Department of Environmental Sciences and Technology
School of Environment and Earth Sciences

Central University of Punjab

Department of Environmental Sciences and Technology

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

Academic Session 2020 – 22 onwards

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

M.Sc. Program Outcomes

The programme focuses on

1. Relating the environmental issues and problems at the local, regional and global level
2. Application of acquired skills on various environmental monitoring techniques, instruments, pollution control technologies, data analysis and interpretation.
3. Developing new technologies and action plan to solve the problems of the environment
4. Designing experiments to perform research on environmental issues
5. Formulation of policies, legislations, conventions and protocols associated with the environment for better environmental management

Semester I

S.No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	EVS.506	Basics in Environmental Sciences/MOOC	F	4	0	0	4
2	EVS.507	Ecological Principles	C	4	0	0	4
3	EVS.508	Environmental Chemistry	C	4	0	0	4
4	EVS. 509	Basic Statistics	F	2	0	0	2
5	EVS. 510	EVS- Lab I Ecology (Practical)	C	0	0	2	1
6	EVS. 511	EVS – Lab II Environmental Chemistry	C	0	0	2	1
7	CST 501	Computer applications	F	2	0	0	2
8	EVS 541	Seminar I	SB	0	0	0	1
9	XXX	Interdisciplinary Course	IDC	2	0	0	2
For students of other departments							
1	EVS. 531	Non-Conventional Energy Systems	IDC	2	0	0	2
2	EVS 532	Waste Management in Our Daily life	IDC	2	0	0	2
3	EVS 533	Environmental Conservation	IDC	2	0	0	2
4	EVS 534	Introduction to Geoinformatics	IDC	2	0	0	2
5	EVS 535	Environmental Geology	IDC	2	0	0	2
6	EVS 536	Health and Hygiene	IDC	2	0	0	2
7	EVS.537	Environmental Issues and Policies in India	IDC	2	0	0	2
		Total		18	0	4	21

L: Lectures P: Practical Cr: Credits

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

Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper: 25 marks

Mid Semester Test-1: Subjective Type Test: 25 marks

End Semester Exam I: Subjective Type Test: 25 marks

End Semester Exam II: Based on Objective Type Tests: 25 marks

Total Marks: 100

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
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Semester II

Sl. No	Paper Code	Course Title	Course type	L	T	P	Cr
1	EVS.521	Environmental Geosciences	C	4	0	0	4
2	EVS.522	Water Pollution and Control Technologies	C	4	0	0	4
3	EVS.523	Energy and Environment	C	4	0	0	4
4	EVS.524	EVS- Lab III Water and Soil Analysis (Practical)	C	0	0	4	2
5	EVS.525	EVS- Lab IV Energy (Practical)	C	0	0	4	2
4	EVS.XXX	Elective I (Opt any one)/MOOC	DE	4	0	0	4
	EVS 526	Soil Pollution and Management	DE	4	0	0	4
	EVS 527	Environmental Nanotechnology	DE	4	0	0	4
	EVS 528	Natural Resource Management	DE	4	0	0	4
5	EVS 542	Seminar II	SB	0	0	0	1
6	XXX	Interdisciplinary Course	IDC	2	0	0	2
		For students of other departments					
1	EVS. 531	Non-Conventional Energy Systems	IDC	2	0	0	2
2	EVS 532	Waste Management in Our Daily life	IDC	2	0	0	2
3	EVS 533	Environmental Conservation	IDC	2	0	0	2
4	EVS 534	Introduction to Geoinformatics	IDC	2	0	0	2
5	EVS 535	Environmental Geology	IDC	2	0	0	2
6	EVS 536	Health and Hygiene	IDC	2	0	0	2
7	EVS.537	Environmental Issues and Policies in India	IDC	2	0	0	2
		Total		18	0	8	23

L: Lectures P: Practical Cr: Credits

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

Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper: 25 marks
Mid Semester Test-1: Subjective Type Test: 25 marks
End Semester Exam I: Subjective Type Test: 25 marks
End Semester Exam II: Based on Objective Type Tests: 25 marks
Total Marks: 100

***Students have to compulsorily complete two-week summer training in an Industry. This would be a non-credit course**.

Department of Environmental Sciences and Technology
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Semester III

Sl. No	Paper Code	Course Title	Course type	L	T	P	Cr
1	EVS. 551	Principles of Geo-spatial Technology	C	4	0	0	4
2	EVS.552	Instrumental Methods of Analysis	C	4	0	0	4
3	EVS.553	EVS- Lab VI Instrumental methods and Geospatial techniques (Practical)	C	0	0	4	2
4	EVS 560	Industrial Visit/Field Visit/Survey and Report Writing	E	0	0	2	1
5	EVS XXX	Elective- II (Opt any one)/MOOC	DE	4	0	-	4
	EVS 556	Waste Management	DE	4	0	-	4
	EVS 557	Ecotoxicology and Occupational Safety	DE	4	0	-	4
	EVS 558	Natural hazards and Disaster Management	DE	4	0	-	4
	EVS 559	Microbial Technology for Environmental Pollution Abatement	DE	4	0	-	4
6	EVS 599	Project work	SB	0	0	12	6
7	XXX	VAC	VAC	1	0	0	1
	For students of other departments						
	EVS 503	Turning waste into product	VAC	1	0	0	1
		Total		13	0	18	22

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

 # Choice based credit system: C- Core courses; E- Elective courses; VAC: Value added course

Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper: 25 marks
Mid Semester Test-1: Subjective Type Test: 25 marks
End Semester Exam I: Subjective Type Test: 25 marks
End Semester Exam II: Based on Objective Type Tests: 25 marks
Total Marks: 100

Department of Environmental Sciences and Technology
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Semester IV

Sl. No	Paper Code	Course Title	Course type	L	T	P	Cr
1	EVS. 571	Environmental Impact Assessment and Auditing	C	4	0	0	4
2	EVS.572	Emerging Trends and Techniques in Environmental Science	C	4	0	0	4
3	EVS 573	Air & Noise: Pollution and Management	C	4	0	0	4
4	EVS 574	Re-drafting Environmental Science - I	DEC	2	0	0	2
5	EVS 575	Re-drafting Environmental Science - II	DEC	2	0	0	2
6	EVS 576	EVS- Lab V Air & Noise pollution (Practical)	C	0	0	4	2
7	EVS.599	Project work	SB	0	0	12	6
8	XXX	VAC	VAC	1	0	0	1
		For students of other departments					
	EVS 503	Turning waste into product	VAC	1	0	0	1
		Total		17	0	16	25

L: Lectures T: Tutorial P: Practical Cr: Credits
 # Choice based credit system: C- Core courses; DEC- Discipline Enrichment course; E-Elective courses; VAC: Value added course

Continuous Assessment: Based on average of best two Surprise tests, Assignment and Term Paper: 25 marks
Mid Semester Test-1: Subjective Type Test: 25 marks
End Semester Exam I: Subjective Type Test: 25 marks
End Semester Exam II: Based on Objective Type Tests: 25 marks
Total Marks: 100

Note:

a) flexibility to conduct the curriculum field work any time during the semester as per the possibility
b) shifting the credits of the field work/industrial/ study tour to the subsequent semesters if unable to conduct them as per the approved curriculum due to unavoidable circumstances like pandemic or any others.

Department of 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 506

L	T	P	Cr
4	0	0	4

Learning outcomes:

At the completion of the course, the learner will be able to:

- Relate to the multidisciplinary nature of environmental science as discipline
- Interpret the relationship among different spheres of the environment
- Discuss the current global environmental issues
- Inspect various environmental laws and regulations

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.

(15 Lectures)

Unit 2: Structure of the Environment

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

(15 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.

(15 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

(15 Lectures)

Suggested Readings:

1. Cunningham, W. P., Cunningham, M. A. (2016). *Principles of Environmental Science, Inquiry and application*, McGraw Hills Education.
2. Chiras, D. D. (2014). *Environmental Science, 10th ed.* Janes & Bartlett Publishers.
3. Dave, D. 2012. *Environmental Studies*, Publisher, CENGAGE learning.

4. Cunningham, W. P, Cunningham, M. A. (2015). *Environmental Science – A global concern, 13th edition,* McGraw Hills Education Publisher.
5. Prasad, G. (2002). *Conservation of natural Resources*, New Delhi: Discovery Publishing.
6. Luthens, F., Tarbuck, E. (2015). *The atmosphere: An introduction to meteorology,* Pearson Publications.
7. Khoiyangbam, R. S., Navindu, G. (2015). *Introduction to Environmental Science,* New Delhi: TERI.
8. Grotzinger, J. P., Jordan, T.H. (2019). *Understanding Earth,* New York: Freeman & Company.

Mode of Transaction: Lecture, power point, demonstration, case study, co-operative learning, group discussion, e learning

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Ecological Principles
Paper Code: EVS 507

L	T	P	C
4	0	0	4

Learning Outcomes
Student will be able to:

- Classify and characterize different types of ecosystems
- Examine imbalance of biogeochemical cycles
- Distinguish between population dynamics and community dynamics
- Identify values and threats of biodiversity
- Demonstrate the strategies for biodiversity conservation
- Apply ecological principles in environmental studies and other disciplines

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

(15 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.

(15 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. Landscape ecology – principles and dynamics.

