. (2012). *Physics of the atmosphere and climate*, Cambridge university press, UK
24. Burt, S. (2012). *The weather of observer's handbook*, Cambridge university press, UK
25. Agvado, E. and Burt, J.E. (2010). *Understanding weather and climate, 5th edition*, Prentice Hall, USA
26. Ackerman, S.A. and Knox, J.A. (2012). *Meteorology, 3rd edition*, Jones and Barnett Learning, USA
27. Harvey, A. (2012). *Introducing geomorphology*, Dunedin, Scotland.
28. Dillenburg, S. and Hesp, P. (2009). *Geology and geomorphology of Holocene coastal barriers of Brazil*, Springer

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Water Pollution and Control Technologies

Paper Code: EVS 508

L	T	P	C	Marks
4	1	0	4	100

Unit 1: Drinking Water Characteristics and Purification Techniques

Water Sources – Availability & quality of Surface water and Ground water; Water Requirements for Domestic Consumption (Population forecasting); Water Treatment process – Principal, process design and applications (Collection & pumping, Aeration, flocculation, Sedimentation, Filtration, Disinfections (Chlorination, UV, Ozonization), water softening Drinking water standards (physical, chemical & bacteriological)

(12 Lectures)

Unit 2: Water pollution

Sources, types, Causes and consequences of water pollution; water pollutants (organic, inorganic, biological and radioactive pollutants); Marine pollution; Thermal pollution; Oil pollution; Classification of wastewater; Bioindicators; Eutrophication;

Characteristics of water and wastewater: Sampling of water and wastewater; collection and storage; Physical, chemical, and biological characteristics of water and wastewater

(14 Lectures)

Unit 3: Wastewater treatment

Wastewater generation; Sewage treatment – Primary, secondary and tertiary treatment – process design and application; Principle, role and design of biological unit process in wastewater treatment - Aerobic (activated sludge process) and anaerobic (UASB) processes; Suspended, attached and hybrid reactors; operational parameters.

Wastewater treatment for small communities – Oxidation ditch, extended aeration system, SBR; Process design and operation of mechanically aerated lagoon and Waste stabilization pond system.

(20 Lectures)

Unit 4: Sludge treatment

Classification of sludge, Sludge treatment – Preliminary operation, Thickening, Conditioning, Dewatering, Filtration, Digestion and Drying of sludge, Sludge disposal.

Laws related to water pollution - Acts, policies and protocol

(12 Lectures)

Suggested readings

1. Wastewater Engineering: Treatment, disposal, Reuse – Metcalf & Eddy Inc.4th ed. TMGHI, New Delhi, 2003.
2. Environmental Engineering- Peavy, HS, Donald RR & G. Tchobanoglous, MGH Int. Ed. New York, 1985.
3. Edzwald, James K. (ed.) (2011) Water quality & treatment : a handbook on drinking water, Mc Graw Hill Publishers
4. Ujang, Zaini (Ed.) (2006) Municipal wastewater management in developing countries: Principles and engineering, IWA Publishing.
5. Palmer, Emmanuel, (2010) Water pollution, Apple Academic Press.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Soil Pollution and Management

Paper Code: EVS 509

L	T	P	Credits	Marks
4	1	0	4	100

Unit 1: Soil formation

Definition, rocks, minerals, soil forming factors, soil weathering- types and processes, soil formation, soil horizon, soil profiles, composition of soil, soil biota and their function in soil, humus, Soil microbes in nutrient cycling, Soil types in India. Physico-chemical and biological properties of soil, sampling and analysis of soil quality

(16 Lectures)

Unit 2: Soil pollution

Definition, sources- point and non- point, soil pollutants – types and characteristics, routes. Soil pollutants – Types, pesticides – classification, formulation; residual toxicity, synthetic fertilizers, heavy metals, Industrial waste effluents and interaction with soil components. Effects and impacts of soil pollution, biomagnification. Thermal pollution – sources and impacts

(14 Lectures)

Unit 3: Soil erosion

Salt affected soil – Saline soils, Sodic soil, Usar, Kallar, Types of erosion – water and wind erosion, causes, soil loss equation. Land degradation – causes and impacts, types of waste lands in India, desertification and its Control.

