



Fergusson College (Autonomous)

Pune

Learning Outcomes-Based Curriculum

For

M.Sc. - I - Environmental Science

With effect from June 2019

Program Structure

Semester	Course code	Course Title	Course	Credits	
Sem - I	EVS4101	Environmental Biology	T Core-1	4	
	EVS4102	Environmental Chemistry	T Core-2	4	
	EVS4103	Environmental Geo and Atmospheric science	T Core-3	4	
	EVS4104	Environmental Science Practical - I	P Core-1	4	
	EVS4105	Environmental Science Practical - II	P Core-2	4	
Sem - II	EVS4201	EIA and Environmental Audit	T Core-4	4	
	EVS4202	Water and Wastewater Treatment Technology	T Core-5	4	
	EVS4203	Biodiversity, Forestry and Conservation	T Core-6	4	
	EVS4204	Environmental Science Practical - III	P Core-3	4	
	EVS4205	Environmental Science Practical - IV	P Core-4	4	
Sem - III	EVS5301	Environmental Statistics	Special -1	4	
	EVS5302	Remote Sensing and GIS	Special -2	4	
	EVS5303	Climate Change and Sustainability	Departmental	4	
			Environmental Issues		General
			Environmental Sustainability		Mooc
	EVS5304	Summer Training	P Special -1	4	
EVS5305	Practical V	P Special -2	4		
Sem - IV	EVS5401	Environmental Law, Ethics, Policies	Departmental	4	
		Environmental Management Systems	General		
		Life Cycle Assessment	Mooc		
	EVS5402	Restoration and Watershed	Departmental	4	
			Green Technologies		General
			Ecology and Society		Mooc
	EVS5403	Environmental Health, Toxicology and Safety	Departmental	4	
			Energy Resources and Technologies		General
			Waste to Energy Conversion		Mooc
EVS5404	Practical VI	P Special -3	4		
EVS5405	Dissertation	P Special -4	4		

Programme Outcomes

PO1	Enrich Knowledge and skill: Demonstrate logical understanding of basic concepts principles and processes underlying the academic field of Environmental Science, its various subfields like Ecology, Earth surface processes, Pollution Control Technology, Environmental Health & Safety, Environmental Laws, Environmental Impact assessment, Toxicology, Waste treatment techniques, Renewable and non renewable energy resources, Restoration, Environmental Economics, Remote sensing and GIS, Climate Change and Sustainability, etc.
PO2	Environmental Experts: Methodological knowledge that creates different types of professionals in the field of Environmental science and related fields such as Environmental quality monitoring, Conservation Biology, Environmental Health & Safety, Environment Management Systems, etc.
PO3	Protection and conservation of Environment: Apply knowledge and skills in order to address Environmental issues and challenges for the protection and conservation of available natural resources and environment.
PO4	Enhance technical and research skills: Use Laboratory and field techniques relevant to academia and industry, generic skills and global competencies, including knowledge and skills that enable students to undertake further studies in the field of Environmental science.
PO5	Career perspectives: Undertake research and on field activities which develop problem solving abilities required for successful career in Environmental Science.
PO6	Importance and applications: Identify and appreciate the importance of the Environmental science and its application in academic, industrial, economic and social context.

EVS4101: Environmental Biology (4 Credits)

Units	Contents	Sessions
Course outcomes: <ul style="list-style-type: none"> • Students will learn the basic principles and theories of ecology as a science and how these can be applied in today's scenario of climate change and degradation of Environment. • They will be introduced to various ecosystems, their natural history and ecology. • They will understand the importance of life sustaining processes on earth. • Recognises the anthropogenic impact on important life supporting systems. • Understands the importance of Biosphere. • Classifies the types of Biomes with its characteristics • Understands the importance of community conserved areas as well as traditional knowledge. 		Suggested Pedagogical Processes <ul style="list-style-type: none"> • Group Discussions to understand biodiversity issues • Use of appropriate ICT tool, wherever necessary • Discussion on different theories of biodiversity and its distribution • Conducting field visits to plan and execute projects • Reviewing research papers for currents updates • Conducting SWOT analysis • Undertaking Case studies
1 Concepts and Scope	<ul style="list-style-type: none"> • Biosphere as an ecosystem, its ecological processes and life support systems. • Anthropogenic impact on the biosphere and its life support systems (Including Flora, Fauna, soil, climate, and atmosphere, terrestrial and aquatic ecosystems). • Role of biological processes in remedial measures and restoration. 	8
2 Fundamental Concepts of Ecology	<ul style="list-style-type: none"> • Ecology: definition, development and scope. • Ecology as an experimental science • Basic principles and laws of Ecology • Ecosystems: concept, components and functioning • Influence of environmental factors (including temperature, light, moisture, soil, nutrients) on organisms and their adaptations in response to them 	8
3 Population Ecology	<ul style="list-style-type: none"> • Population Ecology • Population Characteristics • Population Dynamics: Patterns of survival, age distribution, dispersal and rates of change. • Attributes of K- selected and r-selected species. • Population Growth 	8
4 Community Ecology	<ul style="list-style-type: none"> • Community Ecology • Community Characteristics • Competition, Exploitation (including herbivore, predation, parasitism), Mutualism (including commensalism, cooperation, symbiosis) • Food webs and concepts of niche and keystone species. • Succession, development, climax and stability of 	8
5 Terrestrial	<ul style="list-style-type: none"> • Climatic and edaphic factors of terrestrial biomes. • Heinrich Walter's Biome Climate Diagrams 	8