(15 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 (CBD), CoP 14 on CBD, National Mission on Sustainable Habitat and National Mission on Himalayan Ecosystem

(15 Lectures)

Suggested Readings:

1. Eugene P. Odum and Gary W. Barrett. (2018).Fundamentals of Ecology, 5th Edition. Cengage Learning.
2. Begon, M, Howrath, R.B. and Townsend, C.R. (2014). Essentials of Ecology, 4th Edition.John Wiley & Sons, Inc.
3. Larry L.Rockwood. (2015). Introduction to Population Ecology, Second Edition. John Wiley & Sons, Inc. and Blackwell
4. Peter J. Morin. (2011). Community Ecology, Second Edition. John Wiley & Sons, Inc. and Blackwell
5. Richard B. Primack. (2014).Essentials of Conservation Biology, Sixth Edition. Sinauer Associates, Inc.
6. Agren, G. I. (2011). *Terrestrial Ecosystem Ecology: Principles and Applications*, Cambridge University Press.
7. Day, J. W., Kemp, W. M., Alejandro, Y., and Byron, C. C. (2012). *Estuarine Ecology* (2nd Ed), Wiley-Blackwell Publishers.
8. Fa, J. E. (2011). *Zoo Conservation Biology (Ecology, Biodiversity and Conservation)*, Durrell Wildlife Conservation Trust.
9. Mandal, F. R. and Nepal, C. N. (2009). *Biodiversity: concepts, conservation and biofuture*, Asian Books.
10. Fath, B. (2019). *Encylopedia of Ecology*, Vol 1-5. Netherlands: Elsevier Publishers.
11. Joshi, B. D. Tripathi, C. P. M and Joshi, P. C. (2009). *Biodiversity and Environmental Management.* New Delhi: APH.
12. Joshi, P. C. and Joshi, N. (2009). *Biodiversity and conservation*, New Delhi: APH Publishing Co-operation.
13. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R. (2008). *Invasive Plants and Forest Ecosystems*, CRC Press / Taylor and Francis.
14. Lomolino, M. V., Riddle, B. R., Whittaker, R. J. and Brown, J. H. (2016). *Biogeography (5th Ed)*, Sinauer Associates.
15. Pandey, B. N. and Jyoti, M. K. (2012). *Ecology and Environment*, New Delhi: APH Publishing Co-operation.
16. Pahwa, S. (2011). *Forest & wildlife laws*, 1st edition, Global India Publications.
17. Rana, S. V. S. (2009). *Essentials of Ecology and Environmental Science (5th Ed)*, PHI Learning Pvt. Ltd.
18. Smith, T. M. and Smith, R. L. (2014). *Elements of Ecology, (9th Ed)*, Pearson.
19. Vandermeer, J. H., Riddle, B. R. & Brown, J. H. (2013). *Population ecology*: *First principle* (2nd Ed), Princeton University Press.
20. William, J. M., James, G. G. (2015). *Wetland*, Wiley-Interscience.
21. Sharma, P. D. (2018). *Ecology and Environment, 13th Edition*, New Delhi: Rastogi Publications.

Mode of transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Environmental Chemistry

Paper Code: EVS 508

L	T	P	C
4	0	0	4

Learning Outcomes

Student will be able

- To explain fundamentals of environmental chemistry and nuclear chemistry
- To analyze chemical processes in different matrices of the environment (air, water, soil)
- To recognize types of toxic chemicals in environment
- To apply principles of green chemistry to solve environmental pollution

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.

(15 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.

(15 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

(15 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.

(15 Lectures)

Suggested readings:

1. Ahluwalia, V.K, (2017). Advance Environmental Chemistry. Teri Press Publisher.
2. Weiner E.R, (2013). Application of Environmental Aquatic Chemistry: A practical guide. CRC Press Taylor & Francis Group.
3. Connell D.W, (2005). Basic Concept of Environmental Chemistry. Publisher: CRC Press.
4. Baird, C. and Cann, M. (2012). *Environmental Chemistry,* USA: W.H. Freeman.
5. Manahan, S. E. (2017). *Environmental Chemistry, 10th Edition*. USA: CRC Press.
6. Girard J. (2013). *Principles of Environmental Chemistry, 2nd Edition*. USA: James & Barlett Publishers.
7. Harrison R. M. (2007). *Principles of Environmental Chemistry,* UK: RSC Publishing.
8. Hillel, D. (2008). *Soil in the Environment: Crucible of Terrestrial Life, 1st edition.* USA: Academic Press.
9. Lancaster, M. (2016). *Green Chemistry: An Introductory Text,* UK: RSC Publishing.
10. Manahan, S. E. (2017). *Water chemistry: green science and technology of nature's most renewable resource,* USA: CRC Press.
11. Clark J. H. and Macquarrie, D. J. (2008). *Handbook of Green Chemistry and Technology*, UK: Wiley-Blackwell.
12. Ahluwalia, V. K., Malhotra, S. (2009). *Environmental Science*, Ane Books Pvt. Ltd.
13. Subramanian, V. (2011). *A Textbook of Environmental Chemistry*, New Delhi: I.K International Publishing House.
14. Kaur, H. (2018). *Environmental Chemistry*, Pragati Prakashan, Meerut.

Mode of transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Basic Statistics

Paper Code: EVS.509

L	T	P	C
2	0	0	2

Learning Outcomes: The learner will be able to:

- Apply the statistics as a tool to interpret the data
- Design the experiment for research purpose
- Analyze the sampling techniques for data collection
- Choose appropriate statistical technique for data representation

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. Sampling and Study Design

(8 Lectures)

Unit 3

Random experiments, Probability, combinatorial problems, conditional probability, Binomial Distribution.

(8 Lectures)

Unit 4

Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots; curve fitting; Hypothesis testing, t-test, z-test, $\chi 2$ test.

(6 Lectures)

Suggested Readings

1. Murray, R. S. and Larry, S. (2017). *Schaum's Outline of Statistics,* McGraw-Hill Education (ISE Editions).
2. Meyer, P. L. (2007). *Introductory Probability and Statistical Applications,* Oxford & IBH Publishers.
3. Hogg, R.V. and Craig, A.T. (2018). *Introduction to mathematical statistics*, Macmillan Pub. Co. Inc.
4. Croxton, F.E. and Cowden, D.J. (2014). *Applied General Statistics,* Taylor & Francis group.
5. Rohtagi, V. K. (2015). *An introduction to probability and statistics*, Wiley India private limited.

6. Carlson, K. A., Winquist, J. R. (2014). *An introduction to statistics: an active learning approach,* New Delhi: Saga publication limited.
7. Mohanty, P. K., Patel, S. K. (2015). *Basic statistics,* New Delhi: Scientific Publishers.
8. Sheldon M. R. (2017). *Introductory to Statistics,* Academic Press, Elsevier.
9. McClave, J. (2018). *Sincich Statistics,* Pearson Publisher.
10. Gupta, S. C. (2019). *Fundamental of Statistics,* Himalayan Publisher.

Mode of transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: EVS Lab I Ecology (Practical)

Paper Code: EVS.510

L	T	P	C
0	0	2	2

Learning Outcomes

Student will be able to:

- Apply techniques for qualitative and quantitative sampling of plant diversity
- Apply biochemical methods in ecological research of plant populations.
- Design scientific methods/experiments to study various ecological parameters and biodiversity in laboratory/field conditions

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.

Suggested Readings

1. Darrell Vodopich (2010). Ecology Laboratory Manual 1st Edition. McGraw-Hill Education
2. Magurran,A.E. (2003) Measuring Biological Diversity. Wiley-Blackwell
3. Misra,R. (2018).Indian manual of plant ecology. Scientific publishers
4. Stephen R. Gliessman (2014). Field and Laboratory investigations in agroecology, Third edition CRC Press.

Mode of transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: EVS Lab I Environmental Chemistry (Practical)

Paper Code: EVS.511

L	T	P	C
0	0	2	2

Learning Outcomes

Student will be able to:

- Apply techniques for qualitative and quantitative analysis for water, wastewater and soil
- Design scientific methods/experiments to study various pollutants in laboratory/field conditions

1. Lab safety procedures and protocols
2. Preparation of solutions of different molarity and normality
3. Acid base titrations
4. Determination of pH of water/soil sample.
5. Determination of conductivity of the water/ soil sample.
6. Determination of chloride ions in soil and water.
7. Complexometric titration for determination of hardness (Total, Ca, permanent and temporary).
8. Determination of sulphate by turbidometry
9. Determination of alkalinity
10. Estimation of salts by gravimetry

Suggested Readings

1. American Public Health Association (APHA) (2012). *Standard method for examination of water and wastewater,* 22nd edn. APHA, AWWA, WPCF, Washington.
2. Yadav, M. S. (2008). *Instrumental methods of chemical analysis,* Campus Books International. Delhi.
3. Quevauviller, P. (2006). *Analytical methods for drinking water: Advanced in sampling and analysis,* John Wiley Publisher.
4. Patnaik, P. (2010). *Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes,* London: CRC Press.
5. Nollet, L. M. L (2007). *Handbook of water analysis,* London: CRC Press.
6. Gupta, P. K. (2009). *Methods in environmental analysis water, soil and air,* Jodhpur: Agrobios.

Mode of transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Code: CST.501

Course Title: Computer Applications

L	T	P	C
2	0	0	2

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

- Use different operating system and their tools easily.
- Use word processing software, presentation software, spreadsheet software and latex.
- Understand networking and internet concepts.
- Use computers in every field like teaching, industry and research.

UNIT 1 (15 Hours)

Computer Fundamentals: Introduction to Computer, Input devices, Output Devices, Memory (Primary and Secondary), Concept of Hardware and Software, C.P.U., System bus, Motherboard, Ports and Interfaces, Expansion Cards, Ribbon Cables, Memory Chips, Processors, Software: Types of Software, Operating System, User Interface of popular Operating System, Introduction to programming language, Types of Computer.

UNIT 2 (15 Hours)

Computer Network: Introduction to Computer Network, Types of Network: LAN, WAN and MAN, Topologies of Network, Internet concept, WWW.

Word Processing: Text creation and Manipulation; Table handling; Spell check, Hyper-linking, Creating Table of Contents and table of figures, Creating and tracking comments, language setting and thesaurus, Header and Footer, Mail Merge, Different views, Creating equations, Page setting, Printing, Shortcut keys.

UNIT 3 (15 Hours)

Presentation Tool: Creating Presentations, Presentation views, working on Slide Transition, Making Notes Pages and Handouts, Drawing and Working with Objects, Using Animations, Running and Controlling a Slide Show, Printing Presentations, and Shortcut keys.

Spread Sheet: Entering and editing data in cell, Basic formulas and functions, deleting or inserting cells, deleting or inserting rows and columns, printing of Spread Sheet, Shortcut keys.

UNIT 4 (15 Hours)

Use of Computers in Education and Research: Data analysis tools, e-Library, Search engines related to research, Research paper editing tools like Latex.