(12 Lectures)

Unit 4: Soil management

Methodologies for soil conservation, conservation of arable land, techniques of reclamation and restoration of soil, wasteland reclamation, soil salinity management, remedial measures for soil pollution, bioremediation- insitu, exsitu, phytoremediation and biodegradation. Principles of weed management, Legal measures for land conservation at national and international level.

(12 lectures)

Suggested Readings

1. Abbasi, S. A. Environmental pollution and its control, Discovery Publishing Pvt. Ltd
2. Agarwal, S.K. Heavy metal pollution, APH Publishing, 2009.
3. Greipsson, Sigurdur. Restoration ecology, Jones & Bartlett Learning, 2010.
4. Mirsal, Ibrahim A. Soil pollution: Origin, monitoring and remediation, Springer Science & Business Media, 2008.
5. Mishra, P.C. Soil pollution and soil organisms, APH Publishing Corporation, 2008.
6. Misra, S.G. Soil pollution, APH Publishing Corporation, 2010.
7. Rajagopalan, R. Environmental studies : From crisis to cure, 2 (Ed.), Oxford, 2011.
8. Ramachandra, T.V. Soil and groundwater pollution from agricultural activities, The Energy and Resources Institute, TERI, 2011.
9. Rana, S.V.S. Environmental pollution : Health and toxicology. Alpha Science Intl Ltd; 2011
10. Speight, James G., and Arjoon Karuna K. Bioremediation of petroleum and petroleum products, Wiley, 2012.
11. Stuart, Anthony Soil pollution, Apple Academic Press, Inc., 2010.
12. Tiwari, S.K. Mining and environmental science, Atlantic Publishers & Distributors (P) Ltd., 2010.
13. Trivedi, P.R. Environmental pollution and control, APH Publishing Corporation, 2004.
14. Yong, Raymond N., Nakano, Masashi, and Pusch Roland. Environmental soil properties and behaviour, CRC Press, 2012.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Energy and Environment

Paper Code: EVS 510

L	T	P	Credits	Marks
4	1	0	4	100

Unit 1: Introduction

Introduction to energy sources, Energy scenario in world and India, Potential and perspectives of various energy sources in India, classification of energy resources-conventional and non conventional, renewable and non-renewable, environmental implications of energy resources.

(10 lectures)

Unit 2: Conventional energy

Fossil fuels (Coal, petroleum, LPG and natural gas) – origin, composition and physico chemical characteristics and energy content, sources properties and production process; nuclear energy– fission and fusion, technologies – nuclear enrichment, nuclear reactors, nuclear waste disposal, policies and regulations.

(14 lectures)

Unit 3: Non Conventional energy

Prospects of renewable non-conventional energy, Types-solar energy, wind energy, hydel, tidal and geothermal energy, OTEC: introduction, principle, generation. Solar collectors, applications of solar energy: Solar water heating, solar heating and cooling of buildings, solar photo-voltaics, solar distillation, solar cooking and solar ponds. Basic components of wind energy conversion system, types and applications of wind energy.

(16 lectures)

Unit 4: Waste to Energy and Energy Conservation

Bioenergy - Biomass energy as an energy source, characteristics of biomass, Energy plantations, Biomass conversion technologies. Types of biofuels - Biodiesel, bioethanol, biogas, biohydrogen - importance, production, technologies and applications.

Waste to resource recovery and recycling for energy, conversion technologies. Feed stocks, factors affecting biogas generation, Biogas plants: Classification of biogas plants, advantages and disadvantages of biogas plants, community biogas plants. Microbial fuel cell – principle, types and challenges. Environmental impacts of over exploitation of solar, wind and ocean energy. Energy conservation – principles and approach, energy conservation in buildings, green buildings, solar passive architecture, eco-housing, energy audit, national and international norms.