Biomes	<ul style="list-style-type: none"> • Classification of land biomes with their soil, Climate and vegetation characteristics. Their natural history, wildlife, geography and human influences. • Mountain Biome: Replication of latitudinal changes in the altitudes of high mountains. • Terrestrial biomes, ecosystem diversity, forest and vegetation types in India. 	
6 Freshwater and Marine Biomes	<ul style="list-style-type: none"> • Challenges and adaptations of life in aquatic biomes (freshwater: still and flowing, marine). • Freshwater Biomes (Rivers, streams, lakes, ponds) and their natural history • Marine Biomes (including mangroves, coral islands, kelp Forests, saltwater marshes, seashores, estuaries) and their natural history. • Wetlands – definitions, types, ecological functions and resources. 	8
7 Environmental Microbiology	<ul style="list-style-type: none"> • Classification of microbes and their metabolism and ecology • Micro-organisms and their association with man, animals and plants. • Role of microbes in bio-remedial processes, ecological restoration and other environmental applications. • Environmental factors affecting microbes, their cultivation and growth 	8
8 Ethno- biology	<ul style="list-style-type: none"> • Definition, Concept, History and Scope Stages of Ethno biology • Stage 1. Ethno ecology • Stage 2. TEK: Traditional Ecological Knowledge • Stage 3. Indigenous Intellectual Property and Rights • Moving toward more Local Participation • Ethno biology as Future 	8
<p>Learning Resources :</p> <ul style="list-style-type: none"> • Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. (1982) John Wiley and Sons. • Elements of Microbiology: Pelczar, M.J. and Chan ECS, 1981 McGraw Hill. • General Microbiology: Stainer, R.Y., Adelberg, E.A. and Ingraham, J.L. 1977. Macmillan Press. • Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. 1984. Academic Press. • Microbiological Methods for Environmental Scientists and Engineers: Gaudy, A.F. and Gaudy, E.T. 1980, McGraw Hill. • Fundamentals of Ecology: E. P. Odum • Modern concepts in Ecology: H. D. Kumar • Inorganic Chemistry of Earth: Fergusson J. E. • Introduction to Geochemistry: Krauskoph K Environmental Chemistry: Raiswell • Environmental Chemistry: S. E. Manahan 		

EVS4102: Environmental Chemistry (4 Credits)

Units	Contents	Sessions			
<p>Learning Outcomes:</p> <ul style="list-style-type: none"> • Students will be introduced to different instrumental methods of analysis with reference to principle, working and applications in the field of monitoring of environmental pollutants. • The details of instrumental techniques will also help to apply and develop research oriented mind in students • They will learn about impact of various environmental pollutants, their behavior and effects on the air, water and soil environments, as well as their effects on human health. • Green chemistry aspects will be studied in detail for treatment of wastes • Destruction of hazardous chemicals as an important aspect will enhance their knowledge required for industries 			<p>Suggested Pedagogical Processes</p> <ul style="list-style-type: none"> • Demonstrate and explain standard operational procedures for various instruments used in monitoring and analysing environmental pollutants. • Explain basics of chemistry of water, soil and air environment using charts, ICT etc. • Discuss environmental processing and various problems associated with pollutants with reference to local and popular case studies. • Encourage students to refer research papers and review articles in standard research journals to know the current updates in the subject and alternatives for better future. • Arrange group discussions and debates to aware students about pros and cons of developmental processes and its environmental impacts. 		
1 Environmental Analytical Chemistry Part A	<p>Principle, Instrumentation and Environmental Applications:</p> <ul style="list-style-type: none"> • Gravimetric analysis • Spectrophotometry • Atomic absorption spectroscopy • Flame photometry • Nephelometry and turbidometry • Polarography 	8			
2 Environmental Analytical Chemistry Part B	<p>Principle, Instrumentation and Environmental Applications</p> <ul style="list-style-type: none"> • Gas chromatography • High performance liquid chromatography • Ion exchange chromatography • X-ray fluorescence, x-ray diffraction, x-ray absorption • Neutron activation analysis • Isotope dilution analysis 	8			
3 Chemistry of Soil and Water	<p>Soil:</p> <ul style="list-style-type: none"> • Importance of soil and soil chemistry • Soil composition: minerals, organic matter, moisture, air • Soil pH , Soil acidity • Soil reactions: acid-base and ion exchange reactions • Essential elements: macro and micro elements <p>Water:</p>	8			

	<ul style="list-style-type: none"> • Chemistry of water • Structure and properties of water, • Importance of water. 	
5 Contaminants in Air Environment	<ul style="list-style-type: none"> • Classification of air pollutants: Gaseous and particulate pollutants, point and non-point source, Mobile and stationary sources. • Vehicular pollution: Meaning, causes, effects and solutions <p>a)Criteria Air pollutants: 1. Ground level ozone 2. Particulate matter 3. Carbon Monoxide 4. Lead 5. Sulfur dioxide 6. Nitrogen dioxide</p> <p>b)Hydrocarbons:</p> <ul style="list-style-type: none"> • Classification and sources of hydrocarbons • Environmental effects of hydrocarbons • Environmental degradation and abatement of Hydrocarbons. 	8
4 Contaminants in Water Environment	<p>Chemical contamination of water: From domestic, agriculture, industrial and other sectors.</p> <p>Major contaminants in water:</p> <ul style="list-style-type: none"> • Study of soaps and detergents, chemical pesticides and fertilizers, oil and grease, nutrients etc. on following aspects: <ol style="list-style-type: none"> 1. Sources, classification, characteristics and composition. 2. Environmental problems and toxicity 3. Abatement processes: Microbial decomposition and other treatment methods, Modified Detergents and alternatives. <ul style="list-style-type: none"> • Eutrophication: Concept, causes, abatement, case studies. 	6
		8
6 Contaminants in Soil Environment	<p>a)Polychlorinated Biphenyls (PCB's) :</p> <ul style="list-style-type: none"> • Need and uses of PCB's. • Fate of PCB's in environment. • Environmental effects and abatement procedures for PCB's pollution. <p>b)Chemical Pesticides :</p> <ul style="list-style-type: none"> • Classification • Environmental degradation, • Pollution due to pesticides and DDT problems <p>c)Heavy metals:</p> <ul style="list-style-type: none"> • Physical and chemical properties, behavior, human exposure, absorption, influence of Arsenic, lead and mercury on ecosystem. • Biomagnifications of metals in environment. <p>d) Synthetic Polymers</p> <ul style="list-style-type: none"> • Need ,classification, characteristics, • Environmental effects: occupational hazards, health effects, air, land, marine pollution 	10