Suggested Readings:

1. Sinha, P.K. Computer Fundamentals. BPB Publications.
2. Goel, A., Ray, S. K. 2012. Computers: Basics and Applications. Pearson Education India.
3. Microsoft Office Professional 2013 Step by Step https://ptgmedia.pearsoncmg.com/images/9780735669413/samplepages/9780735669413.pdf

Transactional Modes: PPT, Video, e-content, Google drive

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
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Course Code: EVS. 541

Course Title: Seminar I

L	T	P	C
0	0	0	1

Evaluation criteria for seminar for 50 marks

Report writing (Quality of content, language level, originality etc.)	20 marks
Presentation	15 marks
Knowledge about the topic accessed through questions/discussion	10 marks
Interaction, attentiveness and attendance during seminars	05 marks

Department of Environmental Sciences and Technology
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M.Sc. Environmental Sciences and Technology
Semester- II

L	T	P	C
4	0	0	4

Course Title: Environmental Geosciences

Paper Code: EVS.521

Learning Outcomes:

At the completion of the course, the learner will be able to:

- Relate various earth processes
- Explain the climate system of the earth
- Inspect the ocean circulation mechanism
- Assess the depletion of marine resources

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.

(15 Lectures)

Unit 2: Meteorology

Fundamentals of meteorology, Scales of meteorology, Parameters of meteorology- pressure, wind, Rotation of earth- Coriolis acceleration, angular momentum; temperature, humidity, radiation; Radiation Budget of Earth; Topographic effects.

(15 Lectures)

Unit 3: Climatology

The boundary layer; Local microclimate; Atmospheric movements; General meridional circulations: Hadley cells; Middle latitudes; Circulation of water and energy in atmosphere; Weather, and Climate in India; Seasons and monsoons; Climatic classification schemes; Biogeographical regions of the world; Impact on sea level in south Asian region.

(15 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; Ocean warming, Sea level rise

(15 Lectures)

Suggested readings:

1. Bell, F. G. (1998). *Environmental Geology: Principles and Practice,* USA: Blackwell Science Publisher.
2. Critchfield, H. J. (2008). *General Climatology,* Pearson Education India.

3. Kale, V. S. and Gupta, A. (2012). *Introduction to Geomorphology,* Bangalore: Orient Longman.
4. Singh, S. (2017). *Physical Geography,* Allahabad: Prayag Pustak Bhavan.
5. Strahler, A.N. (2013). *An Introduction to Physical Geography*, UK: John Wiley & Sons.
6. D. S. Lal. (2011). *Climatology,* Sharda Pustak
7. Veena. (2009). *Understanding earth science,* Delhi: Discovery.
8. Bell, F. G. (2007). *Basic environmental and engineering geology,* London: CRC Press.
9. Merritts, D., Menking, K., Wet, A. (2014). *Kirsten, Environmental geology: An earth systems science approach,* New York: W.H. Freeman & company.
10. Roy, R. (2013). *Introduction to general climatology,* New Delhi: Anmol publication private limited.
11. Siddhartha, K. (2014). *Oceanography: A brief introduction*, New Delhi: Kisalaya publications pvt. Limited.
12. Kusky, T. (2017). *The encyclopedia of earth science,* Viva book private limited.
13. Trujillo, A. P., Thurman, H.V. (2014). *Essentials of oceanography*, New York: Pearson education inc.
14. Grotzinger, J. P., Jordan, T.H. (2019). *Understanding Earth,* New York: Freeman & Company.

Mode of transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point, e-learning

Department of 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 522

L	T	P	C
4	0	0	4

Learning Outcomes

At the completion of the course, the learner will be able to:

- Apply water purification techniques to provide safe drinking water
- Develop wastewater treatment technologies for abatement of water pollution
- Inspect the working of water and wastewater treatment plants
- Formulate new wastewater discharge standards

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)

(14 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

(15 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.

(16 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, Jal Shakti Abhiyaan, Namami Gange, National Water Mission

(15 Lectures)

Suggested readings

1. Metcalf & Eddy. (2017). *Wastewater Engineering: Treatment, Disposal, Reuse* (4th Ed.). New Delhi: TMGHl.
2. Peavy, H. S., Donald, R. R., Tchobanoglous, G. (2017). *Environmental Engineering,* New York: McGraw-Hill Education.
3. Edzwald, J. K. (2011). *Water Quality & Treatment: A Handbook on Drinking Water,* McGraw-Hill Education.
4. Ujang, Z. (2006). *Municipal wastewater management in developing countries: Principles and Engineering,* Iwa Publishing.
5. Palmer, E. (2010). *Water pollution,* Apple Academic Press, Inc.
6. Mishra, S. K. (2009). *Assessment of Water Pollution,* APH Publishing corp.
7. Agrawal, S. K. (2013). *Water Pollution,* APH Publisher.
8. Singh, B. S., Kumar, R., Singh, M. R. (2012). *Water pollution and Environment,* Enkay Publishing house.
9. Thomas, S. V. (2008). *Water Pollution issues and development,* Nova science publishers.
10. Soggard, E. G. (2014). *Chemistry of advanced environmental purification processes of water: Fundamental and application,* Elsevier Publisher.
11. Singh, R. (2015). *Membrane technology and engineering for water purification: application, system design, and operation,* Elsevier Publisher.

Mode of Transaction: Lecture, power point, demonstration, case study, e learning, Experimentation, Tutorial, Problem solving, Self-learning

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Energy and Environment

Paper Code: EVS 523

L	T	P	C
4	0	0	4

Learning Outcomes:

Student will be able to:

- Classify types of energy sources
- Explain origin and composition of fossil fuels
- Demonstrate working principles and applications of non-conventional energy sources
- Analyze waste to energy conversion technologies
- Evaluate the environmental impacts of over exploitation of renewable energy sources
- Design models for maximum energy conservation in buildings

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.

(14 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, GRIHA norms; energy audit, national and international norms**,** Pradhan Mantri Ujjwala Yojana, Ujala Yojna, National Solar Mission, National Mission for Enhanced Energy Efficiency,

(16 Lectures)

Suggested Readings:

1. Ahmed F. Zobana and Ramesh C Bansal. (2011). Handbook of Renewable Energy Technology. World Scientific Publishing Company.
2. Abbi, Y. and Jain Shashank. (2015).Handbook on Energy and Environment management. The Energy Resources Institute.
3. Bent Sørensen. (2017). Renewable Energy- Physics, Engineering, Environmental Impacts, Economics and Planning, Fifth Edition. Academic Press, Elsevier Inc.
4. Sergio C. Carpareda. (2013). Introduction to biomass Energy Conversions. CRC press.
5. Sukhatme, S.P. (2000).Solar Energy – Principles of Thermal Collection and Storage.Tata McGraw Hill.
6. European Wind Energy Association.(2009).Wind Energy- The facts: A guide to the technology, economics and future of wind power. Routledge Publishers
7. Gupta, H., Roy, S. (2006). *Geothermal energy: An alternative resource for the 21st century*, Elsevier Science Ltd.
8. Lal, B., Sarma, P.M., (2011). *Wealth from waste: Trends and technologies*, TERI.
9. MNRE (2011). Griha manual volume - 3: Technical manual for trainers on building and system design optimization renewable energy application, Ministry of New and Renewable Energy.
10. Ottmar E., Ramón P., Youba S., Kristin, S., Susanne, K., Timm, Z., Patrick, E., Gerrit, H., Steffen, S., Christoph, S., Patrick, M. (2011). *Renewable energy sources and climate change mitigation: Special report of the intergovermental panel on climate change*, IPCC.
11. Pagliaro, M., Konstandopoulos, A. G. (2010). *Solar hydrogen: Fuel of the future*, Royal Society of Chemistry.
12. Prasad, S., Dhanya, M. S. (2012). *Biofuels,* New Delhi: Narendra Publishing house.
13. Rani, D., Mohd, K.K., Pawan, K. R., Alok, K. S. (2012). *Energy-water-waste nexus: For environmental management,* Narosa Publishing House.
14. Rathore, N. S., Panwar, N. L. (2007). *Renewable energy sources for sustainable development,* New India Publishing Agency.
15. Sawhney, G. S. (2012). *Non - coventional energy resources,* PHI Learning Private Limited.
16. Sukhatme, S. P. (2000). *Solar Energy – Principles of Thermal Collection and Storage,* Tata McGraw Hill.
17. Sunder I. (2010). *Bioenergy and sustainable development*, Sarup & Sons.
18. Tiwari, G. N. (2002). *Solar energy: Fundamentals, design, modeling and applications,* Narosa Publishers.
19. Zobaa, A. F., Bansal, R. (2011). *Handbook of renewable energy technology,* World Scinetific Publishing Co.
20. Bhushan, C. (2014). *State of renewable energy in India: A citizen's report.* Centre for Science and Environment, New Delhi.
21. Ramaswamy, S. (2009). *Energy, environment and sustainable development: Issues and Policies,* Delhi: Regal publications.
22. Glassley, W. E. (2014). *Geothermal energy: Renewable energy and the environment,* 2nd edition, London: CRC press.
23. Wolfson, R. (2017). *Energy environment and climate,* 3rd edition, London: W.W. Norton & company.

Mode of transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point

Course Title: EVS Lab III (Water and Soil Analysis)
Paper Code: EVS.524

L	T	P	C
0	0	4	2

Learning Outcomes

- Illustrate the different physio-chemical analysis of water, wastewater and soil
- Apply the appropriate method of physio-chemical analysis to research and field applications
- Estimate the pollution levels in water, wastewater and soil

Experiments

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) and ammonical nitrogen etc. in water and soil samples.
8. Determination of fluoride content in soil/ water.
9. Determination of nitrate and nitrite in water and wastewater samples.
10. Determination of phosphate in water and wastewater samples.

Suggested Readings:

7. American Public Health Association (APHA) (2012). *Standard method for examination of water and wastewater,* 22nd edn. APHA, AWWA, WPCF, Washington.
8. Yadav, M. S. (2008). *Instrumental methods of chemical analysis,* Campus Books International. Delhi.
9. Quevauviller, P. (2006). *Analytical methods for drinking water: Advanced in sampling and analysis,* John Wiley Publisher.
10. Patnaik, P. (2010). *Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes,* London: CRC Press.
11. Nollet, L. M. L (2007). *Handbook of water analysis,* London: CRC Press.
12. Gupta, P. K. (2009). *Methods in environmental analysis water, soil and air,* Jodhpur: Agrobios.