(16 lectures)

Suggested Readings:

1. Boyle, Godfrey (Ed.) Renewable energy. : Power for a sustainable future, 3rd (Ed). OUP Oxford, 2012.
2. Gupta, Harsh and Roy, S. Geothermal energy: An alternative resource for the 21st century, Elsevier Science Ltd, 2006.
3. Lal, Banwari and Sarma, P.M., Wealth from waste: Trends and technologies, TERI, 2011.
4. MNRE, Griha manual volume - 3 : Technical manual for trainers on building and system design optimization renewable energy application, Ministry of new and renewable energy, 2011.
5. Ottmar Edenhofer, Ramón Pichs-Madruga, Youba Sokona, Kristin Seyboth, Susanne Kadner, Timm Zwickel, Patrick Eickemeier, Gerrit Hansen, Steffen Schlömer, Christoph von Stechow, Patrick Matschoss, Renewable energy sources and climate change mitigation : Special report of the intergovernmental panel on climate change, IPCC,2011.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

6. Pagliaro, Mario and Konstandopoulos, A.G. Solar hydrogen : Fuel of the future, Royal Society of Chemistry, 2012.
7. Prasad, S and Dhanya M.S. Biofuels, Narendra Publishing house, New Delhi, 2013.
8. Rani Devi, Mohd. Kashif Kidwai, Pawan Kumar Rose and Alok Kumar Saran , Energy-water-waste nexus : For environmental management, Narosa Publishing House, 2012
9. Rathore, N.S. Renewable energy sources for sustainable development
10. Sawhney, G.S. Non - conventional energy resources, PHI Learning Private Limited, 2012.
11. Sukhatme, S.P. *Solar Energy – Principles of Thermal Collection and Storage*.Tata McGraw Hill. 2000.
12. Sunder I. Bioenergy and sustainable development, Sarup & Sons, 2010.
13. TERI. TERI energy data directory & yearbook 2012/13, 2011.2012, TERI, 2012, 2013.
14. Tiwari, G.N. Solar energy : Fundamentals, design,modeling and applications, Narosa Publishers, 2002.
15. Zobaa, Ahmed F. and bansal, R. Handbook of renewable energy technology, World Scientific Publishing Co., 2011.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Basic Statistics *

Paper Code: STA.507

L	T	P	Credit	Marks
2	0		2	50

Unit 1

Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart.

(8 Lectures)

Unit 2

Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Data on two attributes, independence and association of attributes in 2x2 tables. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots.

(8 Lectures)

Unit 3

Random experiments, sample spaces (finite and infinite), events, algebra of events, three basic approaches to probability, combinatorial problems. Axiomatic approach to probability. Product sample spaces, conditional probability, Bayes' formula.

(8 Lectures)

Unit 4

Correlation and Regression analysis, rank correlation coefficients, curve fitting.

(6 Lectures)

Suggested Readings:

1. P.L. Meyer, Introductory Probability and Statistical Applications Oxford & IBH Pub, 1975.
2. Hogg, R.V. & Raise, A.T. (1978): Introduction to mathematical statistics, Macmillan Pub. Co. Inc.
3. Croxton, F.E. & Cowden, D.J. (1975): Applied General Statistics.
4. Hoel, P.G. (1997) : Introduction to Mathematical Statistics.

* Course offered by Centre for Physical and Mathematical Sciences

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: EVS Lab III (Water and Soil Analysis - Practical)

Paper Code: EVS.511

L	T	P	Credit	Marks
0	0	0	2	50

1. Determination of pH of water/soil sample.
2. Determination of conductivity/TDS of the water sample.
3. Determination of salinity of the water/soil sample.
4. Determination of dissolved oxygen in water sample.
5. Determination of COD and Total Organic Content.
6. Determination of BOD.
7. Determination of Total Kjeldahl Nitrogen (TKN), ammonical nitrogen etc. in water and soil samples.
8. Determination of fluoride content in soil/ water.
9. Determination of MPN for water samples by membrane filtration, pour plate and spread plate methods.
10. Determination of sulphate reducing bacteria in a given sample of water.