	<ul style="list-style-type: none"> Abatement processes: Microbial decomposition, Polymer decay, photosensitive additives and alternatives for synthetic polymers. 	
<p style="text-align: center;">7</p> <p style="text-align: center;">Destruction of Some Hazardous Substances</p>	<ul style="list-style-type: none"> Destruction techniques, safety considerations, Mutagenicity assays. Destruction of acid halides and anhydrides and alkali metals Destruction of cyanides and cyanogens bromides, Destruction of chromium, aflotoxins 	6
<p style="text-align: center;">8</p> <p style="text-align: center;">Green Chemistry</p>	<ul style="list-style-type: none"> Introduction: Need and Goals of Green Chemistry Principles of Green Chemistry Tools of Green Chemistry: Green Starting Materials, Green Reagent, Green Chemical Products etc Green Chemistry and Sustainability Zero Waste Technologies 	6
<p>Learning Resources :</p> <ul style="list-style-type: none"> Instrumental Methods of Analysis by B. Sivasankar, Oxford University Press Environmental Chemistry by H. Kaur, Pragati Prakashan Textbook of Environmental Chemistry - Balram Pani, IK International Publishing House Delhi Fundamental Concepts of Environmental Chemistry, G. S. Sodhi, Narosa Publishing House Environmental Chemistry - A. K. Dey New Age International publishers Destruction of hazardous chemicals - G. Lunn, E. B. Sandome Hazardous substances in chemical lab - G. D. MuMivir Environmental Chemistry-B.K. Sharma, Goel publishing house, Meerut (U.P.), India. 		

EVS4103: Environmental Geo and Atmospheric Science (4 Credits)

Units	Contents	Sessions
1 Earth	<ul style="list-style-type: none"> • Origin of earth • Structure and composition of earth • Rock cycle and types. • Minerals • Geological time scale • Continental drift • Sea floor spreading and plate tectonic • Earthquakes, volcanoes 	10
2 Earth surface processes and landforms	<ul style="list-style-type: none"> • Weathering and erosion • Devian cycle of erosion • Landslides • Geomorphology of fluvial tracts, arid and coastal regions • Karst landscapes and glaciated region • Soil genesis and soil profile • Land use and Land capability classification 	10
3 Catchment hydrology	<p>Hydrological Cycle : Precipitation, Infiltration, Condensation, Evapo-transpiration and surface runoff</p> <ul style="list-style-type: none"> • Hydrological budget • Surface water, Ground water and Aquifers. 	5
4 Oceanography	<p>Oceanography :</p> <ul style="list-style-type: none"> • Concept and scope • Ocean basins and physical structure of the ocean floor • Ocean Currents, waves and tides • Thermohaline circulation and the global conveyor belt. • Current research in oceanography 	5
5 Atmospheric science	<ul style="list-style-type: none"> • Need of atmospheric studies in environmental sciences 	10

	<ul style="list-style-type: none"> • Evolution of atmosphere • Composition and structure of the atmosphere • Elements of weather and climate • Weather parameters (temperature, wind, pressure, relative humidity, rainfall) • Climatology of weather parameters, long-term and short term climatic effects. 	
<p style="text-align: center;">6 Insolation and atmospheric temperature, pressure</p>	<p>Insolation :</p> <ul style="list-style-type: none"> • Insolation, Basic laws of radiation, black body radiation • Factors affecting the distribution of Insolation • Earth's radiation budget, Net radiation and latitudinal heat balance <p>Atmospheric Temperature and pressure :</p> <ul style="list-style-type: none"> • Horizontal and vertical distribution of temperature, • Temperature inversion and its types • Pressure and wind belts • Factors affecting wind, Geotropic and gradient winds. 	10
<p style="text-align: center;">7 Air masses</p>	<ul style="list-style-type: none"> • Air masses • Classification and modifications of air masses • Characteristics and types of fronts • The jet stream 	5
<p style="text-align: center;">8 Environmental abnormal events</p>	<ul style="list-style-type: none"> • Thunderstorm and lightening • Tropical cyclone • Ozone depletion • El-Nino, La-Nina phenomena. • Floods • Droughts 	5
<p>Learning Resources :</p> <ul style="list-style-type: none"> • Savindra Singh .2002, Geomorphology, Prayag Pustak Bhawan, Allahabad. • Chamley, H. and Chamley, H. 2003. Geosciences, Environment and Man Elsevier Science & Technology • D.S Lal : Climatology, Sharda Pustak Bhawan, 2003 ISBN 8186204121, 9788186204122. • Majid Husain : Fundamentals of Physical Geography. • Parmodh Alexander. 2009, A Handbook of Minerals, Crystals, Rocks and Ores , By, New India Publishing. • Tarak Das Biswas, S.K. Mukherjee ,2001Textbook of Soil Sciences, Tata McGraw-Hill Education. • David Keith Todd, Larry W. Mays. 2005, Groundwater Hydrology, Wiley, • R. J. Garde . 2006, River Morphology, New Age International, Publication. • Robert H. Stewart.2009, Introduction to Physical Oceanography, University Press of Florida. • Richard Chorley and Roger G. Barry: Atmosphere, Weather and Climate. 		

EVS4104: Environmental Science Practical – I (4 credits)

- **Course Outcomes:**
- Practicals based on field techniques of vegetation studies by using various methods.
- Students will learn various indices to analyze and compare ecological studies.
- Students will be introduced to basic microbiological techniques
- Students will be competent to use GIS techniques for environmental biology.
- Practicals based on Environmental Chemistry will be helpful to increase laboratory skills in Water Quality monitoring.

