Central University of Punjab

Centre for Environmental Sciences and Technology

Course Structure of M.Sc. (Environmental Sciences and Technology)

Academic Session 2017-18

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester I

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E	CBCS #
							A	B	C	D		
1	EVS.501	Basic Statistics	2	1	-	2	25	25	25	25	50	F
2	EVS.502	Computer applications	2	1	-	2	25	25	25	25	50	F
3	EVS.503	Basics in Environmental Sciences	4	1	-	4	25	25	25	25	100	F
4	EVS.504	Ecological Principles	4	1	-	4	25	25	25	25	100	C
5	EVS.505	Environmental Chemistry	4	1	-	4	25	25	25	25	100	C
6	XXX	Interdisciplinary Course*	2	1	-	2	25	25	25	25	50	E
7	EVS. 506	EVS- Lab I (Ecology)	-	-	2	2	-	-	-	-	50	C
8	EVS.507	EVS- Lab II (Environmental Chemistry)	-	-	2	2	-	-	-	-	50	C
		Total	18		4	22					550	

***Student has to choose the relevant courses offered in other Centres**

 # Choice based credit system: C- Core courses; F- Foundation courses; E- Elective courses

A: Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper
B: Pre-scheduled Test-1: Based on Objective Type & Subjective Type Test
C: Pre-scheduled Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester II

Sl. No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E	CBCS #
							A	B	C	D		
1	EVS.511	Environmental Geosciences	4	1	-	4	25	25	25	25	100	C
2	EVS.512	Water Pollution and Control Technologies	4	1	-	4	25	25	25	25	100	C
3	EVS.513	Energy and Environment	4	1	-	4	25	25	25	25	100	C
4	EVS.XXX	Elective I	4	1	-	4	25	25	25	25	100	E
5	XXX	Interdisciplinary Course	2	1	-	2	25	25	25	25	50	E
6	EVS.517	EVS- Lab III (Water and Soil Analysis)	-	-	2	2	-	-	-	-	50	C
7	EVS.518	EVS- Lab IV (Energy and Geosciences)	-	-	2	2	-	-	-	-	50	C
8	EVS 599	Seminar I	-	-	2	2	-	-	-	-	50	F
Elective Course (Elective I): Select any one course from the following												
4	EVS 515	Soil Pollution and Management	4	1	-	4	25	25	25	25	100	E
	EVS 516	Environmental Nanotechnology	4	1	-	4	25	25	25	25	100	E
		Total	18		6	24					600	

***Interdisciplinary course: Student has to choose the relevant course from other Centres**

 # Choice based credit system: C- Core courses; F- Foundation courses; E- Elective courses

A: Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper
B: Pre-scheduled Test-1: Based on Objective Type & Subjective Type Test
C: Pre-scheduled Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester III

Sl. No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E	CBCS #
							A	B	C	D		
1	EVS.601	Scientific Writing and Research Methodology	2	1	-	2	25	25	25	25	50	F
2	EVS. 602	Principles of Geo-spatial Technology	4	1	-	4	25	25	25	25	100	C
3	EVS.603	Instrumental Methods of Analysis	4	1	-	4	25	25	25	25	100	C
4	EVS.604	Air & Noise: Pollution and Management	4	1	-	4	25	25	25	25	100	C
5	EVS XXX	Elective- II	4	1	-	4	25	25	25	25	100	E
6	EVS.608	EVS- Lab V (Air & Noise pollution)	-	-	2	2	-	-	-	-	50	C
7	EVS.609	EVS- Lab VI (Instrumental methods and Geospatial techniques)	-	-	2	2	-	-	-	-	50	C
8	EVS 610	Industrial Visit/Field Visit and Report Writing			2	2					50	E
9	CSH XXX	Compulsory course in humanities*										
Elective II: One course to be selected from the following												
5	EVS 606	Waste Management	4	1	-	4	25	25	25	25	100	E
	EVS 607	Ecotoxicology and Occupational Safety	4	1	-	4	25	25	25	25	100	E
		Total	18		6	24					600	

* Non-credit Compulsory course in humanities for science students

 # Choice based credit system: C- Core courses; F- Foundation courses; E- Elective courses

A: Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper
B: Pre-scheduled Test-1: Based on Objective Type & Subjective Type Test
C: Pre-scheduled Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester IV