Course Title: EVS Lab IV (Energy and Environment – Practical)

Paper Code: EVS.512

L	T	P	Credit	Marks
0	0	2	2	50

1. Determination of Gross Calorific Value of fuel/straw samples using Bomb Calorimeter.
2. To determine the kinematic viscosity of the sample by viscometer
3. To determine the flash point of the sample
4. To determine the cloud and pour point of the sample
5. To analyze the biogas composition by gas chromatography
6. To determine the volatile solids present in the sample
7. Preparation and characterization of biodiesel.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester III

Course Title: Geospatial Technology

Paper Code: EVS.601

L	T	P	Credit	Marks
4	0	0	4	100

Unit I: Introduction

Concept of space and time; Global Positioning System (GPS); Types of Satellites; Google Earth; Bhuvan; GPS; GAGAN; Space Agencies in India; IRS Satellite Series.

(10 Lectures)

Unit 2: Remote sensing

Fundamentals, Electromagnetic radiations, Spectral reflectance, Sensors, Active and passive remote sensing; Types of platform; Types of orbits (Geostationary, Polar, Sun-synchronous); Scanning Systems (Pushbroom and Whiskbroom); Types of Sensors; Data collection, Aerial Photography, Visual Image Interpretation, Digital image processing.

(18 Lectures)

Unit 3: Concepts of GIS

Elements of GIS; Map Projection; Data structures in GIS: Raster and Vector data GIS softwares, Hierarchical, Network and relational data, Geo-relational and object oriented vector data structure; Vector and Raster based analysis; Overlays operations; Map algebra; Network Analysis; Spatial analysis

(14 Lectures)

Unit 4: Applications of Geospatial Technology

Biodiversity, Land, air, ground water and water pollution studies, Coastal zone management, Mineral resources, Landslide, Earthquake, Tsunami, Vegetation mapping, Wildlife monitoring, Wasteland mapping, Conservation of resources, Watershed Management.

(14 Lectures)

Suggested readings:

1. John A. Richards, Xiuping Jia (2006). Remote Sensing Digital Image Analysis: An Introduction. Fourth Edition, Springer India Pvt. Ltd., New Delhi.
2. Russell G. Congalton, Kass Green (2009). Assessing the accuracy of Remotely Sensed Data: Principles and Practices. Second Edition, CRC Press, Taylor and Francis Group, U.S.A.
3. Dr. B.C. Panda (2009). Remote Sensing- Principles and Applications, Viva Books Pvt. Ltd., New Delhi
4. Qihao Weng (2010). Remote Sensing and GIS Integration: Theories, Methods and Application, Tata McGraw Hill, USA.
5. Denny, Mark (2008). *How The Ocean Works? An Introduction to Oceanography*. Overseas Press India Pvt. Ltd., New Delhi.
6. Pinet, Paul R. (2009). *Invitation to Oceanography*. Fifth Edition, Jones and Barnett Learning, USA
7. Williams, Richard G., Follows, Michael, J. (2011). *Ocean Dynamics and Carbon Cycle: Principles and Mechanisms*. Cambridge University Press, U.K.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Instrumentation

Paper Code: EVS.602

L	T	P	Credits	Marks
4	1	0	4	100

Unit 1: Quantitative analysis

Acid-base, complexometric, precipitation and redox titrimetry. Gravimetric analysis – total solids, suspended solids and volatile solids.

(10 Lectures)

Unit 2: Instruments

pH meter, Conductivity meter, TDS meter, DO meter, Salinity meter, Ion Selective Coulometry, Anode and cathode stripping voltammetry, dropping mercury electrode(DME), merits and demerits of DME.

(12 Lectures)

Unit 3: Spectrometric and Thermogravimetric Methods

U.V. spectrophotometer, fluorescence, Flame photometry, Atomic absorption and atomic emission spectrophotometry, molecular structure determination using X- ray, fluorescence and X-ray diffraction, different types of mass spectrometry and surface plasma resonance.

Thermogravimetric Analysis, Differential Scanning Calorimetry.