Practicals based on EVS4101: Environmental Biology

1. Visit to a sacred grove/Forest / Grassland / Marine ecosystem to assess its biodiversity.
2. Vegetation studies by line and belt transects and quadrates.
3. Estimating frequency, Density and Abundance of species from Forest/Grassland area.
4. Calculation of Shannon and Simpson's Index for community comparison.
5. Study of Wetland or Riverine ecosystem (source region visit) and rapid assessment its vegetation.
6. To visit Forest/Coastal area and to conduct SWOT analysis.
7. Sterilization and media preparation for microbial techniques.
8. Classification of Bacteria by Gram Staining method.
9. Study of motility of bacteria by hanging drop technique.
10. Isolation and culturing of microbes from soil / water samples.
11. Methods used for sterilization and media preparation for microbial practicals.
12. Isolation of Nitrogen fixing bacteria from given soil sample. (Azotobacter/Rhizobium)
13. Calculation of Palmer Index from a given data..
14. To study association between species in a Forest area.
15. Using a hand held GPS instrument locate coordinates of a demarcated field site.
16. Mapping of water bodies using Bhuvan web portal
17. To conduct group field survey of birds and upload data on e bird web portal.
18. Collect matured leaves (minimum hundred for a class) from two different plants (e.g. Shishoo tree & Monkey biscuit tree). Measure and record the length (in cm.) along the midrib using a flexible thread. Tabulate the data, make frequency polygon, apply "t" test to the data and comment on the significance of the difference in leaf length between the two plant species.

Practical Based on EVS4102: Environmental Chemistry

1. Estimation of Turbidity by nephelometric method
2. Estimation of Na/K (alkali metals) from water/soil by Flame-photometry.
3. Estimation of Alkalinity from the given water sample.
4. Estimation of phosphate from given water sample by Colorimetry and Spectrophotometry.
5. Estimation of Total hardness and Ca, Mg hardness from given water sample.
6. Determine of pH and Conductivity of water sample.
7. Visit to instrumentation laboratory.
8. Estimation of chlorides from water samples.
9. Estimation of acidity of the given water samples
10. Estimation of sulfates by Turbidometry from given water sample.
11. Visit to polluted aquatic systems to study impact of pollution like eutrophication.

EVS4105: Environmental Science Practical – II (4 credits)

Course Outcomes:

- Students will learn about the basics of deification of rocks and minerals.
- Students will be learn about Toposheet based analysis and interpretation of various geographical aspects.
- Students will understand the mapping system of various atmospheric parameters.
- Practicals based on Environmental Chemistry will be helpful to increase analytical laboratory skills

Practical Based On EVS4103: Environmental Geo and Atmospheric Science

1. Identification of Rocks.
2. Identification of Minerals
3. Mapping of Hazard zones in India – Earthquake mapping
4. Mapping of Hazard zones in India – Floods/ Landslides mapping
5. Visit to Geological Survey of India
6. Visit to IITM
7. Visit to Indian Metrological Department , Shimala Office
8. Introduction to Toposheet and its interpretation
9. To find out bifurcation ratio of given watershed.
10. To measure, length, perimeter and area of watershed from given Toposheet
11. To measure slope and aspect of river / water body from given Toposheet
12. To find out slope angle of watershed from given Toposheet.
13. To draw longitudinal profile of stream/ river or water body
14. To find out slope angle of watershed from given Toposheet.
15. Estimation of distribution of solar radiation / Insolation over Earth's surface
16. Exercises based on incoming and outgoing solar radiations
17. Plume dispersion model (case studies) (optional)
18. Diagrammatic representation of Climograph
19. Diagrammatic representation Wind roses Simple
20. Diagrammatic representation Wind roses Compound Station Model - Coding decoding and plotting of synoptic data
21. Exercises based on adiabatic lapse rates (Graphical / Calculation)
22. Visit to national oceanographic research institutes.

Practicals Based on EVS4102: Environmental Chemistry

1. Preparation of acid digest for heavy metal analysis.
2. Estimation of chromium form given water sample
3. Estimation of SPM and PM from atmosphere
4. Determination of SO _x from ambient air sample.
5. Determination of NO _x Determination of SO _x from ambient air sample.
6. Estimation of Carbon dioxide and hydrocarbon from air sample
7. Estimation of organic carbon and organic matter from soil.
8. Estimation of N/ P/ K from soil (3P)
9. Estimation of water holding capacity / bulk density and textural classification of soil.
10. To conduct market survey to study status of plastic utility and create awareness about treats and alternatives for plastic.

EVS4201
Environmental Impact Assessment and Environmental Audit
(4 Credits)

<p>Course Outcomes: The aim of the course is to learn the practices followed for EIA at national and international level. Mainly the contents focus on terminologies, practices and methodologies followed in relation with case studies. After completion of paper students will have understanding of</p> <ul style="list-style-type: none"> • Scope, importance and opportunities in EIA practices in relation with sustainable development aspects • Details about environmental impact assessment studies along with case studies of various developmental activities and importance of public participation • Administrative requirements and policies as per government guidelines • Methodologies followed for impact assessment, role of funding agencies and guidelines given by them • The details environmental management system and the requirements for environmental audit • Interdisciplinary nature of environmental sciences • Formats and techniques required to assess impacts, perform audits and to protect environment as per guidelines by government agencies 	<p>Suggested Pedagogical Processes:</p> <ul style="list-style-type: none"> • Demonstrate and explain practices followed for EIA studies with help of videos, PowerPoint presentations and notes. • Field oriented case studies will be given much emphasis. • Discussion on various EIA reports will be carried out with reference to national and international case studies. • Students will be asked to refer standard formats and research articles to get updated knowledge • Group discussion methods will be followed for clear-cut identification of outcomes of given topics • Various methods of EIA will be understood by using on-paper studies and key techniques for identification of impacts
--	---