Sl. No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E	CBCS
							A	B	C	D		
1	EVS. 611	Environmental Impact Assessment and Auditing	4	1	-	4	25	25	25	25	100	C
2	EVS.612	Emerging Trends and Techniques in Environmental Science	4	1	-	4	25	25	25	25	100	C
3	EVS XXX	Elective III	4	1	-	4	25	25	25	25	100	E
4	EVS XXX	Elective IV	4	1	-	4	25	25	25	25	100	E
5	EVS.699	Departmental/ Industrial Project/Dissertation			10	10						
		Total	16		10	26					400	
Elective III and IV/Optional courses: Select any two courses from the following based on specialization												
3 & 4	EVS 616	Natural Resource Management	4	1	-	4	25	25	25	25	100	E
	EVS 617	Natural hazards and Disaster Management	4	1	-	4	25	25	25	25	100	E
	EVS 618	Microbial Technology for Environmental Pollution Abatement	4	1	-	4	25	25	25	25	100	E

 # Choice based credit system: C- Core courses; F- Foundation courses; E- Elective courses

A: Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper
B: Pre-scheduled Test-1: Based on Objective Type & Subjective Type Test
C: Pre-scheduled Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester- I

Course Title: Basic Statistics

Paper Code: EVS.501

L	T	P	Cr	Marks
2	0	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- mean, mode and median; dispersion (including box and whisker plot), skewness and kurtosis. Data on two attributes, independence and association of attributes in 2x2 tables. Data, Sampling, and Study Design

(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, Binomial Distribution.

(8 Lectures)

Unit 4

Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots; rank correlation coefficients, curve fitting; Hypothesis testing, t-test, z-test, , $\chi 2$ test, residuals plots; Analysis of categorical data: goodness-of-fit. Application Softwares -SPSS, Sigma Plot, Origin, Excel,etc

(6 Lectures)

Suggested Readings

1. Murray R. Spiegel and Larry Stephens. Schaum Outline of Statistics. McGraw-Hill Education (ISE Editions)
2. Meyer. P.L. Introductory Probability and Statistical Applications, Oxford & IBH Publishers.
3. Hogg, R.V. and Raise, A.T. Introduction to mathematical statistics, Macmillan Pub. Co. Inc.
4. Croxton, F.E. and Cowden, D.J. Applied General Statistics.
5. Hoel, P.G. Introduction to Mathematical Statistics.

Course Title: Computer Applications

Paper Code: EVS 502

L	T	P	Cr	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. MS Word for Dummies.Wiley.
2. Harvey, G. MS Excel for Dummies. Wiley
3. Sinha, P.K. Computer Fundamentals, BPB Publications

Course Title: Basics in Environmental Sciences
Paper Code: EVS 503

L	T	P	Cr	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

(12 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 Accident, 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; IPCC and its reports

(16 Lectures)

Suggested Readings:

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

Course Title: Ecological Principles

Paper Code: EVS 504

L	T	P	Cr	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.
2. Day, John W., Kemp W. M., Alejandro Yáñez-Arancibia and Byron C. Crump. Estuarine Ecology (2nd Ed), Wiley-Blackwell Publishers.
3. Fa, John E. Zoo Conservation Biology (Ecology, Biodiversity and Conservation), Durrell Wildlife Conservation Trust.
4. Fatik B. Mandal. and Nepal C. Nandi. Biodiversity: concepts, conservation and biofuture, Asian Books.