(16 Lectures)

Unit 4: Separation/ Chromatographic Techniques

Partition coefficient, chromatography, general chromatography, chromatographic methods: Paper, Thin Layer chromatography, Column, High Performance Thin Layer Chromatography (HPTLC), Gas Chromatography (GSC and GLC), GC-MS, High Pressure Liquid Chromatography, Ion Exchange chromatography, Ion/Size Exclusion Chromatography and Electrophoresis.

(18 Lectures)

Suggested readings:

1. Skoog D. A., Holler F.L. and Crouch, S. R.(2007); *Principles of instrumental analysis*, Thomson Brooks/Cole Publishers, USA
2. Svehla G. (1996); *Vogel's qualitative inorganic analysis, 7th Edition*, Prentice Hall, USA
3. Wiersma G.(2004); *Environmental monitoring*, CRC Press, UK.
4. Eaton, A. D., Clesceri, L.S., Rice, E.W. and Greenberg, A.E. (2005); *Standard methods for examination of water and wastewater 21st Edition*. American Public Health Association, American Water Worker Association, Water Environment Federation, USA.
5. Ewing, G. W. (1985); *Instrumental methods of chemical analysis, 5th edition*, McGraw Hill Publications, USA
6. Patnaik, P. (2010); *Handbook of environmental analysis*, CRC Press, USA
7. Shukla, S. K. and Srivastava, P. R. (1992); *Methodology for environmental monitoring and assessment*, Commonwealth Publishers, New Delhi.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Air and Noise Pollution Management

Paper Code: EVS.603

L	T	P	Credits	Marks
4	1	0	4	100

Unit I: Air Pollution

Air pollution – world and Indian scenario, Sources and classification of air pollutants, Air pollutants effects and consequences.

Atmospheric Aerosols: Size Distribution, lognormal number, surface area, volume and mass distribution, dynamics, thermodynamics of aerosol and Nucleation phenomenon.

Laws, Rules and Convention: The air (Prevention and Control of Pollution) Act – 1981 and its Amendments, Geneva Convention on long range transport of atmospheric pollutants.

(14 Lectures)

Unit 2: Air Monitoring

Ambient air sampling using impactor, Cyclone, dichotomous and impingement devices, filter media selection. Adsorption and adsorption based sampling, Indoor environment monitoring.

Industrial Monitoring: Flow velocity and temperature monitoring, isokinetic sampling and compositional analysis, Flue gas analyzer principles for monitoring CO_x, NO_x, SO_x, hydrocarbon.

Air dispersion and Modelling: Plume behaviour and principles of air pollutants dispersion (Gaussian dispersion model) Plume rise estimation, Effluent dispersion theories and Atmospheric and Indoor chemical modelling.

(12 Lectures)

Unit 3: Air Pollution Control Technologies

Particulates - filters, gravitational, centrifugal-multiple type cyclones, Scrubbers and electrostatic precipitators: Equipment descriptions Prediction of collection efficiency and Pressure drop. Adsorbents, PSA, adsorption cycle, rotary bed/fluidized bed, Condensation - contact condensers, shell and tube condenser, flaring. Gaseous Pollutants - absorption: Packed and plate columns. Low NO_x burner, Wellman Lord Process, Fuel desulphurization and denitrogenation.

Vehicular Pollution Control: Combustion Cycle, Fuel/air ratio and Catalytic convertor; selective catalytic and selective non-catalytic reduction.

(16 Lectures)

Unit 4: Noise Pollution

Definition, sources, properties of sound waves, Sound pressure, intensity, decibel, measurement and analysis of sound, Noise Indices, Sound absorption, Meteorological effects on Noise propagation, Effects and impacts on human, Noise exposure level and standards, Noise control, Preventive measures and abatement measures.