Units	Contents	Sessions
Unit I	<p>Introduction</p> <ul style="list-style-type: none"> • Need for EIA: Scope and Objectives • History and evolution of EIA • EIA and sustainable development. • Indian Policies Requiring EIA • Components of EIA • Baseline Data • Identification of Key Issues • Risks to Environment and Human Health • Socioeconomic Impacts • National Environmental Policy Act (NEPA) 1969, USA 	6
Unit II	<p>A Step Forward in EIA</p> <ul style="list-style-type: none"> • EIA Notification 1994 • QCI/NABET Criteria for EIA consultant Organizations • National Plan of Action for Preventing Pollution of Coastal Waters from Land Based Activities • List of Ecologically Sensitive Areas • Project Technology and Associated Impacts • International Agreements and Commitments to Conventions • Importance of Coastal Management Zone Notification • Guidance Notes on Pre-Appraisal and Appraisal • Model Letters According to Environmental Clearance 	8
Unit III	<p>Methods Used in EIA</p> <ul style="list-style-type: none"> • The Role of Expert Judgment • Appropriateness of Methods for Developing Countries 	8

	<ul style="list-style-type: none"> • Ad Hoc Method • Checklists • Matrices • Sectoral Guidelines • The Systematic Sequential Approach • Networks • Simulation Modelling Workshops • Overlays and Geographic Information Systems • Rapid Assessment of Pollution Sources • Role of WTO, WB, UNEP and other Funding Agencies 	
Unit IV	<p>Guidelines by MoEFCC on Methodology</p> <ul style="list-style-type: none"> • Overview of Methods of Monitoring and Analysis • Key Activities and Likely Associated Air Pollutants • Models for Impact Predictions • Checklist for Ecological Impact Assessment • Guidance for Relevant Issues for Different Project Types • Good Practices of Prediction • Risk Assessment • Impact Mitigation Measures • Studies on Carrying Capacity • Project and Process Alternatives • Criteria for Environmental Grading of Large construction Projects 	8
Unit V	<p>EIA Notification 2006</p> <ul style="list-style-type: none"> • Requirements of Prior Environmental Clearance (EC) • Committees and Authorities under Notification • Stages in Prior Environmental Clearance Process for New Projects • Grant or Rejection of Prior Environmental Clearance • Validity, Transferability of EC • List of Projects/Activities Requiring Prior Environmental Clearance • Structure of Form 1 • Form 1 A: Check List of Environmental Impacts • Generic Structure of Environmental Impact Assessment Document • Procedure for Conduct of Public Hearing • Procedure Prescribed for Appraisal 	8
Unit VI	<p>Case Studies of EIA</p> <ul style="list-style-type: none"> • Infrastructure • Industrial Development • Energy Sector • Construction • Mining 	6
Unit VII	<p>Environmental Management Plan</p> <ul style="list-style-type: none"> • Significant or Unacceptable Impacts Requiring Mitigation • Mitigation Plans, Relief & Rehabilitation • Physical Planning, Financial Planning • Appropriate Resource Management • Environmental Health and Occupational Safety • Risk Assessment and Disaster Management Plan • Maintenance and Performance of Environment Control Systems • Functions of Environment Cell • Review of Environmental Management Plan 	8

Unit VIII	<p>Environmental Audit</p> <ul style="list-style-type: none"> • Types of Audit: Compliance Audit and Performance Audit • Importance of ISO 14000 Series: EMS • Criteria under ISO 14001 for Environmental Audit • ISO 45001: OH&S Audit and Applications • Environmental Audit under EPA (Rule 14, Form V) • Eco-Management and Audit Scheme • Importance of PDCA in Audit • Requirement of Documents under Environmental Audit • Audit Tools and Technology • Responsibilities of Auditor • Role of INTOSAI, International Training Organizations and Government Agencies in Audit 	8
----------------------	---	----------

Learning Resources :

- Environmental Impact Assessment: A Guide to Best Professional Practices. 2011, Charles H. and Eccleston. CRC Press.
- Environmental Impact Assessment: A Comparative Review. 2014, Chris Wood. Routledge.
- Peter Wathern. 2015, Taylor & Francis. Environmental Impact Assessment: Theory and Practice.
- Introduction to Environmental Impact Assessment .2005, John Glasson. Spon Press.
- Environmental Impact Assessment .2004, P. R. Trivedi. Laurier Books.
- Environmental Impact Assessment. 2014, N. S. Raman, A.R. Gajbhiye and S.R. Khandeshwar. I K International Publishing House Pvt. Ltd.
- Environmental Impact Assessment Methodologies.2010, Y. Anjaneyulu. B.S. Publications.
- Environmental Impact Assessment: Theory and Practice. 2016, M. Anji Reddy. B. S. Publications.
- Environmental Impact Assessment .1996, L. W. Canter. McGraw Hill, New York.
- Environmental Impact Assessment: A Practical Guide.1997, Betty Bowers Marriott. McGraw Hill Education Publisher.
- Environmental Impact Analysis Handbook.1980, John G. Rau, David C. Wooten. McGraw Hill Higher Education.
- Environmental Impact Assessment. 2012, R.R. Barthwal. New Age International Private Limited.
- S. A. Abbasi and N. Ramesh. 2003, The Theory and the Practice of Environmental Impact Assessment. DPH, New Delhi.
- Petts, J. 2005, Handbook of Environmental Impact Assessment. Volume 1 and 2. Blackwell Publishers, UK.
- Glasson, J. Therivel, R. and Chadwick, A., Routledge.2006, Introduction to Environmental Impact Assessment. London.
- EIA reports for various sectors available on the official website of Ministry of Environment, Forest and Climate Change (www.envfor.nic.in)
- United Nations Reports and Guidelines on Environmental Impact Assessment.