5. Jorgensen, Sven Erik. Encylopedia of Ecology. Vol 1-5. Elsevier Publishers. Netherlands.
6. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C. Biodiversity and Environmental Management. APH, New Delhi.
7. Joshi, P.C. and Joshi, N. Biodiversity and conservation. APH Publishing Co-operation, New Delhi.
8. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R.. Invasive Plants and Forest Ecosystems. CRC Press / Taylor and Francis.
9. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. and Brown, J.H. Biogeography (4^{th} Ed). Sinauer Associates.
10. Odum, E.P., Barrick, M. and Barret, G.W. Fundamentals of Ecology (5^{th} Ed).Thomson Brooks/Cole Publisher, California.
11. Pandey, B.N. and Jyoti, M.K. Ecology and Environment. APH Publishing Co-operation, New Delhi.
12. Professional. Forest & wildlife laws. Professional Publishers.
13. Rana, S.V.S. Essentials of Ecology and Environmental Science (5^{th} Ed), PHI Learning Pvt. Ltd.
14. Sharma, P.D. Ecology and Environment. Rastogi Publications. New Delhi.
15. Smith, T.M and Smith, R.L. Elements of Ecology (8^{th} Ed), Benjamin Cummings.
16. Vandermeer, John H., Riddle,B.R. and Brown, J.H. Population ecology : First principle (2^{nd} Ed). Princeton University Press.
17. William J. Mitsch, James G. Gosselink, Li Zhang, Christopher J. Anderson. Wetland ecosystems, Wiley-Interscience.

Course Title: Environmental Chemistry

Paper Code: EVS 505

L	T	P	Cr	Marks
4	1	0	4	100

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, Pourbiax 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, O_3, 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. Environmental Chemistry W.H. Freeman, USA.
2. Manahan, S. E. Fundamentals of Environmental Chemistry, 3rd Edition, CRC Press, USA.
3. Connell D. W. Basic concepts of Environmental Chemistry 2nd Edition, CRC Press, USA.
4. Girard J. Principles of Environmental Chemistry 2nd Edition, James &Barlett Publishers, USA.
5. Harrison R. M. Principles of Environmental Chemistry, RSC Publishing, UK.
6. Hillel, D. Soil in the Environment: Crucible of Terrestrial Life, 1st edition, Academic Press, USA.

7. Lancaster M.Green Chemistry: An Introductory Text, RSC Publishing, UK.
8. Manahan, S. E. Green Chemistry and the Ten Commandments of Sustainability, 2nd Edition, Chem Char Inc. Publishers, USA
9. Manahan, S. E. Water chemistry: green science and technology of nature's most renewable resource, CRC Press, USA
10. Clark J. H. and Macquarrie, D. J. Handbook of Green Chemistry and Technology, Wiley-Blackwell, UK.

Course Title: EVS Lab I (Ecological Principles)

Paper Code: EVS.506

L	T	P	Cr	Marks
0	0	0	2	50

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)

Paper Code: EVS.507

L	T	P	Cr	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

Semester- II

L	T	P	Cr	Marks
4	1	0	4	100

Course Title: Environmental Geosciences
Paper Code: EVS.511

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; **anaerobic co-digestion**, 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. Bell F. G. Environmental Geology: Principles and Practice. Blackwell Science Publisher, USA
2. Critchfield H. J. General Climatology, PHI Learning, New Delhi.
3. Kale, V. S. and Gupta, A. Introduction to Geomorphology. Orient Longman, Bangalore.
4. Singh, S. Physical Geography, Prayag Pustak Bhavan, Allahabad.
5. Strahler, A.N. and Strahler. An Introduction to Physical Geography. John Wiley & Sons, UK.
6. D.S. Lal Climatology, Sharda Pustak

Course Title: Water Pollution and Control Technologies
Paper Code: EVS 512

L	T	P	Cr	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. Metcalf & Eddy Inc. Wastewater Engineering: Treatment, Disposal, Reuse (4th Ed.). TMGHl, New Delhi.
2. Peavy, HS, Donald RR & G. Tchobanoglous. Environmental Engineering-, McGraw-Hill Education New York.
3. Edzwald, James K. Water Quality & Treatment : A Handbook on Drinking Water, McGraw-Hill Education
4. Ujang, Zaini. Municipal wastewater management in developing countries. : Principles and Engineering. Iwa Publishing.
5. Palmer, Emmanuel. Water pollution. Apple Academic Press, Inc.

Course Title: Energy and Environment

Paper Code: EVS 513

L	T	P	Cr	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, characterstics 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. Gupta, Harsh and Roy, S. Geothermal energy: An alternative resource for the 21st century, Elsevier Science Ltd.
2. Lal, Banwari and Sarma, P.M., Wealth from waste: Trends and technologies, TERI.
3. MNRE, Griha manual volume - 3 : Technical manual for trainers on building and system design optimization renewable energy application, Ministry of New and Renewable Energy.
4. OttmarEdenhofer, Ramón Pichs-Madruga, YoubaSokona, Kristin Seyboth, Susanne Kadner, TimmZwickel, Patrick Eickemeier, Gerrit Hansen, Steffen Schlömer, Christoph

von Stechow, Patrick Matschoss, Renewable energy sources and climate change mitigation : Special report of the intergovermental panel on climate change, IPCC.