(14 Lectures)

Suggested Readings:

1. Jeremy, C., Tiwary, A. and Colls, J. (2009). Air pollution: measurement, modeling and mitigation, 3rd Edition, Crc Press, USA.
2. Clarke A. G. (1997). Industrial air pollution monitoring: gaseous and particulate emissions, Springer, USA.
3. Kenneth Jr., W., Davis, W. T., Warner C. F. (1998). Air pollution and its origin and control, 3rd edition, Prentice Hall, USA.
4. Cheremisinoff N. P. (2002). Handbook of air pollution prevention and control, Butterworth-heinemann Publishers, UK.
5. Rao, C.S. (2006). Environmental pollution control engineering, New Age International Publishers, New Delhi.
6. Vallero, D. A. (2007). Fundamentals of air pollution 4th edition, Academic Press, USA
7. Wang, Lawrence K. Wang, Lawrence K. Pereira Norman C. (2004). Advanced air and noise pollution control.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Waste Management

Paper Code: EVS 604

L	T	P	C	Marks
4	1	0	4	100

Unit 1: Municipal Solid Wastes

Waste: Sources, classification of waste, generation rates, Traditional waste collection and disposal Sources, composition, collection, transportation and characterization of municipal solid wastes – proximate and ultimate analysis, transfer stations, waste processing – volume and size reduction, source reduction, recycling, waste minimization.

(14 Lectures)

Unit 2: Hazardous Wastes

Hazardous waste: Definition, sources, classification, collection, segregation, characterization, Treatment and disposal.

Radioactive wastes: Definition, sources, classification, collection, segregation, Treatment and disposal.

E waste: Definition, sources, classification, collection, segregation, Treatment and disposal.

Biomedical wastes: Definition, sources, classification, collection, segregation, Treatment and disposal.

(14 Lectures)

Unit 3: Waste Treatment and Disposal

Incineration, Combustion, Stabilization, Solidification, chemical fixation, encapsulation, Composting, Vermicomposting, Energy from waste - Biogasification - Anaerobic digestion, pyrolysis, refuse derived fuels; Landfill bioreactors

Burning, open dumping - problems, Landfill – site selection, Sanitary and secured – structure, design, construction, operation and closure. Landfill leachate and gas management, Landfill bioreactors

(14 Lectures)

Unit 4: Waste Handling Rules

Waste management rules: EPA (1986) Section 25; Municipal waste (management and handling) rules (2000) and its amendments, hazardous waste (management and handling) rules (2008), biomedical waste handling rules, flyash rules, recycled plastics usage rules (2003), batteries (management and handling) rules.

(14 Lectures)

Suggested Readings:

1. Williams, Paul T. (2013) Waste treatment and disposal, John Wiley Publishers
2. Johri, Rakesh (Ed.), (2009) E-waste : Implications, regulations and management in India and Current global best practices, TERI press
3. Letcher, Trevor M. (Ed.) (2011) Waste : A handbook for management, Academic Press London
4. Sahai, Sushma (2009) Bio- medical waste management, APH Publishing
5. Rosenfeld, Paul E., (2011) Risks of hazardous wastes, Elsevier London
6. R E Hester (ed.); Roy M Harrison (ed.) (2008) Electronic waste management : design, analysis and application, Cambridge Royal Society of Chemistry

Course Title : Scientific Writing and Research Methodology

L	T	P	C	Marks
2	0	0	2	50

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Paper Code: EVS.605

Unit 1: General Principles of Research Methodology

Meaning and importance of research, Critical thinking, Formulating hypothesis and development of research plan, Review of literature, Interpretation of results and discussion.

Library: Classification systems, e-Library, Reference management, Web-based literature search engines.

(14 Lectures)

Unit 2: Scientific Writing

Technical writing: Scientific writing, Reference styles-APA, PNAS, Chicago style, Writing research paper, Poster preparation and Presentation and Dissertation.

Indexing: H-Index, G- Index, Citation

Research and academic integrity: Plagiarism, copyright issues, Intellectual property rights (IPRs).