Mode of Transaction: Lecture, demonstration, Experimentation, Tutorial, Problem solving, Self-learning

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: EVS Lab IV (Energy)

Paper Code: EVS.525

L	T	P	C
0	0	4	2

Learning Outcomes

Student will be able

- To identify quality of any fuel sample
- To demonstrate the working principle of equipment in energy research

Experiments

1. Determination of Gross Calorific Value of fuel/straw samples using Bomb Calorimeter.
2. To determine the kinematic viscosity of the fuel sample by viscometer
3. To determine the flash point of the fuel 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 fuel sample
7. Preparation and characterization of biodiesel.
8. To estimate acid value of the fuel sample
9. To estimate iodine value of the sample
10. To design solar PV system
11. To design biogas plant
12. To estimate required wind turbine power

Suggested Readings

1. Francis, W. and Peters, M.C. (2013). Fuels and Fuel Technology: A Summarized Manual, 2nd Edition, Pergamon
2. Ahmad,M., Khan, M.A., Zafar, M. and Sultana,S. (2012). Practical Handbook on Biodiesel Production and Properties. CRC Press
3. Schmidt, P. (2010). Fuel Oil Manual 4th Edition. Industrial Press, Inc.
4. Solar Energy International (2004). Photovoltaics: Design and Installation Manual 1st Edition

Mode of transaction: Lecture, demonstration, discussion, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Elective I

Course Title: Soil Pollution and Management
Paper Code: EVS 526

L	T	P	C
4	0	0	4

Learning Outcomes
Student will be able

- To classify different types of rocks and minerals
- To explain processes in weathering and soil formation
- To identify soil types in India
- To determine the properties of soil
- To distinguish sources of soil pollutants
- To evaluate the impacts of soil pollution
- To explain types of soil erosion and salt affected soils
- To analyze causes and consequences of land degradation
- To recommend methods for conservation and reclamation of soil

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, CoP 14- Delhi Declaration, Land Restoration

(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, National Mission for Sustainable Agriculture

(16 lectures)

Suggested Readings

1. Alfred R. Conklin Jr. (2014). Introduction to soil chemistry- Analysis and Instrumentation.John Wiley & Sons Inc.
2. Humberto Blanco and rattan Lal. (2008). Principles of Soil Conservation and Management. Springer Netherlands
3. Dorian Green. (2017). Elements of soil conservation. Koros Press Ltd.
4. Mishra, P.C. (2008). Soil Pollution and Soil Organisms. APH Publishing Corporation
5. Rathore, H.S. and Nollet, L.M.L. (2012). Pesticides- Evaluation of Environmental Pollution. CRC Press
6. Botkin, D. B., Keller, Edward, A. (2007). *Environmental Science: Earth as a Living Planet*, 6th ed. USA: John Wiley & Sons.
7. Cutler, S. L. (1999). *Environment Risks and Hazard*, Delhi: Prentice Hall of India.
8. De, A. K. (2000). *Environmental Chemistry*, New Delhi : New Age International (P) Ltd. Publishers.
9. Hillel, D. (1982). *Introduction to Soil Physics*, Academic Press, New York.
10. Kapoor, B. S. (2000). *Environmental Sanitation*, New Delhi: S. Chand & Sons.
11. Raven, P. H., Berg, L.R. Hassenzahl, David M. (2008), *Environment.* 6th ed. John Wiley & Sons., USA.
12. Sanai, V. S. (1990) *Fundamentals of Soil*, Kalayani Publishers, New Delhi.
13. Sharma, B. K. (2000). *Environmental Chemistry*, Goel Publishing House, Meerut.
14. Singh, H. P., Batish, D. R. and Kohli, R. K. (2006). *Handbook of Sustainable Weed Management*. Haworth Press, Inc., USA.
15. Singh, R. A. (1997). *Soil Physical Analysis*, New Delhi: Kalayani Publishers.
16. Mishra, S. G., Vani, D. (2009). *Soil pollution*, Aph Publishing group.
17. Mirsal, I. A. (2008). *Soil pollution: origin, monitoring & remediation,* Springer, Berlin.
18. Stuart, A. (2010). *Soil Pollution,* apple academics, Oakville.
19. Irena, S. (2015). *Heavy metal contamination of soil: monitoring and remediation,* New York: Springer.
20. Havlin, J. L., Tisdale, S. L. (2011). *Soil fertility and fertilizers: An introduction to nutrient management,* New Delhi: PHI learning.
21. Blanco, H., Rattan, L. (2008). *Principles of soil conservation and management.* USA: Springer
22. Blum, W. E. H., Schad, P., Nortcliff, S. (2018). *Essentials of Soil Science: Soil formation, functions, use and classification* (World Reference Base, WRB), Borntraeger Gebrueder Publisher.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Environmental Nanotechnology

Paper Code: EVS.527

L	T	P	C
4	0	0	4

Learning Outcomes

On completion of the course, the learner will be able to:

- Relate the concept of nanotechnology and nanomaterials
- Choose appropriate methods for synthesis and characterization of nanomaterials
- Apply the technology of nanomaterials to environmental applications
- Inspect the fate and impacts of nanomaterials on environment and health

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).

(15 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.

(15 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 microfuel cell, fuel Cell, hydrogen storage.

(15 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. Ethical issues and safety issues.

(15 Lectures)

Suggested Readings:

1. Balaji S. (2010). *Nanobiotechnology,* Chennai: MJP Publishers.
2. Poole, C. P. Jr., Owens F. J. (2009). *Introduction to nanotechnology*, New Delhi: Wiley India.
3. Nouailhat, A. (2015). *An introduction to nanoscience and nanotechnology*, Wiley India.
4. Rubahn, H. G. (2008). *Basics of nanotechnology,* Weinheim: Wiley-VCH.
5. Lead, J., Smith, E. (Ed.). (2009). *Environmental and Human impacts of nanotechnology,* Wiley.
6. Hornyak, et al. (2009). *Fundamental of Nanotechnology,* London: CRC Press.
7. Theodore, L., Kunz, R. G. (2013). *Nanotechnology: Environmental implications and solutions,* New Delhi: Wiley & Sons inc.
8. Pillai, S. C., Lang, Yvonne, L. (2019). *Toxicity of Nanomaterials: Environmental and Healthcare Applications,* CRC Press.

Mode of Transaction: Lecture, power point, demonstration, e learning, Tutorial

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Natural Resource Management

Paper Code: EVS 528

L	T	P	C
4	0	0	4

Learning Outcomes

On completion of the course, the learner will be able to:

- Relate the importance of natural resources in the environment
- Discuss the causes of natural resource depletion
- Apply the various management strategies to protect and restore the natural resources
- Inspect various legal measures taken at the national and international level to conserve and restore natural resources

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.

(15 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; Jal Shakti Abhiyaan, Namami Gange, National Water Mission

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.

(15 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-CoP 14-Delhi Declaration; 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.

(15 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

(15 Lectures)

Suggested Readings:

1. Anderson, David A. (2013). *Environmental economics and natural resource management,* Taylor and Francis 4th Edition.
2. Gurdev, S. (2007). *Land resource management,* Oxford publishers.
3. Kathy, W. P. (2010). *Natural resources and sustainable developments,* Viva books.
4. Lynch, D. R. (2009). *Sustainable natural resource management for scientists and engineers,* Cambridge University Press.
5. Jaidev, S. (2010). *Natural resources in 21st century,* Oxford Publishers.
6. Mishra, S. P. (2010). *Essential Environmental Studies,* Ane Books.
7. Kudrow, N. 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, N. S. (2009). *Water resources management: Principles, regulations, and cases*. McGraw Hill Professional.
10. Beckman, D. W. (2013). *Marine environmental biology and conservation,* Jones and Barlett learning.
11. Primak, R. B. (2014). *Essentials of Conservation biology,* Sinauer Publishers, 6th edition.
12. Ghosh, A. (2010). *Natural resource and conservation and environment management,* Aph Publishing corp.
13. Mohanka, R. (2009). *Bioresources and human Environment,* APH Publishing Corporation, Delhi.
14. Raju, N. J., et al., (2014). *Management of Water, Energy and Bio-resources in the Era of Climate Change: Emerging Issues and Challenges,* Springer.
15. Mohanka, R., (2009). *Bioresources and Human Environment,* APH Publishing Corporation.
16. Kohli, R. K., Batish, D. R., et al. (2009). *Invasive Plants and Forest Ecosystems,* CRC Press.
17. Bravo, F., et al. (2008). *Managing forest ecosystems: the challenge of climate change*. Springer.
18. Balyani, R. (2012). *Indian Forest and Forestry,* Jaipur: Pointer Publishers.
19. Rao, N. (2008). *Forest Ecology in India. Colonial Maharashtra 1850-1950*. Cambridge University Press.
20. Jetli, K. N. (2011). *Mineral Resources and policy in India,* New Century Publications, Delhi.
21. Singh, C. K. (2018). *Geospatial Applications for natural Resources Management,* CRC Press.

Mode of Transaction: Lecture, power point, demonstration, case study, co-operative learning, group discussion, e learning

EVS.542 Seminar II

L	T	P	C
0	**0**	**0**	**1**

Evaluation criteria for seminar for 50 marks

Report writing (Quality of content, language level, originality etc.)	20 marks
Presentation	15 marks
Knowledge about the topic accessed through questions/discussion	10 marks
Interaction, attentiveness and attendance during seminars	05 marks

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology
Semester III

Course Title: Principles of Geospatial Technology
Paper Code: EVS.551

L	T	P	C
4	0	0	4

Learning Outcomes

The student will be able to:

- Identify geospatial tools- remote sensing, GIS and GPS
- Apply the concept of remote sensing and GIS for solving environmental problems
- Choose appropriate geospatial technique for environmental management

Unit 1: Introduction

Concept of space and time; Satellite based navigation system; Types of Satellites; Google Earth; Bhuvan; GPS; GAGAN; Space Agencies in India - History and Development; International Space Agencies; IRS Satellite Series.

(13 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; Microwave Remote Sensing, SAR, Drones

(16 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

(16 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.