EVS4202:
Water and Wastewater Treatment Technology
(4 Credits)

Units	Contents	Sessions
<p>Learning Outcomes:</p> <ul style="list-style-type: none"> • The concepts of waste water treatment and applications are introduced in syllabus. • Problems based on population forecasting and its computation by various methods will give idea about quantum of waste generation. • The guidelines given by various agencies regarding water quality will help them to understand actual quality and current status of water. • Practical approach on designing of water treatment plants its operation and maintenance will help students. • Students will understand the role of biological treatment processes and advance treatment processes for improving treatment efficiency. • Current trends in water treatment are introduced to students. <p>Suggested Pedagogical Processes:</p> <ul style="list-style-type: none"> • Provide theoretical data to students for designing of ETP and drawing flow charts for various industries like textile, paper, distillery etc. • Use charts, working models to explain working and operation mechanisms of various treatment units of ETP. • Arrange visit to ETP and STP units for better understanding of actual treatment processes, its limitations and scope for improvement. • Encourage students to develop lab scale models for effluent treatment with reference to specific industry. • Discuss water quality parameters before and after treatment with reference to water quality standards for effluent discharge. 		
1 Water requirements	<p>Population forecasting methods :</p> <ul style="list-style-type: none"> • Arithmetical progression method, Geometrical progression method, Logistic methods, Graphical projection method. • Quality of water required for: (a) Domestic, (b) Institutional (Schools, Hostels, Hospitals), (c) Fire fighting, (d) Commercial (Hotels, Restaurant), (e) Industrial (Dairy, Sugar, Pulp and Paper, etc.) 	10
2 Impurities in water and water quality standards	<ul style="list-style-type: none"> • Physical, chemical and biological impurities in water. • Need of water quality standards for domestic & industrial purpose. • General effluent standards • Specifications for drinking water by Bureau of Indian Standards (IS 10500) & World Health Organization. • Packaged drinking water. 	10
3 Designing of waste water treatment plant and advanced water treatments.	<ul style="list-style-type: none"> • Principle, Applications and Designing of following Unit Operation in water treatment : a) Collection & pumping b) Screen chamber c) Grit chamber d) Oil and grease removal e) Dissolve air floatation. f) Aeration g) Flocculation h) Settling tank (primary and secondary) i) Filtration j) Disinfection methods (Chlorination, UV, Ozonization) • Demineralization, Ultra filtration, Reverse osmosis, Color & odor removal by activated carbon, Iron removal. 	10

	<ul style="list-style-type: none"> • Selection of appropriate unit operations for the treatment and flow chart of water treatment plant. • Operation and Maintenance of treatment plant. 	
4 Wastewater engineering for biological treatment	<p>Principle, role of microorganisms, ecosystem and designing of following biological unit operations in wastewater treatment.</p> <p>Types: a. Aerobic and anaerobic treatments b. Suspended and attached growth treatment processes.</p> <p>1. Aerobic treatment processes:</p> <p>a. Activated sludge process b. Stabilization pond, c. Aerated lagoon, d. Trickling filters e Sequence batch reactor f. Rotating Biological contactor.</p> <p>2. Anaerobic treatment processes:</p> <p>a. Anaerobic packed Bed reactors b. Anaerobic Fluidized and Expanded bed Reactors c. UASB reactor etc.</p>	10
5 Industrial Wastewater Treatment	<p>Selection of appropriate unit operations for the treatment and flow chart of wastewater treatment plant for :</p> <p>a. Dairy industry b. Pulp and Paper industry c. Textile industry d. Pharmaceutical industry e. Fertilizer industry f. Oil refineries</p>	12
5 Biotechnology & Waste Management	<p>Application of biotechnology for the treatment of :</p> <p>a. High strength waste : e.g. whey (Dairy industry) and spent wash (Distillery) b. Sewage treatment: Impact of Future growth and development and change in quality of life on sewage quality & quantity. Unit operations for the treatment and flow chart of sewage treatment plant. c. Sludge treatment processes.</p>	6
6 Overview of water audit in industries	<p>a. Water audit in industries: case studies b. Industrial etiquettes</p>	4
<p>Learning Resources :</p> <ul style="list-style-type: none"> • Water pollution – A. K. Tripathi and S. N. Pande • Water pollution – V.P. Kudesai • Pollution control in process industry – S. P. Mahajan • Introduction to waste water treatment process – Ramalho RS • Rao C. S.1994,Environmental Pollution Control and Environmental Engineering:Tata McGraw Hill; New Delhi. • Pollution Management; Agarwal S.K. • Water pollution : Causes, Effects and Control, P.K.Goel • Environmental Biotechnology: Basic concepts and applications- Indu Shekhar Thakur, I.K. International Pvt. Ltd. New Delhi. • Environmental Biotechnology: M.H.Fulekar, Oxford and IBH publishing C..Pvt. Ltd. • Environmental Biotechnology, Alan Scragg, Oxford university press. • Environmental Science; Daniel Chiras. • Waste Water Engineering, Treatment, Disposal & Reuse; Metcalf & Eddy. • Handbook of Methods in Environmental Studies Vol-I &II; Maiti S.K.; ABD Publishers; Jaipur. • Manivasakam N.1984,Physico-Chemical Examination of Water, Sewage & Industrial Effluents; 		

Pragati Prakashan; Meerut.

- Trivedi R.K. & Goel P.K. 1986, Chemical & Biological Methods for Water Pollution Studies;; Environmental Publications; Karad.
- Manual of Microbiology : Tools and techniques , Ane Books Pvt. Ltd. - Kanika Sharma

EVS4203: Biodiversity, Forestry and Conservation (4 Credits)

