

Deccan Education Society's  
**FERGUSSON COLLEGE, PUNE**  
**(AUTONOMOUS)**

**SYLLABUS UNDER AUTONOMY**

**M.Sc. - II**  
**Environmental Science**

**SEMESTER – III**

**Academic Year 2017-2018**

Deccan Education Society's  
FERGUSON COLLEGE, PUNE  
**Scheme of Course Structure with Course Code (Faculty of Science) Post-graduate**

Semester	Course code	Paper	Title of paper	Credits
<b>III</b>	<b>COMPULSORY PAPERS</b>			
	EVS5301	I	Environmental Pollution: Air, Noise and Radiation	4 credits
	EVS5302	II	Environmental Impact Analysis and Environmental Audit	4 credits
	EVS5303	III	Remote Sensing and GIS	4 credits
	EVS5304	IV	In-plant training + Dissertation	4 credits
	EVS5305	V	Practical	4 credits
	<b>Optional paper(Any two options)</b>			
	EVS5306		Green Technologies	2 credits
	EVS5307		Environmental Biotechnology	2 credits
	EVS5308		Environmental Management Systems	2 credits
		EVS5309		Self Learning Course 3
<b>IV</b>	<b>COMPULSORY PAPERS</b>			
	EVS5401	I	Environmental Toxicology, Health and Safety	4 credits
	EVS5402	II	Restoration and Watershed Management	4 credits
	EVS5403	III	Renewable and Non-Renewable Energy	4 credits
	EVS5404	IV	Environmental Law Ethics and policy	4 credits
	EVS5405	V	Dissertation and Project Work	4 credits
	<b>Optional paper(Any two options)</b>			
	EVS5406		Environmental Economics	2 Credits
	EVS5407		Wild life and Habitat Management	2 Credits
	EVS5408		Hazardous Waste Management	2 Credits
		EVS5409		Self Learning Course 4

<b>EVS5301: Environmental Pollution II: Air, Noise and Radiation (4Credits)</b>		
<b>Units No.</b>	<b>Title and Contents</b>	<b>No. of Lectures</b>
<b>1</b>	<p style="text-align: center;"><b>Air Pollution</b></p> <ul style="list-style-type: none"> <li>• Chemical composition of atmosphere</li> <li>• Greenhouse effect and global warming</li> <li>• Air pollution disasters.</li> <li>• Atmospheric reaction.</li> <li>• Ozone depletion.</li> <li>• Air Quality and emission standards.</li> </ul>	<b>2</b>
<b>2</b>	<p style="text-align: center;"><b>Classification and effect of air pollution</b></p> <ul style="list-style-type: none"> <li>• Sources, classification and effects of air pollutants.</li> <li>• Effects of gaseous and particulate air pollutants on plant, animal and human health.</li> <li>• Economic effects of air pollution.</li> <li>• Particulates, NO<sub>x</sub>, SO<sub>x</sub>, and Oxides of Carbon and hydrocarbons, wet and dry deposition on plants, animals and properties</li> <li>• Acid rain.</li> </ul>	<b>4</b>
<b>3</b>	<p style="text-align: center;"><b>Industrial air pollution</b></p> <ul style="list-style-type: none"> <li>• Point and non-point sources of air pollution</li> <li>• Principle causes of industrial pollution</li> <li>• Environmental problems of industries - <ul style="list-style-type: none"> <li>➤ Mining and metallurgy industry,</li> <li>➤ Cement industry,</li> <li>➤ Thermal power plants,</li> <li>➤ Nuclear power plants.</li> </ul> </li> <li>• Preventive measures for industrial pollution.</li> </ul>	<b>4</b>
<b>4</b>	<p style="text-align: center;"><b>Analytical methods for air quality analysis</b></p> <ul style="list-style-type: none"> <li>• Air monitoring (Site Selection, types of Sampling, instruments and techniques)</li> <li>• Monitoring of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, hydrocarbons and particulate matter, SPM, trace metals.</li> </ul>	<b>10</b>
<b>5</b>	<p style="text-align: center;"><b>Prevention and control of air pollution through different technologies</b></p> <ul style="list-style-type: none"> <li>• Control of air pollution by fuel selection</li> <li>• Principle and working of – cyclones, scrubbers, settling chambers and electrostatic precipitators</li> <li>• Control of gaseous pollutants by absorption, adsorption, condensation, vapor incineration</li> <li>• Equipments for control of air pollution – Cyclones, Wet scrubbers, Electrostatic precipitators, fabric filters, absorption</li> </ul>	<b>10</b>
<b>6</b>	<p style="text-align: center;"><b>Noise Pollution</b></p> <ul style="list-style-type: none"> <li>• The physics of sound and its transmission,</li> <li>• Sound hearing mechanism</li> <li>• Sources of Noise</li> <li>• National Laws and standards</li> <li>• Effects of noise: i)Auditory effects, TTS,PTS, acoustic trauma, ii) Physiological and psychological effects iii)General Effects- speech interference, annoyance, sleep interference,</li> </ul>	<b>15</b>