(15 Lectures)

Suggested readings:

1. Lillisand, T. M., Keifer, R. W. (2007). *Remote sensing and image interpretation,* USA: John Willey and Sons.
2. Barrett, E. C. and Curtis, L. F. (1999). *Introduction to environmental remote sensing,* USA: Chapman and Hall Publishers.
3. Joseph, G. (2003). *Fundamentals of remote sensing,* Hyderabad: Universities Press.
4. Chang, K. (2002). *Introduction to geographic information systems,* USA: Tata McGraw-Hill.

5. Curran, P. J. (1988). *Principles of Remote Sensing,* ELBS: Harlow Longman Scientific and Technical.
6. Skidmore, A. (2010). *Environmental modelling with GIS and remote sensing*, New Delhi, Crc Press.
7. Shamsi, U. M. (2012). *GIS applications for water, wastewater, and stromwater systems,* CRC Press.
8. Bhatt, B. (2011). *Remote sensing and GIS,* New Delhi: Oxford university press.
9. Abbasi, T. (2010). *Remote sensing GIS and wetland management*, Discovery publishing house.
10. Shellito, B. (2017). *Geospatial technologies*, 4th edition, W. H. Freeman Publisher.
11. Singh, C. K. (2018). *Geospatial Applications for natural Resources Management,* CRC Press.

Mode of Transaction: Lecture, power point, demonstration, case study, group discussion, e-learning

L	T	P	C
4	0	0	4

Course Title: Instrumental Methods of Analysis
Paper Code: EVS.552

Learning Outcomes
Student will be able to:

- Introduce acid base equilibria
- Apply principles and steps in precipitation, complexation and titrations
- Explain principle, instrumentation and application of instruments
- Distinguish steps and working principle of spectrometric and thermogravimetric methods
- Describe the types, principle and applications of chromatographic techniques

Unit 1: Quantitative analysis

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

(13 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.

(15 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.

(16 Lectures)

Suggested readings:

1. Skoog D. A., Holler F.L. and Crouch, S. R. (2007). *Principles of instrumental analysis,* USA: Thomson Brooks/Cole Publishers.
2. Harris D. C. (1948). *Exploring Chemical Analysis,* 3rd edition. W. H Freeman & Company.
3. Holler F. J, Crouch S.R. (2014). *Skoog & West's Fundamental of Analytical Chemistry,* 9th edition, CENGAGE learning.
4. Ahluwalia V. K. (2015). *Instrument Methods of chemical analysis,* Ane Books Pvt. Ltd.

5. Ewing, G. W. (1985). *Instrumental methods of chemical analysis, 5th edition,* USA: McGraw Hill Publications
6. Patnaik, P. (2010). *Handbook of environmental analysis,* CRC Press, USA
7. Svehla G. (1996). *Vogel's qualitative inorganic analysis, 7th Edition,* Prentice Hall, USA
8. Wiersma G. (2004). *Environmental monitoring,* CRC Press, UK.
9. Eaton, A. D., Clesceri, L. S., Rice, E. W., 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.
10. Shukla, S. K., Srivastava, P. R. (1992). *Methodology for environmental monitoring and assessment,* New Delhi: Commonwealth Publishers.
11. Rajvaidya, N., Markandey, D. (2005). *Environmental Analysis and Instrumentation*, APH Publisher.
12. Chatwal, G. R., Anand, S. K. (2013). *Instrumental Methods of Chemical Analysis,* Himalaya Publishing House, New Delhi.
13. Skoag, D. A., Holler, F. J., Crouch, S. R. (2007). *Principles of Instrumental Analysis,* CENGAGE Learning.
14. Rouessac, F., Roussac, A. (2008). *Chemical analysis: modern instrumentation and techniques,* Wiley, England.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

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

Paper Code: EVS.553

L	T	P	C
0	0	4	2

Learning Outcome:

The students will be able to:

- Design various experiments for analysing the pollutants in environmental matrices.
- Apply remote sensing and GIS software for environmental problems
- Develop the analytical skills for handling instruments for quantitative analysis

Experiments

1. Familiarization with Google Earth and Bhuvan
2. Georeferencing of Toposheet and satellite Images
3. Digitization and thematic map creation.
4. Visual interpretation using IRS false color composite.
5. Digital image processing – supervised and unsupervised classification.
6. Calibration of volumetric glassware Pipette, Burette and Volumetric flask.
7. Potentiometric determination of pH of water/wastewater and soil samples.
8. Conductivity of water and wastewater samples using conductivity and TDS meter.
9. Working, standardization of DO meter and determination of DO of sewage water.
10. Working, standardization of flame photometer and plotting calibration curve for metal ions.
11. Working, of chromatographic techniques TLC, Column, HPLC and GC-MS.

Suggested readings

1. Kennedy, M. (2013). *Introducing geographic information systems with ArcGIS: A workbook approach to learning GIS,* Wiley & Sons Publications.
2. Kennedy, M. (2010). *The Global positioning system and ArcGIS*. Crc Press.
3. American Public Health Association (APHA) (2012). *Standard method for examination of water and wastewater*, 22nd edn. APHA, Washington.
4. Yadav, M. S. (2008). *Instrumental methods of chemical analysis*, New Delhi: Campus Books International.
5. Rajvaidya, N., Markandey, D. (2005). *Environmental Analysis and Instrumentation*, APH Publisher.
6. Chatwal, G. R., Anand, S. K. (2013). *Instrumental Methods of Chemical Analysis*, New Delhi: Himalaya Publishing House.
7. Skoag, D. A., Holler, F. J., Crouch, S. R. (2007). *Principles of Instrumental Analysis*, CENGAGE Learning.

Mode of Transaction: Lecture, demonstration, Experimentation, Tutorial, Problem solving, Self-learning

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology
Elective II

Course Title: Waste Management

Paper Code: EVS 556

L	T	P	C
4	0	0	4

Learning Outcomes

On completion of the course, the learner will be able to:

- Relate the sources of waste generation
- Inspect the reasons for waste generation
- Apply various treatment and disposal techniques to manage the solid waste
- Formulate new strategies for managing the solid and hazardous waste
- Assess the various legal framework of solid waste management.

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.

(15 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.

(15 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 (15 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.

(15 Lectures)

Suggested Readings:

1. Williams, P. T. (2013). *Waste treatment and disposal*, John Wiley Publishers.
2. Johri, R. (Ed.). (2009). *E-waste: Implications, regulations and management in India and Current global best practices,* TERI press.
3. Letcher, T. M. (Ed.) (2011). *Waste: A handbook for management.* Academic Press London.
4. Sahai, S. (2009). *Bio- medical waste management*, APH Publishing.
5. Rosenfeld, P. E. (2011). *Risks of hazardous wastes,* London: Elsevier.
6. Hester, R. E. (ed.); Roy, M. H. (ed.) (2008). *Electronic waste management: design, analysis and application,* Cambridge Royal Society of Chemistry.
7. Smith, K. (2013). *Environmental Hazards: Assessing Risk and Reducing Disaster,* Routledge Taylor & Francis group.
8. Cherry, P. M. (2016). *Solid and Hazardous waste management*, New Delhi: BCS publishers and Distributors.
9. Letcher, T. M., Vallero, D. (2019). *Waste: a handbook for management*, 2nd Edition, Academic Press.

Mode of Transaction: Lecture, power point, demonstration, case study, co-operative learning, group discussion, e learning, self-learning

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Ecotoxicology and Occupational safety

Paper Code: EVS 557

L	T	P	C
4	0	0	4

Learning Outcomes

On completion of the course, the learner will be able to:

- Relate the sources of environmental toxicants and their effects
- Inspect the routes of entry of different environmental toxicants
- Explain the techniques of toxicant monitoring
- Apply different prevention and control measures to ensure safety against occupational hazards

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.

(15 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.

(15 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.

(15 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.

(15 Lectures)

Suggested readings:

1. Tatiya, R. (2013). *Elements of industrial hazards: Health, safety, environment and loss prevention,* Taylor and Francis.
2. Theodore, L. (2012). *Environmental health and hazard risk assessment: Principles and calculations,* CRC Press.

3. Wong, M. H. (Ed.) (2013). *Environmental contamination: Health risks and ecological restoration,* CRC press.
4. Ware, G. M.(Ed) (2007). *Reviews of environmental contamination and toxicology*. Vol. 190: *Continuation of residue reviews,* Springer Publishers.
5. Manahan, S. E. (2013) F*undamentals of environmental and toxicological chemistry: Sustainable sciences,* CRC press.
6. Landis et al. (2011). *Introduction to environmental toxicology: molecular substructures to ecological landscapes,* CRC Press.
7. Greim H. (Ed.) (2008). *Toxicology and risk assessment: A comprehensive introduction,* John Wiley.
8. Dong, M. (2018). *An introduction to toxicology*, 4th edition, CreateSpace independent Publishing Platform.

Mode of Transaction: Lecture, power point, demonstration, case study, e learning

Department of 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.558

L	T	P	C
4	0	0	4

Learning outcomes:

On completion of the course, the students will be able to:

- Describe disaster management, hazard, vulnerability and risk assessment.
- Deliberate how remote sensing and GIS can be used for effective management of disasters.
- Outline the legal framework for disaster management.

Unit 1: Introduction to Disasters

Introduction to Natural and Manmade 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.

(15 Lectures)

Unit 2: Risk Assessment

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

(15Lectures)

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; Future satellites for disaster management.

(15 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; Scope of Disaster Management Law with reference to Disaster Management Bill 2005, Local Administration and disaster risk reduction; Relief and Rehabilitation; CoP25-Disaster Resilience; Global pandemics and use of technology for their management, Sendai Framework for Disaster Risk Reduction.

(15 Lectures)

Suggested Readings

1. William H. D., Bruce R. M. (1986). *Geology and Engineering,* Iowa: WCB Publishers.
2. John M. W., Peter V. H., (1977). *Atmospheric Science: An Introductory Survey,* New York: Academic Press.
3. Barbar W., Murk et. al., (1996). *Environmental Geology,* John Wiley & Sons, New York.