Units	Contents	Sessions
1 Biodiversity: Concept and Scope	<ul style="list-style-type: none"> • Biodiversity Types of Biodiversity Climatic Zones and Biodiversity Biodiversity as a natural resource • Indian Biodiversity Vegetation Zones Zones of Faunal distribution Major protected areas & their importance • Global Biodiversity Major Biodiversity areas of the world Biodiversity Hot Spots • Basic Taxonomy 	6
2 Inventory of Bio – Resources: Global And National	<ul style="list-style-type: none"> • An inventory of Global and Indian biological resources and their present and potential uses. • Magnitude and distribution of Biodiversity (global and Indian) and its characterization. • Rapid assessment of biodiversity and its valuation; skills, trained personnel and resources needed for the task. • Evaluating nature, scale and intensity of the threats to biodiversity. • Developing measures for conservation of 	6

	biodiversity and approaches to its sustainable utilization.	
3 Protected Areas and people participation	<p>Management of Protected areas</p> <ul style="list-style-type: none"> • Management of Protected areas • Principles of wildlife management • Habitat management • Improving carrying capacity • Dealing with Human –Wildlife conflicts • Approaches to conservation of plants (in situ and ex situ) • Regulating forest usage (e.g. grazing at Keoladeo / Gir, Fishing in Sunderbans, Mahua collection in Kanha) 	6
4 Conservation Actions at International, National and Local Levels	<ul style="list-style-type: none"> • Important conventions and treaties on conservation (including WCS, CBD, CITES, IPCC, Ramsar Convention, UNCLOS, Montreal Convention and others) <ul style="list-style-type: none"> • People and conservation <ul style="list-style-type: none"> Traditional knowledge and Traditions & cultures Tribal communities/Locals in conservation Women in conservation Youth in Conservation • Role of NGOs in conservation <ul style="list-style-type: none"> International NGOs; UNEP, GEF, WCS, Bird Life International Important NGOs in India & their contributions WWF, ATREE, BNHS, WTI, Kalpavriksha etc. Important NGO movements Chipko movement, Narmada BachavoAandholan PaniPanchayats, Seed Movement etc. 	6
5 Planning and Execution of Field Surveys	<ul style="list-style-type: none"> • Field surveys & observations <ul style="list-style-type: none"> Sampling methods and identifying study sites Different methods of transacts & quadrates Techniques of field observation • Recording & Evaluation of Data <ul style="list-style-type: none"> Field note book and its records Field kit and its usage • Different methods of recording field observations • Ethics in Field Studies 	6
6 Advanced Field techniques	<ul style="list-style-type: none"> • Analysis of Animal tracks & signs <ul style="list-style-type: none"> Tracking Large mammals Studying & analyzing Animal Tracks & signs Scat analysis and evaluation of food, feeding and health Enumeration using tracks & signs, Nest census • Camera trapping: technique, applications and limitations • Information Technology in Field Biology <ul style="list-style-type: none"> Radio-telemetry: technique, devises, applications of telemetry, limitations and ethics Audio recording techniques and applications Remote Sensing and GIS 	6
7 Forestry	<ul style="list-style-type: none"> • Forests and Forestry: Forest types of the world. Champion 	6

	<p>and Seth's Forest Types of India. Forest diversity of Oriental Region.</p> <ul style="list-style-type: none"> • Forest Management: Working plans in forestry. Forests Departments and their structure. Conservation and protection of natural forests. Nursery, seed stock and forest plantation. • Community participation in forestry: Joint forest management. Social forestry. Eco-development. Habitat management in wastelands for forestry and national resources conservation. • Traditional knowledge and management practices: Medicinal plants in forestry. Rare and endangered forest species. Future sciences in forestry applications. 	
8 Agro-biodiversity and Cultivated Taxa	<ul style="list-style-type: none"> • Introduction, Origin and Evolution of Cultivated species Diversity • Diversity in Domesticated species, Land Races, Advanced Cultivars, Wild relatives of Cultivated plants, Wild Plants • Importance of Agrobiodiversity in changing climate patterns 	
Internal assessment A	Assignments, Review of Research Papers, Presentations, Group discussion	6
Internal assessment B	Open Book, Internal I and Internal II Examinations	6
<p>Learning Resources :</p> <ul style="list-style-type: none"> • Medicinal Plants of India's Hotspots. Daya Publishing House, New Delhi. • Gary K Meffe and Ronald Carroll C .1994, Principles of Conservation Biology. Sinauer Associates Inc., Massachusetts. • Groombridge B (Ed.) 1992. Global Biodiversity Status of the Earths Living Resources. Chapman & Hall, London. • IUCN .1992.Global Biodiversity and Strategy. • Sharma PD .2000. Ecology and Environment. Rastogi Publications, Meerut, India. • Singh MP, Singh BS and Soma S. Dey .2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi. • Virchow D .1998. Conservation and Genetic Resources, Springer-Verlag, Berlin. • Singh B, 1992.Social Forestry for Rural Development, Anmol Publishers, New Delhi. • Murthy J.V.S., 1994,Watershed Management in India. • John Wiley ,1984,Raymond F Dasmann, Environmental Conservation. • Kato, M. The Biology of Biodiversity, 1999, Springer Verlag, Tokyo. • Kotwal, P.C. and S. Banerjee. Biodiversity Conservation – In Managed forest and Protected areas, 2002. Agrobios, India. • Krishnamurthy, K.V. An Advanced Textbook on Biodiversity – Principles and Practice, 2003. Oxford and IBH Publishing, New Delhi. • Negi, S.S., 1993. Biodiversity and its conservation in India. Indus Publishing Co., New Delhi • Singh and Vijaykumar, 2001. Economics of PA's and its effect on biodiversity. APH Publishing Corporation, New Delhi. 		

EVS4204: Environmental Science Practical – III (4 credits)

Course Outcomes:

After completion of practical course students will/can

- Prepare flowcharts, network diagrams, Leopold matrix, checklist as part of impact assessment techniques.
- Understand primary and secondary impacts due to developmental activities
- Understand nature and structure of formats (Form V, Form 1, Form 1 A) required by government agencies .
- Critically prepare EIA/EMP report and can find merits and demerits of the practices followed in assessment of impacts .
- Understand various case studies of EIA .
- Prepare video documentaries, understand field conditions, observe impacts on environmental components with use of online softwares and advanced techniques.
- Students will be able to analyse various atmospheric parameters data generated using instruments and softwares.
- They are able to draw and design flow charts for different industries and sewage treatment.