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

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Elective I

L	T	P	Cr	Marks
4	1	0	4	100

Course Title: Soil Pollution and Management

Paper Code: EVS 515

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.

(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.

(14 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. Botkin, Daniel B. and Keller, Edward A. *Environmental Science: Earth as a Living Planet*. 6th ed. John Wiley & Sons, USA. 2007.
2. Cutler, S.L, *Environment Risks and Hazard*. Prentice Hall of India, Delhi. 1999.
3. De, A.K., *Environmental Chemistry*. New Age International (P) Ltd. Publishers,New Delhi. 2000.
4. Hillel, D., *Introduction to Soil Physics*, Academic Press, New York. 1982.
5. Kapoor, B.S. *Environmental Sanitation.* S. Chand & Sons, New Delhi. . 2000.
6. Raven, Peter H., Berg, Linda R. and Hassenzahl, David M. *Environment.* 6th ed. John Wiley & Sons., USA. 2008.
7. Sanai, V.S. *Fundamentals of Soil.* Kalayani Publishers, New Delhi. 1990.
8. Sharma, B.K. *Environmental Chemistry*, Goel Publishing House, Meerut. 2000.
9. Singh, H.P., Batish, D.R. and Kohli, R.K. *Handbook of Sustainable Weed Management*. Haworth Press, Inc., USA. 2006.
10. Singh, R.A. *Soil Physical Analysis*, Kalayani Publishers, New Delhi. 1997.

Course Title: Environmental Nanotechnology

Paper Code: EVS.516

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Synthesis and Advanced Characterization of Nanomaterials

Physical and chemical method of synthesis for SWCNT, MWCNT, Metal nanoparticles and Metal oxide and Chalcogenide nanoparticles. Biologically Synthesized Nanoparticles, Nanostructures and Synthetic Nanocomposites - Protein-Based Nanostructure Formation - DNA-Templated Nanostructure Formation - Protein Assembly - Biologically Inspired Nanocomposites

Advanced Characterization Methods**:** Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, XPS – Working Principle, Instrumentation and Applications X-ray diffraction - Raman Spectroscopy and its Applications – Dynamic Light Scattering (DLS).

(14 Lectures)

Unit 2: Properties of Nanomaterial

Carbon nanotubes: electrical properties, vibrational properties, mechanical properties and applications of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis – mechanical reinforcement. Semiconductor nanostructures – electronic properties, optical behavior and quantum confinement, characterization of semiconductor nanostructures.

(14 Lectures)

Unit 3: Nanomaterials in Environment

DNA, protein, molecular motors, aerosols, self-assembly and natural surfactants, Identification and characterization of Hazardous waste, Nano Pollution, Air, Water and Soil Contaminants.

Environmental Nano Remediation Technology - Nanotechnology for water remediation and purification: nZVI, Ag, Photofenton process, TiO_2 and its modification for efficient photodegradation, Nano Filtration for treatment of waste – removal of organics & inorganics and pathogens, Nanomembranes in Drinking water treatment, Nanomembranes in Sea desalination. Application of Nanomaterial in microfuelcell, fuel Cell, hydrogen storage.

(14 Lectures)

Unit 4: Environmental Nanotoxicology

Fate of nanomaterials in environment, environmental life cycle of nano materials, environmental and health impacts of nano materials, toxicological threats, eco-toxicology, exposure to nano particles – biological damage, threat posed by nano materials to humans, environmental reconnaissance and surveillance.

(14 Lectures)

Suggested Readings:

1. Balaji S., (2010). *Nanobiotechnology*, MJP Publishers,Chennai.
2. Poole, C. P. Jr. and Owens F. J. (2009). *Introduction to nanotechnology*, Wiley India, New Delhi.