(14 Lectures)

Suggested Readings:

1. Gupta, S. (2005). *Research methodology and statistical techniques*. Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C.R. (2008). *Research methodology (s)*. New Age International (p) Limited. New Delhi.
3. www.sciencedirect.com for journal references.
4. www.springer.com for journal references and update
5. www.pnas.org for journals.
6. www.apa.org for referencing styles.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: EVS Lab V (Air Pollution Sampling and Analysis – Practical)

Paper Code: EVS.606

L	T	P	Credit	Marks
0	0	2	2	50

1. Calibration of flow meters for high volume sampler.
2. Study of TSPM, PM₁₀ and PM_{2.5} in ambient air.
3. Study the efficiency of the filter media for particulate matter.
4. Determination of SO₂, NO_x, Cl₂ and O₃ using UV-Vis Spectrophotometry.
5. Sample preparation for PAH analysis.
6. Sampling and analysis of Metal ion in ambient air.
7. Sampling and analysis of semivolatile organics in air samples.
8. Sampling and analysis of Benzene in ambient air.
9. Sampling and analysis of SPM in stationary sources.
10. Vehicular emission testing.
11. Sampling and analysis of Noise.

Course Title: EVS Lab VI (Instrumental methods and Geospatial techniques– Practical)

Paper Code: EVS.607

L	T	P	Credit	Marks
0	0	2	2	50

1. Google Earth – Calculation of ground distance, aerial distance, path and area of given features.
2. Georeferencing of toposheets and satellite Imageries
3. Digitization and thematic map creation.
4. Visual interpretation using IRS false color composite.
5. Digital image processing – supervised and unsupervised classification.
6. Change detection using Image Processing softwares
7. Hands-on for Image Processing and GIS Softwares – ARC GIS, ILWIS, ERDAS.
8. Calibration of volumetric glasswares Pipette, Burette and Volumetric flask.
9. Potentiometric determination of pH of water/wastewater and soil samples.
10. Conductivity of water and wastewater samples using conductivity and TDS meter.
11. Working, standardization of DO meter and determination of DO of sewage water.
12. Working, standardization of flame photometer and plotting calibration curve for metal ions.
13. Working, of chromatographic techniques TLC, Column, HPLC and GC-MS.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester IV

Course Title: Environmental Impact Assessment and Auditing

Paper Code: EVS 608

L	T	P	Credits	Marks
4	1	0	4	100

Unit 1: Introduction

Environment Impact Assessment - Principles, Origin, development, types, issues, problems and limitations, environmental risk assessment, environmental management plan, environmental impact statement (EIS), Strategic Environmental Assessment (SEA), EIA guidelines (1994) and notifications (Govt. of India 2006), Scope of EIA in project planning and implementation, Indian directions of EIA, Monitoring tools for EIA, surveys, spatial databases, experiments, models, Decision support system, Sources and collection of data for EIA, various appendices and forms for application.

(12 Lectures)

Unit 2: EIA methodology

Components of EIA, EIA methodology – project screening, scoping, base line data, impact identification, prediction, evaluation, mitigation. Assessment techniques – cost benefit analysis, analysis of alternatives, methods of prediction matrices, networks, checklists and overlays and assessment of impacts – air, water, soil, noise, biological, social, cultural, economical, environmental factors. EIA standards and guidelines, public participation- procedure of public hearing, presentation, review and decision making. Quality control – trends in EIA practice, evaluation criteria, expert system in EIA, use of regulations. Documentation and monitoring – Generic structure of EIA Document, planning, collection, use of display materials, team writing, checklist, environmental monitoring guidelines and policies, Environment management plan, post audit.

(12 Lectures)

Unit 3: Environmental Auditing and Management

Definition and types of audits, EMS, Guidelines for environmental auditing, methodologies for Environmental Auditing, Matrix methods and Batelle method of auditing, Types of projects requiring Environmental Clearance, EAC, EIA case studies, Legal requirements for environmental auditing. Restoration and rehabilitation technologies, Environmental planning, urban planning, rural planning and land use pattern.

(14 Lectures)

Unit 4: Environmental Risk Analysis

Definition of risk, environmental risk analysis – risk assessment and risk management. Basic steps in risk assessment – hazard identification, Exposure assessment, Dose-response assessment, risk characterization. Risk assessment in EIA.