4. Bohle, H. G., Downing, T. E., Watts, M. J. *Climate change and social vulnerability: the sociology and geography of food insecurity,* Global Environmental Change. No.4, pp. 37-48.
5. Collins L.R., Schneid, T. D. (2000). *Disaster Management and Preparedness*. Taylor and Francis.
6. Goel S. L., Kumar, R. (2001). *Disaster Management*, Deep and Deep Publications.
7. Parasuraman S. (2004). *India Disasters Report: Towards a Policy Initiatives*, Oxford University Press.
8. Yadav, R. K., Singh, R. (2013). *Hazard Analysis and Management.* New Delhi: Oxford Book Company.
9. Schwab, A. K. (2017). *Hazard mitigation and preparedness: An introductory text for emergency management and planning professionals,* CRC Press.
10. Jain, A. K. (2008). *A practical guide to disaster management*, Delhi: Pragun Publication.
11. Vaidyanathan, S. (2011). *An Introduction to disaster managements: Natural Disasters and manmade hazards*, New Delhi: Ikon books.
12. López-Carresi, A., et al., (2014). *Disaster management: International lessons in risk reduction, response and recovery,* New York: Routledge.
13. Kukal, S. S., Kingra, P. K. (2019). *Introduction to Environmental and Disaster Management*, Kalyani Publishers.
14. Mullick, N. H. (2011). *Disaster Management,* Enkay Publication House, New Delhi.
15. Shaw, R., Krishnamurthy, R. R. (2009). *Disaster Management: Global Problems and Local Solutions*, Hyderabad: Universities Press.
16. Arvind, A. (2009). *Environment and disaster management,* New Delhi: Shree Publishers.
17. Smith, K. (2013). *Environmental Hazards: Assessing Risk and Reducing Disaster,* Routledge: Taylor & Francis group.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Microbial Technology for Pollution Abatement
Paper Code: EVS 559

L	T	P	C
4	0	0	4

Learning Outcomes
Student will be able to:

- Explain role of microbes in the environment
- Analyze biosensors for environmental pollution detection and monitoring
- Apply bioremediation techniques for pollution control and management of xenobiotics
- Develop ecofriendly products from metabolic processes of microorganisms
- Discuss risks and benefits of genetically modified organisms in the environment

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.

(14 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.

(14 Lectures)

Suggested Readings

1. Sharma, P. D. (2005). *Environmental Microbiology,* Narosa Publishing House.
2. Sanai, V. S. (1990). *Fundamentals of Soil,* New Delhi: Kalyani Publishers.
3. Sharma, B. K. (2000). *Environmental Chemistry,* Meerut: Goel Publishing House.
4. Okafor, N. (2011). *Environmental microbiology of aquatic and waste systems,* USA: Springer.
5. Yarón B., Calvet R., Prost R. (1996). *Soil pollution: origin, monitoring and remediation,* USA: Springer.
6. Ronald L. C., Don L. C. (2005). *Bioremediation: principles and applications.* UK: Cambridge University Press.
7. Chandra, R., Dubey, N. K., Kumar, V. (2017). *Phytoremediation of Environmental Pollutants,* CRC Press.
8. Kaur, J. (2007). *Organic farming for sustainability,* Ludhiana: Academic book Depot.
9. Peppler, H.J., D. Perlman, (2012). *Microbial Technology: Microbial processes,* Amsterdam: Academic Press.
10. Maheshwari, D.K., Dubey, R.C. (2012). *Bioremediation of pollutants,* I.K. International Publishing House, New Delhi.
11. Fulekar, M.H. (2010). *Bioremediation Technology: Recent Advances,* Netherlands: Springer.
12. Das, S. (2014). *Microbial biodegradation and bioremediation,* London: Elsevier.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Title: Industrial Visit/Field Visit and Report Writing

Paper Code: EVS 560

L	T	P	C
0	0	0	1

Learning Outcomes

On completion of the course, the learner will be able to:

- Relate the theoretical knowledge gained in lectures to practical studies in field
- Inspect the working mechanism of techniques used in industries for environmental monitoring
- Design experiments to implement theoretical and laboratory knowledge to field studies
- Choose appropriate demonstration skills for field/ action report preparation

Mode of Transaction: demonstration, Experimentation, Tutorial, Problem solving, Self-learning

EVS.599 Project Work

Evaluation criteria

L	T	P	C
0	0	12	6

The student will be evaluated (Satisfactory/ Not Satisfactory) based on

- Synopsis report
- Formatting and timely submission
- Quality of presentation
- Response to questions of the committee
- Continuous evaluation by the guide

Department of 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 571

L	T	P	C
4	0	0	4

Learning outcomes

On completion of this course students should be able to:

- Explain the major principles of environmental impact assessment
- List the different steps within environmental impact assessment
- Evaluate the implications of current rules and regulations in relation to environmental impact assessment
- Outline the key aspects of environmental audit and risk analysis
- Formulate an EIA report
- Analyse different case studies of EIA in practice

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; National Green Tribunal

(14 Lectures)

Unit 3: Environmental Auditing and Management

Definition and types of audits, Environment management plan (EMS), Guidelines for environmental auditing, methodologies for Environmental Auditing, Matrix methods and Battelle 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. Shrivastav A. K. (2011). *Environmental Impact Assessment,* APH Publishing Corporation.
2. Eccleston C. H. (2011). *Environmental Impact Assessment: a guide to best professional practices,* CRC Press.
3. Kulkarni, V., Ramachandra, T. V. (2009). *Environmental Management.* New Delhi: Capital Pub. Co.
4. Petts, J. (2005). *Handbook of Environmental Impact Assessment*. Volume 1 and 2, UK: Blackwell Publishers.
5. Glasson, J., Therivel, R., Chadwick, A. (2006). *Introduction to Environmental Impact Assessment,* London: Routledge.
6. Canter, W. L. (1995). *Environmental Impact Assessment*, New York: McGraw-Hill Science/ Engineering/ Math.
7. Fischer, T. B. (2007). *Theory and Practice of Strategic Environmental Assessment*, London: Earthscan.
8. Lawrence, D. P. (2003). *Environmental Impact Assessment: practical solutions to recurrent problems*, Hoboken NJ: John Wiley & Sons.
9. Morris, P., Therivel, R. (1995). *Methods of Environmental Impact Assessment*, London: UCL Press.
10. Petts, J. (1999). (ed) *Handbook of Environmental Impact Assessment.* volume 1 and 2, Oxford: Blackwell Science.
11. Therivel, R. and Partidario, M. R. (1996) (eds). *The Practice of Strategic Environmental Assessment,* London:Earthscan.
12. Vanclay, F. Bronstein, D. A. (1995) (eds). *Environmental and Social Impact Assessment,* Chichester: Wiley & Sons.
13. Wood, C. (2003). *Environmental Impact Assessment – A Comparative Review*, Prentice Hall, London.
14. Hosetti, B.B., Kumar, A. (2013). *Environmental Impact: Assessment and Management,* New Delhi: Daya Publishing House.
15. Chitkara, M. G. (2013). *Environmental Impact Assessment,* New Delhi: APH Publishing Corporation.
16. Khandeshwar, S. R., Raman, N. S., Gajbhiye, A. R. (2019). *Environmental Impact Assessment,* Dreamtech Press.
17. Morris, P., Therivel, R. (2009). *Methods of Environmental Impact Assessment,* London: Routledge.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Emerging Techniques in Environmental Science

Paper Code: EVS 572

L	T	P	C
4	0	0	4

Learning Outcomes

On completion of the course, the learner will be able to:

- Relate the significance of advanced wastewater treatment process over conventional process
- Inspect the emerging trends and techniques in environmental research
- Explain the process of carbon management and sustainable development
- Develop research ideas for dissertation/project

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, Biosensors.
(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. (14 Lectures)

Unit 4: Sustainable management

Brundtland Commission, Sustainable development – principles and practices in relation to economics and ecology, SDGs, National Missions in India related to SDGs; Green architecture and Green Buildings; 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; (14 Lectures)

Suggested Readings

1. Crittenden, J. C., Trussell, R. R. Hand D. W. (2005), *Water treatment: principles and design*,2nd edition, USA: Wiley Publishers.
2. Judd, S. (2011). *The MBR book: principles and applications of membrane bioreactors for water and wastewater treatment.* 2nd edition, UK: Butterworth-Heinemann publishers.
3. Okafor, N. (2011). *Environmental microbiology of aquatic and waste systems*, *1st edition,* USA: Springer publication.
4. Parsons, S. (2004). *Advanced oxidation processes for water and wastewater treatment,* London, UK: IWA Publication.
5. Tchobanoglous, G., Burton, F. L., Stensel, H. D. (2002), *Wastewater engineering: treatment and reuse,* USA: McGraw-Hill Science.
6. Kaur, J. (2007). *Organic farming for sustainability,* Ludhiana: Academic book depot.
7. Rajvaidya, N., Markandey, D. K. (2008). *Environment pollution control,* Delhi: Aph publishing corporation.
8. Noor, M. (2012). *Environment and water pollution: cause, effect and control,* Delhi: Cyber tech publications.
9. Klein, A. (2010). *Encyclopedia of environmental pollution and its control,* Oakville: Apple academic press.
10. Noor, M. (2011). *Low cost waste water technologies,* New Delhi: Cyber Tech Publications.
11. Fulekar, M. H., (2010). *Bioremediation Technology: Recent Advances,* Netherlands: Springer.
12. Das, S. (2014). *Microbial biodegradation and bioremediation,* London: Elsevier.
13. Peppler, H. J., Perlman, D. (2012). *Microbial Technology: Microbial processes,* Academic Press, Amsterdam.
14. Maheshwari, D. K., Dubey, R. C. (2012). *Bioremediation of pollutants,* New Delhi: I.K. International Publishing House.
15. Davis, M. (2019). *Water and wastewater engineering: design principles and practice*, 2nd edition, McGraw-Hiss Education.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study, group discussion, e learning, self-learning

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Air & Noise: Pollution and Management

Paper Code: EVS.573

L	T	P	C
4	0	0	4

Learning outcomes

On completion of this course students should be able to

- Analyze the causes and effects of air pollution.
- Describe the type and nature of air pollutants,
- Explain the methods of analysis of air pollutants and instruments involved
- List the methods available for air and noise pollution control
- Outline air quality management system

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.

(15 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.

(15 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.

(15 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.