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

Paper Code: EVS.517

L	T	P	Cr	Marks
0	0	2	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 Kjehldahl 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 Geosciences)
Paper Code: EVS.518

L	T	P	Cr	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.
8. To estimate acid value of the sample
9. To estimate iodine value of the sample

Semester III

Course Title: Scientific Writing and Research Methodology

L	T	P	Cr	Marks
2	0	0	2	50

Paper Code: EVS.601

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)

Unit2: 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.

Course Title: Principles of Geospatial Technology
Paper Code: EVS.602

L	T	P	Cr	Marks
4	0	0	4	100

Unit 1: 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, Tsuanami, Vegetation mapping, Wildlife monitoring, Wasteland mapping, Conservation of resources, Watershed Management.

(14 Lectures)

Suggested readings:

1. Lillisand, T. M. and Keifer, R. W. (2007). *Remote sensing and image interpretation*. John Willey and Sons, USA
2. Barrett, E. C. and Curtis, L. F. (1999). *Introduction to environmental remote sensing*. Chapman and Hall Publishers, USA.
3. Joseph G. (2003). *Fundamentals of remote sensing.* Universities Press, Hyderabad.
4. Chang, Kang-taung (2002). *Introduction to geographic information systems*, Tata McGraw-Hill, USA.
5. Curran, PJ. Principles of Remote Sensing. ELBS, Harlow Longman Scientific and Technical, 1988.

Course Title: Instrumental Methods of Analysis

Paper Code: EVS.603

L	T	P	Cr	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.

Course Title: Air & Noise: Pollution and Management
Paper Code: EVS.604

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: 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 COx, NOx, SOx, 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 NOx 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 andmitigation, 3rd Edition, Crc Press, USA.

2. Clarke A. G. (1997). Industrial air pollution monitoring: gaseous and particulateemissions, 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 InternationalPublishers, 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 andnoise pollution control.

Elective II

Course Title: Waste Management
Paper Code: EVS 606

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Municipal Solid Wastes

Waste: Sources, classification of waste, generation rates, Traditional waste collection and disposalSources, 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, hazardous waste (management and handling) rules, biomedical waste handling rules, flyash rules, recycled plastics usage rules, batteries (management and handling) rules, Schemes and programmes of Government- Swachchh Bharat Abhiyaan.

(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: Ecotoxicology and Occupational safety

Paper Code: EVS 607

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Introduction to Toxicology

Definitions, Classification, Origin and General Nature of Toxicants in Environment, concepts; Toxic chemicals in the environment - air, water & their effects; Basic Probit analysis; Toxicants – Toxicity, mechanism of toxicity - Acute, sub-acute, chronic, dose effect, LD 50, LC 50 and response safe limits; IT, IC, LD_{80}, LD_{90}, LCIC, Dose response relationship, concentration response relationship; Influence of route of administration; determination of toxicity of chemicals.

(14 Lectures)

Unit 2 Toxic Mechanisms

Bioaccumulation and Biomagnification of toxic materials in food chain, detoxification, bioconcentration; Toxicology of major pesticides and heavy metals (Aluminium, arsenic, cadmium, chromium, lead and mercury) - biotransformation, biomonitoring, residual effects; bioindicator– definition, groups and examples.

(14 Lectures)

Unit 3:Bioassays

Concepts, types, characteristics and significance of bioassay; Bioassay test models and classification - Microbiol, algal, invertebrates and alternative toxicity tests; Immunotoxicity, histotoxicity, cell toxicity. Ecotoxicology – Legislative perspectives.

(14 Lectures)

Unit 4: Occupational Health

Occupational hazards in industries and other sectors, Safety requirements and Measures; Occupationally induced illness, non-occupational illness, discomfort at work, Occupational diseases- Pneumoconiosis, Silicosis, Anthracosis, Byssinosis, Bagasosis, Asbestosis, Farmer's lung, Metal poisoning, Occupational cancer, Occupational dermatitis; Radiation, fire and explosion hazards Hazards; occupational health practice; risk assessment techniques for accidental release of toxic and inflammable materials; Role of WHO in occupational health. Occupational health Standards - ISO.