Practicals based on EVS4201: Environmental Impact Assessment and Environmental Audit

1. Preparation of flowcharts and network diagrams to carry out impact analysis.
2. Identification of primary and secondary impacts of nearby ongoing developmental activity.
3. Preparation of checklist of the activities and the impacts associated with it.
4. Study of Environmental Audit of selected industrial unit with reference to environment protection act (Form V)
5. Evaluation of EIA by using Leopold matrix technique: A case study of mining/dam site.
6. Environmental survey based on questionnaire: A case study of construction site
7. To understand structure of 'Form 1' for obtaining prior environmental clearance
8. Preparation of outline of EIA report: A case study of dam/mining/construction/industrial site.
9. Preparation of environmental management plan for a selected industry.
10. Study of physical, chemical and biological analysis of the impact area based on soil and water parameters.
11. Field visit to affected areas due to developmental activities and study EIA aspects in relation with EIA notification 2006.
12. Collection of secondary data based on impacts and analysis by using online software's.
13. Online questionnaire survey of the on-going developmental activity.
14. Submission of video documentary of affected areas due to developmental activities.
15. Use of RS-GIS techniques for mapping of impacts.
16. Use of online softwares for impacts identification and analysis.
17. Problems based on impact assessment and prediction methodologies.
18. Identification of impacts and reason associated with on nearby selected ecosystem due to urban growth.

Practical Based on EVS4202: Water and Wastewater Treatment Technology

1. Designing of ETP/STP : Piping and instrumentation diagram.
2. Efficiency estimation of waste water treatment plants for various industries (Based on given data).
3. Designing of Screen chamber and oil and grease removal tank (based on given data).
4. Designing of equalization tank.
5. Designing of Primary and secondary settling tank (based on given data).
6. Designing of Aeration tank.
7. Designing of Chlorine contact tank.
8. Estimation of MLSS, MLVSS and Sludge volume index.
9. Study of chemical properties of sewage (Nitrate / phosphate)
10. Study of Electrocoagulation for waste water treatment.
11. Study of Models of anaerobic digestion.
12. Study of physical properties (colour, odour, temperature, turbidity) of sewage.
13. Visit to water pumping station.

EVS4205: Environmental Science Practical – IV (4 credits)

Course Outcomes:

- Students will learn techniques in assessment of biodiversity.
- Independent field project planning and execution will be learnt.
- Students will acquire Field surveys and monitoring skills.
- Competency to geospatial techniques for biodiversity studies will be developed
- Students will be trained to ETP techniques.
- Students will be introduced to pollution monitoring techniques.
- Lab scale level treatment methods are introduced to get real sense and applications of wastewater treatment methods.

Practical Based on EVS4202: Water and Wastewater Treatment Technology

1. Study of coagulation and flocculation treatment by using jar test apparatus.
2. Visit to industrial Effluent Treatment Plant.
3. Visit to Sewage Treatment Plant.
4. Study of Photocatalytic treatment of wastewater: i) Solar photo catalysis ii) Advance oxidation processes.(2P)
5. Standard analysis of water for presence of coliforms: Presumptive Test
6. Standard analysis of water for presence of coliforms: Confirmed Test
7. Standard analysis of water for presence of coliforms: Confirmed Test
8. Water audit in industries. E.g. Textile, distillery etc.
9. Determination of DO from given water/ wastewater sample.
10. Determination of BOD from given water/wastewater sample.
11. Determination of COD from given water/wastewater sample.
12. Estimation of oil and grease from given water / wastewater sample.
13. Estimation of MPN from given water sample.
14. Estimation of Residual chlorine from given water/ wastewater sample.

Practical Based On EVS4203: Biodiversity, Forestry and Conservation

1. To find out Carrying Capacity of protected area.
2. Plant species diversity in a sacred grove or forest area (one season data only).
3. Species wise population count of birds in a wetland.
4. List of minor forest produce used by a community living inside or in the proximity of a protected area.
5. Establish micro-plan and action programme for village-level joint forest management committee and local communities.
6. Develop a biodiversity register at village level near or within Protected Areas.
7. Do flora species counts with local forest guards / forest officials in development areas of Pune, Nashik and Ahmadnagar Districts
8. Verification of forest working plan
9. Develop and maintain a herbarium of flora species along a water stream in the hills.
10. Develop or verify or monitor and evaluate the conservation action plan for a protected area in collaboration with the forest department and the local village-level community
11. Develop or verify or monitor and evaluate the eco-tourism action plan near a protected area in collaboration with the forest department and the local village-level community.

12. Identification and documentation of birds using e-bird resource.e
13. Identification and study of venomous snakes, action of their venom and first aid for Cobra (spectacled & monocled), Common krait, Banded krait, Russell's Viper, Saw scaled Viper, Pit vipers (Bamboo, Green, Malabar)
14. On a phytogeographic map of India locate & demarcate major sanctuaries / national parks.
15. Identify and describe land use patterns from false colour images (satellite image); City, reservoir, forest, agricultural land, sea-shore.
16. Compare and interpret given sonograms of bird calls (any two e.g. Courtship calls, Alarm calls).
17. Identify and study specifications & applications of various ringing & tagging devices
18. Study of animal Tracks & signs Field or using photographs or drawings. e.g. pugmarks, foot prints, tracks, claw marks, browse lines, dung mounts, regurgitates (e.g. owls), hair, scats, burrows, dens, nests etc.
19. Identify and study specifications & applications of various telemetric devices: (Photographs or Models or working models and diagrams); Antennae, transmitters (ingestible, implantable, strap) Digitized tags (e.g. implantable micro chips) Dart Gun & Tranquilizing agents & there action.
20. Using a Simulated data perform the following :- Classify the data and calculate ecological indices; Dominance index, Shannon-Wiener Index, Similarity Index, Diversity index. Evaluate and interpret each of the index values.
21. Prepare an audio-visual presentation to communicate conservation to the youth & general public on some environment issues (e.g. : Destruction of local biodiversity site like mangrove or sea shore or a forest patch, Human-wildlife conflict, Developmental activity that has potential threat to local biodiversity etc.)
22. Comparative Survey of Biodiversity at Urban and Rural Market of nearby area.