(15 Lectures)

Suggested Readings:

1. Jeremy, C., Tiwary, A., Colls, J. (2009). *Air pollution: measurement, modeling and mitigation*, 3rd Edition, USA: Crc Press.
2. Clarke A. G. (1997). *Industrial air pollution monitoring: gaseous and particulate emissions,* USA: Springer.
3. Kenneth Jr., W., Davis, W. T., Warner C. F. (1998). *Air pollution and its origin and control,* 3rd edition, USA: Prentice Hall.
4. Cheremisinoff, N. P. (2002). *Handbook of air pollution prevention and control,* UK: Butterworth-Heinemann Publishers.
5. Rao, C. S. (2006). *Environmental pollution control engineering,* New Delhi: New Age International Publishers.
6. Schnelle, K. B., Dunn, R. F., ternes, M. E. (2017). *Air pollution control technology handbook,* Routledge Publisher.
7. Vallero, D. A. (2014). *Fundamentals of air pollution*. 5th edition, Academic Press, USA.
8. Wang, L. K., Pereira, N. C. (2010). *Advanced air and noise pollution control,* Humana Publisher.
9. Jacobson, M. Z. (2012). *Air pollution and global warming: History, Sciences and solutions,* Cambridge University Press.
10. Cooper, D. C. (2015). *Air pollution control*. Medtech Publisher.
11. Tiwari, A., Williams, I. (2018). *Air Pollution: Measurements, Modelling and Mitigation,* 4th Edition, CRC Press.
12. Klein, A. (2010). *Encyclopedia of Environmental Pollution and its Control,* Apple Academic Press.
13. Agrawal, S. K. (2009). *Noise Pollution*, APH Publishing Corporation.
14. Kumar, A. (2011). *Noise Pollution and its control,* New Delhi: Shree Publishers & Distributors.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Redrafting Environmental Science-I

Paper code: EVS 574

L	T	P	C
2	0	0	2

Course Outcome:

Student will be able to:

- Evaluate the knowledge gained on management measures of air, water, soil and noise
- Prepare for NET and other competitive examinations

Unit I: Water management (7 Lectures)

Hydrological cycle; Water as a universal solvent; Types, sources and impacts of water pollution. Water quality analysis; Indian standards for drinking water (IS:10500, 2012). Drinking water and wastewater treatment; Thermal, Marine Pollution and Radioactive pollution

Unit II: Air and noise management (8 Lectures)

Composition of air; photochemical reactions in the atmosphere, Oxygen and Ozone chemistry; Photochemical smog. Sources, types and impact of pollutants; air sampling and monitoring; Indian National Ambient Air Quality Standards; dispersion of air pollutants - Gaussian plume model, line source model and area source model. Control devices for particulate and gaseous pollutants; Indoor air pollution, Vehicular emissions and Urban air quality. Noise Pollution: Sources, effects, noise indices (Leq, L10, L90, L50, LDN, TNI); Noise control and abatement measures

Unit III: Soil management (8 Lectures)

Components of soils, minerals, weathering and soil formation, erosion, properties, soil types, biogeochemical cycles, soil pollution control, management and analysis.

Unit IV: Waste management and Environmental analysis (7 Lectures)

Solid waste collection and transportation; Solid waste processing and recovery; Waste treatment and disposal of solid wastes; Hazardous waste, e waste, plastic waste, fly ash, biomedical waste management. Titrimetry, gravimetry, spectrophotometery and chromatography

Mode of transaction: Power point, E-tutoring, discussion

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Redrafting Environmental Science-II

Paper Code: EVS 575

L	T	P	C
2	0	0	2

Learning Outcome:
Student will be able to:

- Recall the concepts and applications of ecological principles, geosciences, energy and environmental impact assessment
- Prepare for NET and other competitive examinations

Unit 1: Environmental Biology

Major concepts in Ecology, Ecosystem Dynamics- structure, function, types and characteristics, energy flow models, biomes. Population ecology, Community ecology, Biodiversity and its Conservation, Environmental Biotechnology (7 Lectures)

Unit 2: Environmental Geosciences

Radiation Budget, Plate tectonics, Climate of India, Indian Monsoons, Natural Hazards and Disaster Management, Principles and Applications of remote sensing and GIS (7 Lectures)

Unit 3: Energy and Environment

Sun as energy source, fossil fuels, nuclear energy, Renewable energy sources- solar energy, hydro-power, tidal energy, ocean thermal energy conversion, wind power, geothermal energy, bioenergy – Principle and applications. (7 Lectures)

Unit 4: EIA and Environmental Legislations

Environmental Impact Assessment (EIA)- Objectives, methodologies, Risk Assessment, Environmental Laws in India, Environmental Conventions and Agreements, Current Environmental Issues in India (7 Lectures)

Mode of transaction: Power point, E-tutoring, discussion

Department of 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)

Paper Code: EVS.576

P	Cr	Marks
4	2	50

Learning outcomes

On completion of this course students should be able to

- Explain the methods of analysis of air pollutants
- Enlist the instruments for air pollution measurements
- Develop the analytical skills for quantitative analysis of air and noise pollution
- List the methods available for air and noise pollution control
- Design various experiments for analyzing the air pollutants

Experiments

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.

Suggested readings

1. Gupta, P. K. (2018). *Methods in environmental analysis: water soil and air,* 2nd Edition. Jodhpur, India: Agrobios Publication.
2. Patnaik, P. (2017). *Handbook of environmental analysis: chemical pollutants in air, water, soil and solid wastes*, 3rd Edition, London: Crc press.
3. Hess-Kosa, K. (2018). *Indoor air quality: The latest sampling and analytical methods,* London: CRC press.
4. Maiello, M., Hoover, M. D. (2011). *Radioactive air sampling methods*, 1st Edition. CRC Press Book.
5. Lodge, J. P. (2017). *Methods of air sampling and analysis,* 3rd Edition, New York: Taylor & Fransic Group.

Mode of Transaction: Lecture, demonstration, Experimentation, Tutorial, Problem solving, Self-learning

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Project Work

L	T	P	C
0	0	12	6

Paper Code : EVS.599

Evaluation criteria

The student will be evaluated (Satisfactory/ Not Satisfactory) based on

- Project report
- Formatting and timely submission
- Plagiarism
- Quality of viva presentation
- Response to questions of the committee
- Continuous evaluation by the guide

INTERDISCIPLINARY COURSES

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Paper Code: Non-Conventional Energy Systems

L	T	P	C
2	0	0	2

Course code: EVS. 531

Learning Outcomes: Student will be able to:

- Classify types of energy sources
- Explain origin and composition of fossil fuels
- Demonstrate working principles and applications of non-conventional energy sources

Unit-1

Energy related units in SI system of units, Energy scenario of the country, introduction of non-conventional technologies, status of different non-Conventional energy devices installation in the country (6 lectures**)**

Unit-2

Biomass, physical, chemical and thermal characterization of biomass; stoichiometric air-fuel ratio, biomass thermal conversion; biomass combustion, biomass gasifiers, types of gasifier, performance characteristics, application of producer gas thermal and engine. Economics (10 lectures)

Unit-3 Plant oils, Biodiesel production from plant oils, characteristics of biodiesel, application of biodiesel in engines. Bioethanol production from lignocellulosic agricultural residues, application of bioethanol in engines. (8 lectures)

Unit-4

Basics of solar radiation, Solar thermal systems; solar water heaters, solar dryers, solar cooking systems, solar photovoltaic power generation systems, introduction to wind mills. (8 lectures)

Suggested books:

1. Non-conventional, Renewable and Conventional by S.S. Rao and B.B. Parulekar. Khanna Publishers, Nai Sarak, Delhi.
2. Thermochemical Conversion of Biomass : Handbook of Biomass Downdraft Gasifier Engine System, Thomas B Reed and Aqua Das
3. Anaerobic Digestion of Biomass:Biogas Systems (Principles & Applications) by K.M. Mittal, New Age International (P) Ltd., New Delhi
4. Solar Energy: Solar Energy Fundamentals and Applications, H.P. Garg and J.Prakash, Tata McGraw-Hill Publishing Co. Ltd., New Delhi
5. Wind Energy: Hydraulic Machines by Abdula Sharif et. al., Published by Dhanpat Rai & Sons

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Waste Management in Our Daily life

Paper code: EVS 532

L	T	P	C
2	0	0	2

Unit 1: Waste

What is waste? Sources of waste generation; Composition and classification of waste; Sorting and segregation of waste at source of generation (kitchen, garden, residential colonies and commercial areas); waste collection – sample collection bins; storage and transport

(7 Lectures)

Unit 2 Waste processing and prevention

Waste prevention and recycling at home, small communities; reduce, recycle and reuse; Waste processing – size and volume reduction

(7 Lectures)

Unit 3: Waste treatment

Composting – vermicomposting, kitchen garden; anaerobic digestion – biogas, manure; waste to energy – pyrolysis, refuse derived fuels

(7 Lectures)

Unit 4: Disposal of waste

Safe disposal of waste; open dumping, problems of open dumping and burning; landfills; diseases associated with waste handling; Best practices for solid waste disposal

(7 Lectures)

Suggested Readings:

1. Ramachandra T.V., (2009), *Management of municipal solid waste*, published by TERI Press, New Delhi
2. Williams, P. T. Williams A. (2005), *Waste treatment and disposal*, 2nd Edition Wiley publications, UK.
3. Dhamija, U., (2009). *Sustainable solid waste management: issues, policies, and structures*. Academic Foundation, New Delhi.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Environmental Conservation
Paper Code: EVS 533

L	T	P	C
2	0	0	2

Learning Outcomes
Student will be able to:

- Analyse need and scope of environmental conservation
- Demonstrate methods of soil and water conservation
- Illustrate the approaches for biodiversity conservation
- Assess the ways to conserve energy at different sectors

Unit 1: Introduction

Man and environment, Importance of environmental conservation, natural resources, waste as a resource. (7 Lectures)

Unit 2: Soil and Water conservation

Land degradation, soil erosion, conservation measures – afforestation, mulching, Soil fertility restoration - organic manure application, need for sustainable water management, judicious water consumption at home, measures for effective irrigation – sprinkler, drip, watershed management, rain water harvesting, indigenous micro-irrigation devices. (7 Lectures)

Unit 3: Biodiversity conservation

Significance of biodiversity conservation, threats to biodiversity – pollution, population, habitat destruction, overexploitation, man- wildlife conflicts, strategies for biodiversity conservation - garden – herbal, ornamental, kitchen, organic farming and biodiversity conservation, conservation farming, national parks, sanctuaries, zoo, botanical gardens, Forest and wildlife conservation. (7 Lectures)

Unit 4: Energy conservation

Ways to conserve energy at home, offices, buildings, energy efficiency – electrical appliances, CFL, LEDs, OLEDs, clean fuels for vehicles (7 Lectures)

Suggested Readings:

1. Ahluwalia, V.K. (2013). Environmental Studies : Basic concepts, TERI.
2. Beheim, Einar (2010). Integrated watershed management: perspectives and problems, Springer.
3. Bhatt, S. (2004). Environment protection and sustainable development, APH Publishing Corporation.
4. Burchett, Stephen. (2010). Introduction to wildlife conservation in farming, Wiley-Blackwell.
5. Fa, John E. (2011). Zoo Conservation Biology (Ecology, Biodiversity and Conservation), Durrell Wildlife Conservation Trust.