(14 Lectures)

Suggested readings:

1. Tatiya, Ratan raj (2013) Elements of industrial hazards: Health, safety, environment and loss prevention Taylor and Francis
2. Theodore, Louis (2012) Environmental health and hazard risk assessment : Principles and calculations, CRC Press
3. Wong, Ming H. (Ed.) (2013) Environmental contamination: Health risks and ecological restoration, CRC press
4. Ware, George M.(Ed) (2007) Reviews of environmental contamination and toxicology. Vol. 190: Continuation of residue reviews, Springer Publishers
5. Manahan, Stanley E. (2013) Fundamentals of environmental and toxicological chemistry: Sustainable sciences, CRC press

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

Paper Code: EVS.608

L	T	P	Cr	Marks
0	**0**	**2**	**2**	**50**

1. Calibration of flow meters for high volume sampler.
2. Study of TSPM, PM_{10} and $PM_{2.5}$ in ambient air.
3. Study the efficiency of the filter media for particulate matter.
4. Determination of SO_2, NO_x, Cl_2 and O_3 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)

Paper Code: EVS.609

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.

Title: Industrial Visit/Field Visit and Report Writing

Paper Code: EVS 610

L	T	P	Cr	Marks
0	0	2	2	50

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Semester IV

L	T	P	Cr	Marks
4	1	0	4	100

Course Title: **Environmental Impact Assessment and Auditing**

Paper Code: EVS 611

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.

(14 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.

(14 Lectures)

Unit 3: Environmental Auditing and Management

Definition and types of audits, EMS, Guidelines for environmental auditing, methodologies for EnvironmentalAuditing, 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.

(14 Lectures)

Suggested Readings

1. Kulkarni, V. and Ramachandra, T.V. Environmental Management. Capital Pub. Co., New Delhi. 2006.
2. Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK 2005.

3. Glasson, J. Therivel, R. and Chadwick, A. Introduction to Environmental Impact Assessment. Routledge, London. 2006.
4. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York;
5. Fischer, T. B. (2007). Theory and Practice of Strategic Environmental Assessment, Earthscan, London.
6. Lawrence, D. P. (2003) Environmental Impact Assessment: practical solutions to recurrent problems, John Wiley & Sons, Hoboken NJ;
7. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London;
8. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford;
9. Therivel, R. and Partidario, M. R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London;
10. Vanclay, F. and Bronstein, D. A. (1995) (eds) Environmental and Social Impact Assessment, Wiley & Sons, Chichester
11. Wood, C. (2003) Environmental Impact Assessment – A Comparative Review, Prentice Hall, London.

Course Title: Emerging Techniques in Environmental Science

Paper Code: EVS 612

L	T	P	Cr	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; CO_2 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.

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Electives III and IV

Course Title: Natural Resource Management

Paper Code: EVS 616

L	T	P	Cr	Marks
4	1	0	4	100

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.
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

Centre for Environmental Sciences and Technology

Scheme of Courses M.Sc.

M.Sc. Environmental Sciences and Technology

Course Title: Natural Hazards and Disaster Management

Paper Code: EVS.617

L	T	P	Cr	Marks
4	0	0	4	100

Unit 1: Introduction to Disasters

Introduction to Natural and Manmade Disasters; Dimensions of Natural and Anthropogenic Disasters; Floods –nature and frequency of flooding, flood hazards, urbanization and flooding, flood hydrographs, Dams barrages and river diversions; Landslides; Coastal hazards – tropical cyclone, coastal erosion, sea level changes, coastal zone management; Earth quakes - Seismic waves, quake resistant buildings and dams; Tsunamis; Volcanoes; Wild fires; Oil spills; Urban hazards and disasters.

(14 Lectures)

Unit 2: Risk Assessment

Pre-Disaster Management activities; Hazard and vulnerability analysis; capability assessment; emergency / contingency planning and post-disaster management activities; Development planning, planning environment, types of plans, MBO, SWOT analysis.

(14 Lectures)

Unit 3: Geoinformatics in Disaster Management

Role of GPS, GIS and Remote Sensing in disaster management - Landslides, Volcanoes, Tsunami, Cyclones, Urban and Forest fires, Landslides;Decision-making models and processes; Hazard monitoring, tracking and modelling; Early warning systems; Indian space programme, future satellites for disaster management; Case studies.