(12 Lectures)

Suggested Readings

1. Abbi, Y.P. and Jain Shashank. Handbook on energy audit and environment management, The Energy and Resources Institute, TERI, 2009.
2. Aral, Mustafa M. Environmental modeling and health risk analysis (acts/risk), Springer, 2010.
3. Dwivedi, Ranjit. Conflict and collective action : The sardar sarovar project in India, Routledge India, 2006.
4. Glasson, John, Therivel Riki, and Chadwick Andrew. Introduction to environmental impact assessment, 3rd (Ed). Routledge, 2005.
5. Lawrence, D. P. (2003) Environmental Impact Assessment: practical solutions to recurrent problems, John Wiley & Sons, Hoboken NJ;
6. Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK. 2005.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

7. Shrivastava, A.K. Environment auditing, APH Publishing Corporation, 2003.
8. Srivastava, A.K. Environment impact assessment, APH Publishing Corporation, 2003.
9. Therivel, R. and Partidario, M. R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London;
10. Trivedi, P.R. Environmental impact assessment. APH Publishing Corporation, 2004.
11. Wood, C. (2003) Environmental Impact Assessment – A Comparative Review, Prentice Hall, London.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Emerging Technologies in Environmental Science

Paper Code: EVS 609

L	T	P	C	Marks
4	1	0	4	100

Unit 1: Water and wastewater treatment

Advanced wastewater treatment processes - Nutrient removal – nitrification, denitrification, ANAMMOX, SHARON, CANON process, Biological phosphate removal (BPR); Membrane processes - Fundamentals, membranes – types, classifications, microfiltration, ultrafiltration, nanofiltration and reverse osmosis, electrodialysis, Membrane fouling, cleaning and mitigation techniques; Ion exchange; Advanced oxidation process: Photocatalysis, ozonation – ozone/UV, ozone/hydrogen peroxide, hydrogen peroxide/UV, applications, oxidation of refractory organic compounds.

Bioreactors for wastewater treatment - Membrane bioreactors (MBR), Moving bed biological reactors (MBBR), anaerobic baffled reactor (ABR),

Sludge disintegration methods; sludge pretreatment – thermal, physical, chemical, mechanical and biological

Energy recovery from wastewater: microbial fuel cells, microbial electrolysis cells, microbial desalination cell, biohydrogen production

(20 Lectures)

Unit 2: Microbiology in pollution control

Bioremediation processes reducing environmental impacts of synthetic pesticides, viral pesticides, Microbial degradation of naturally occurring compounds-cellulose, lignin, hydrocarbons. Bioprospecting, Biopiracy

(12 Lectures)

Unit 3: Eco-agriculture

Allelopathy, Natural plant products as bioherbicides, Organic farming, Eco-farming, Biofertilizers. Terrestrial Phytotechnology: Phytoremediation, Phytovolatilization, Phytodegradation, Phytostabilization - Aquatic Phytosystems: Blastofiltration, Rhizoremediation, Constructed wetlands, Algal blooms; fly ash treatment

(12 Lectures)

Unit 4: Sustainable management

Brundtland Commission, Sustainable development – principles and practices in relation to economics and ecology, green architecture and ground water recharge; CO₂ management, Carbon Sequestration, Environmental conferences - Stockholm, Rio, Johannesburg and Copenhagen Conferences; Kyoto Protocol – Radiative Forcing and Carbon cap; Clean Development Mechanism, Joint Implementation, Emission Trading, Certified Emission Reduction (CER) and Assigned Amount Units (AAU), Land Use Land Cover Change and Forestry.

(12 Lectures)

Suggested readings

1. Crittenden, J. C., Trussell, R. R. and Hand D. W. (2005). *Water treatment: principles and design*, 2nd edition, Wiley Publishers, USA.
2. Judd S (2011). *The MBR book: principles and applications of membrane bioreactors for water and wastewater treatment 2nd edition*, Butterworth-Heinemann publishers, UK.
3. Okafor N. (2011). *Environmental microbiology of aquatic and waste systems, 1st edition*, Springer publication, USA.
4. Parsons, S. (2004). *Advanced oxidation processes for water and wastewater treatment*, IWA Publication, London, UK.
5. Tchobanoglous G, Burton, F. L., Stensel H. D. (2002). *Wastewater engineering: treatment and reuse*, McGraw-Hill Science, USA