6. Fatik B. Mandal. and Nepal C. Nandi. (2013). Biodiversity: concepts, conservation and biofuture, Asian Books.
7. Prasad, Govid. (2013). Conservation of natural Resources, Discovery Publishing.
8. Misra, S.P. (2018). Essential Environmental Studies 4/E. Ane Books
9. Pandey, S.N. and.Misra, S.P. (2018). Environment and Ecology, 2E. Ane Books

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Introduction to Geoinformatics
Paper Code: EVS 534

L	T	P	C
2	0	0	2

Learning Outcomes

The student will be able to:

- Identify geospatial tools- remote sensing, GIS and GPS
- Apply the concept of remote sensing and GIS for solving environmental problems
- Describe the history of Space Programme in India
- Enlist international and Indian space agencies

Unit 1

Remote Sensing: Fundamentals of Remote Sensing, Types of Remote Sensing; Visual Image interpretation; Digital Image Processing. (7 Lectures)

Unit 2

GIS - GIS and other information system; Maps and spatial information, Domains of spatial information system, Information presentation; Internet based GIS. (7 Lectures)

Unit 3

GPS - Introduction to GPS system, GPS receivers, advantages and limitations, Applications of Geoinformatics; Case studies in Indian context. (7 Lectures)

Unit 4

Indian space programmes, History of Development of Space Technology; Space Agencies in India and World; Indian Satellites; Satellite Data Repositories (7 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.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, Term papers

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Environmental Geology
Paper Code: EVS 535

L	T	P	C
2	0	0	2

Learning outcomes: The students should be able to

- Acquire knowledge about the issues related to human population growth and its impact on the natural resources
- Explain the ways that human activities contribute to natural disasters
- Analyse the cause of soil and water pollution and ways to prevent pollution
- Identify the current environmental issues in India and possible solutions

Unit –I: Fundamental of Environmental Geology

Concept and principle of Environmental Geology. Domains of the Earth: lithosphere, hydrosphere, atmosphere, biosphere. Soils and minerals: Formation of soils, soil weathering, types of soils, soil profiles, composition of soil, rocks types, and minerals, source of natural waters, water-rock interactions (7 lectures)

Unit –II: Environmental Pollution

Definition of environmental pollution and its types - point and non-point sources. Physical, chemical and biological agents found in water, air, and soil. Cause and effect air, water, and soil pollution. Interactions between anthropogenic activities such as industrialization, urbanization, agriculture, and mining and environment. Prevention of pollution (8 lectures)

Unit –III: Natural hazards

Concept and principles of natural hazards and disasters such as floods, droughts, earthquake, cyclones and landslides. Humans add to natural disaster. Man-made disasters, (wild fire, radioactive pollution, dam failure). Case studies in India. Disaster mitigation and management (8 lectures)

Unit –IV: Current Environmental Issue and possible solutions

Global warming, Acid rain, Ozone layer depletion. Acid Mine drainage (AMD), Groundwater depletion, Water stress and water scarcity, River interlinking conflict in India, Use of plastic, Narmada Dam, Tehri Dam, Soil Erosion, Deforestation (7 Lectures)

Suggested Readings:

- Bennet, M. R., Doyle P (2016). Environmental Geology: Geology and Human Environment. John Wiley & Sons.
- Arora, S. (2018). Environmental issues & challenges in India. Shrinkhala Publishing House
- Bhattacharya, R. (2012). Environmental Issues in India. Pragun Publication.
- Abel, D.C., (2014). Environmental Geology Today. Jones & Bartlett learning.

- Bell, F.G. (2007). Basic Environmental and Engineering Geology. CRC Press, London.
- Gill Robin (2015). Chemical Fundamentals of Geology and Environmental Geosciences. Wiley Blackwell.
- Barbar W. Murk et. al., (1996). Environmental Geology, John Wiley & Sons, New York.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Health and Hygiene
Paper Code: EVS 536

L	T	P	C
2	0	0	2

Learning outcomes: The students should be able to:

- Acquire knowledge about the issues related to human health
- Explain the mode of spread of communicable and non-communicable diseases
- Identify the current national programmes on community health

Unit –I

Health and hygiene, personal health, domestic hygiene, clean food and water, cooking with care, food hygiene and kitchen safety nutrients , malnutrition and processed food, food preservation and its impact, abstaining from habit forming substances, exercise, regular sleep and relaxation. (7 Lectures)

Unit –II

Community health national programmes on community health, health education; Environmental hygiene, environmental pollution, social responsibility. (8 Lectures)

Unit –III

Disease communicable and non-communicable diseases, epidemics, endemics communicable diseases spreading (direct and indirect); Measures to prevent diseases, protection from communicable diseases by immunization, innate immunity, acquired immunity. (8 lectures)

Unit –IV

First aid, bleeding, nose bleed, fainting, dehydration, animal bite burns; Occupational health; Recycling and reusing the biodegradables and dry waste. (7 Lectures)

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Department of Environmental Sciences and Technology
Scheme of Courses M.Sc.
M.Sc. Environmental Sciences and Technology

Course Title: Environmental Issues and Policies in India

Paper Code: EVS.537

L	T	P	C
2	0	0	2

Learning Outcomes: The students should be able to:

- Describe current environmental issues and concerns in India.
- Identify the magnitude of problem, current scenario and their impacts on human health and environment.
- Enlist the various government initiatives/policies and their progress.

Unit: 1

Air quality: state of pollution in major Indian cities; major air pollutants, their impacts on human health. Government initiatives to tackle air pollution: Central and State Pollution Control Board (CPCB), Continuous emissions monitoring system, SAFAR, National Clean Air Programme, Comprehensive Action Plan. (8 Lectures)

Unit: 2

Water quality: state of water pollution of major Indian rivers. Government action plans: National Water Quality Monitoring Programme, Namami Gange, and Zero Liquid Discharge.

Freshwater status and conservation in India. Ground water depletion and pollution.

(7 Lectures)

Unit: 3

Garbage Disposal and Sanitation; Electronic and plastic waste, Types of Plastic Waste, Plastic Waste Management Rules of 2016; Swachh Bharat Abhiyan. Open Defecation: open defecation eradication in India, community approaches to total sanitation.

Degradation of land, causes and mitigation strategies; United Nations Convention to Combat Desertification (UNCCD), and Reclaiming degraded lands. (8 Lectures)

Unit: 4

Energy situation and related environmental problems; coal & oil combustion pollution. Clean and green fuel; Pradhan Mantri Ujjwala Yojana, Ujala Yojna. Greenhouse Gas (GHG) emissions, Climate change; Wildlife and Biodiversity. (8 Lectures)

Suggested readings:

1. Singh, N., Thakur, A. K., Sharma, P. L., Sharma, P. (2016). Climate Change and Environmental Issues. The Energy and Resources Institute (TERI).
2. Metcalf and Eddy. (2015).Wastewater Engineering Treatment and Reuse. Mc Graw Hill Education (India) Private Limited.
3. John, H. (2015). Global Warming: The Complete Briefing. Cambridge University Press.

4. Gurjar, B. R., Molina, T., Ojha, C. S. P. (2010). Air Pollution Health and Environmental Impacts. CRC Press.
5. Abbi, Y. and Jain Shashank. (2015).Handbook on Energy and Environment management. The Energy Resources Institute.
6. Sinha, M., Sinha, R. K. (2016). Swachh Bharat. Prabhat Prakashan.

Mode of transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Value added Course

Course Title: Turning waste into product
Paper Code: EVS.503

L	T	P	C
2	0	0	2

Learning Outcomes: The students should be able to:

- Classify wastes.
- Analyze various types of waste to product recovery

Unit: 1

Waste: definition, types and characterization; origin and waste generation status in India, impact waste on health, livestock and environment. (7 Lectures)

Unit: 2

Waste to Energy: major waste to energy conversion routes –thermochemical, biochemical and physico-chemical. Biofuels: liquid fuels, such as ethanol, methanol, biodiesel, Fischer-Tropsch diesel; and gaseous fuels, methane and hydrogen; Refuse-derived fuel..

(8 Lectures)

Unit: 3

Waste to fertilizer: utilization of waste for fertilizer production: Animal Manure, Composting, Vermicomposting, Sewage sludge treatment; Bio fertilization in agriculture and their environmental impact. (8 Lectures)

Unit: 4

Waste to useful material; plastic waste: Recycling and transformation of plastic waste into useful material; methods of recycling plastic.

Case study: identify a type of waste and provide potential solutions to turn it to a value product.
(7 Lectures)

Suggested Readings:

1. Ramachandra T.V. (2009). Management of municipal solid waste. TERI Press
2. Rogoff, M., Screve, F. (2019). Waste-to-Energy: Technologies and Project Implementation. Academic Press.
3. Letcher, T. M.; Vallero, D. A. (2019). Waste: a handbook for management. Academic Press.
4. Polprasert, C., Koottatep, T. (2017). Organic Waste Recycling: Technology, Management and Sustainability. IWA Publishing.

Mode of transaction: Lecture, demonstration, Power point, discussion, assignments