(14 Lectures)

Unit 4: Legislations and Policies for Disaster Management

India Disaster Resource Network; Emergency Management and planning; Organization and structure for Emergency Management; Principles and Practice of Disaster Relief and Recovery; Disaster management policy; Command and coordination in disaster management; Important statutes with provisions relevant to Disaster Management; Role of legislations in Disaster Management, Scope of Disaster Management Law with reference to Disaster Management Bill 2005, National Green Tribunal, Environment Protection Act, 1986, including Hazardous Substances Rules, Explosives Act, 1872, Explosive Substances Act, 1908, Mines and Minerals (Regulation and Development) Act, 1957, Insecticides Act, 1968, Atomic Energy Act, 1962, Factories Act, 1948; Local Administration and disaster risk reduction; Relief and Rehabilitation.

(14 Lectures)

Suggested Readings

1. William H. Dennen and Bruce R. Moore, WCB Publishers, Iowa, 1986.
2. John M. Wallace and Peter V. Hobbs, Atmospheric Science: An Introductory Survey, Academic Press, New York, 1977.
3. EgbortBocker and Rienk Van Grondille, Environmental Physics, John Wiley & Sons Ltd., 1999.
4. Barbar W. Murk et. al., Environmental Geology, John Wiley & Sons, New York, 1996.
5. Bohle, H. G., Downing, T. E. and Watts, M. J. Climate change and social vulnerability: the sociology and geography of food insecurity, Global Environmental Change. No.4, pp. 37-48.

6. Collins Larry R. and Schneid Thomas D., Disaster Management and Preparedness, Taylor and Francis 2000
7. Goel S.L. and Kumar Ram, Disaster Management, Deep and Deep Publications, 2001
8. Living With Risk: A global Review Of Disaster Reduction Initiatives 2004 Vision, United Nations, 2004.
9. Parasuraman S., India Disasters Report: Towards a Policy Initiatives, Oxford University Press, 2004.

Course Title: Microbial Technology for Pollution Abatement
Paper Code: EVS 618

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Introduction

Microbial diversity in the environment, classification, role of microbes in environment protection, management of resources, bioindicators, biosensors - types and applications in environmental pollution detection and monitoring.

(12 Lectures)

Unit 2: Environmental bioremediation

Bioremediation, biotransformation and biodegradation**,** microbial interactions with inorganic pollutants - Microbial metal resistance; Microbial transformation; accumulation and concentration of metals; biosorption, bioleaching and biobenificiation, Bioaccumulation; Microbial leaching of low grade mineral ores, molecular probes for organisms in mines and mine tailings, Petroleum pollutant biodegradation, Improved oil recovery. Biofertilizer, biopesticides from microbes in pollution abatement.

(16 Lectures)

Unit 3: Ecofriendly products

Development of biodegradable and eco-friendly products –biopolymers, bioplastics, use of micro-organisms in waste treatment, composting and methane production, biofuel-biohydrogen, bioethanol, Microbial fuel cells. Fermentation Technology- Bioreactors; industrial fermentation, types of fermentation processes; Enzyme Technology- Production, recovery, stability and formulation of Primary and secondary metabolites- Alcohol (ethanol), acids, solvents, antibiotics, amino acids; Extracellular enzymes -amylase, protease, glucose isomerase; Enzyme and cell immobilization and their industrial applications, Mushroom cultivation for waste management.

(16 Lectures)

Unit 4: Genetically Modified Organisms and Environment

Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Microbial bioengineering for chemical biosynthesis, Transgenic plants-Pest and Disease Resistance, Herbicide resistant plants, Bt cotton, Genetically engineered insects**,** Relevance of Biosafety, Cartagena Protocol.

(12 Lectures)

Suggested Readings:

1. Sharma, P.D. (2005). Environmental Microbiology, Narosa Publishing House.
2. Sanai, V.S. (1990). *Fundamentals of Soil.* Kalyani Publishers, New Delhi.
3. Sharma, B.K.(2000). *Environmental Chemistry*, Goel Publishing House, Meerut.
4. Okafor,N., (2011), *Environmental microbiology of aquatic and waste systems*, Springer, USA.
5. Yarón B., Calvet R. and Prost R. (1996).*Soil pollution: origin, monitoring and remediation.* Springer, USA.
6. Ronald L.C. and Don L.C. (1996). *Bioremediation: principles and applications.* Cambridge University Press, UK.