	<p>effects on performance, subjective response</p> <ul style="list-style-type: none"> <li>• Noise measurements: Basic definitions and terminology. Frequency, loudness</li> <li>• Noise control : i)At source: Sound path receiver concept, control by design ii)Noise control in the transmission path: Acoustical separation, physical barriers, Isolators and Silencers iii)Protecting the receiver: personal protection devices</li> </ul>	
7	<p style="text-align: center;"><b>Radiation pollution</b></p> <ul style="list-style-type: none"> <li>• Radioactivity –Types of radiations. Internal and external radiation, Measurement of radiations.</li> <li>• Detection of nuclear radiations – G. M.counter, scintillation counter, semi-conductor detector.</li> <li>• Sources of Radiation – natural and manmade</li> <li>• Safety Measures: safe handling methods, personal dosimetry, reactor safety.</li> <li>• Units of measurements: half-life period, radiation dose measurement.</li> <li>• Biological effects and health hazards associated with radiation. <ul style="list-style-type: none"> <li>i)Interaction of radiations with biological cells,</li> <li>ii) somatic and genetic effects.</li> </ul> </li> <li>• Classification of radio-active wastes – gas, solid, liquid.</li> <li>• Control measures –treatment and disposal of radio-active waste.</li> <li>• ICRP recommendations. AERB classification.</li> <li>• Case Studies : Three miles and Chernobyl accidents.</li> </ul>	15
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>• Air pollution – M. N. Rao</li> <li>• Air pollution – A. C. Stern, Academic press Vol. I-X.</li> <li>• Air pollution – V. P. Kudesia</li> <li>• Global air pollution – Brijman</li> <li>• Air pollution control – NEERI</li> <li>• Air pollution – Leadbetter Vol. I and II</li> <li>• Air pollution – Magill Holder and Ackely</li> <li>• Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition 2001.</li> <li>• Environmental Chemistry, A. K. Day, Fourth Edition, New Age International Publishers-2002</li> <li>• Environmental Science; by-Santra SC; Central Publ. New Delhi</li> </ul>		

<b>EVS5302: Environmental Impact Analysis and Environmental Audit (Credits 4)</b>		
<b>Units No.</b>	<b>Title and Contents</b>	<b>No. of Lectures</b>
<b>1</b>	<p style="text-align: center;"><b>Introduction</b></p> <ul style="list-style-type: none"> <li>• Scope and Objectives of EIA</li> <li>• Concept of EIA and Scope of EIA throughout the world.</li> <li>• History and evolution of EIA</li> <li>• Terminologies used in EIA</li> <li>• Assessment, environmental impact statement.</li> <li>• EIA and sustainable development.</li> <li>• Strategic environmental assessment and social impact assessment</li> <li>• Benefits of EIA.</li> <li>• Drawbacks in EIA process</li> </ul>	<b>8</b>
<b>2</b>	<p style="text-align: center;"><b>Policies, Legislation and Procedures</b></p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) 1969, USA.</li> <li>• EIA notification for India and its implementation</li> <li>• EIA Guidelines and compliance requirements</li> <li>• Requirements and administrative procedures in India and states of India.</li> <li>• Accreditation of EIA consultants by Quality Control of India: Requirements and guidelines.</li> <li>• EIA systems in foreign countries</li> <li>• Role of WTO, WB, UNEP and funding agencies</li> <li>• Responses by countries in development of laws</li> </ul>	<b>8</b>
<b>3</b>	<p style="text-align: center;"><b>Methodology</b></p> <ul style="list-style-type: none"> <li>• Methods of impact analysis.</li> <li>• Description of the environmental setting. Baseline</li> <li>• Data collection for EIA procedure of baseline data collection.</li> <li>• Guidelines used for collection of baseline data for different environment e.g. water, air, soil, Hydrogeology, climate, micro-climate etc. Environmental risk assessment.</li> <li>• International EIA experts</li> <li>• Guidelines on accurate methods</li> </ul>	<b>8</b>
<b>4</b>	<p style="text-align: center;"><b>Prediction, Assessment and Writing of EIA report</b></p> <ul style="list-style-type: none"> <li>• Types of assessment</li> <li>• Basic Steps in Assessment</li> <li>• Use of advance techniques</li> <li>• Air, water, noise, biological, cultural and socio-economic, mining, blasting etc</li> <li>• Formats and guidelines for EIA report</li> </ul>	<b>8</b>
<b>5</b>	<p style="text-align: center;"><b>Public participation</b></p> <ul style="list-style-type: none"> <li>• Public participation in environmental decision making</li> <li>• Regulatory requirement, techniques</li> </ul>	<b>8</b>

	<ul style="list-style-type: none"> <li>• Advantages and disadvantages of public participation</li> <li>• Environmental and social considerations by public participation</li> <li>• International guidelines and variations in implementation by various countries</li> </ul>	
6	<p style="text-align: center;"><b>Case studies of EIA</b></p> <ul style="list-style-type: none"> <li>• Infrastructure</li> <li>• Industrial development</li> <li>• Energy Sector</li> </ul>	<b>4</b>
7	<p style="text-align: center;"><b>Environmental management plan</b></p> <ul style="list-style-type: none"> <li>• Planning and selection of appropriate resource management procedures</li> <li>• Resources recovery and reuse</li> <li>• Ecology and biodiversity</li> <li>• Noise and vibration</li> <li>• Occupational safety and health</li> <li>• Risk assessment and disaster management plan</li> <li>• Prevention, maintenance and operation of environment control systems</li> <li>• Functions of environment cell</li> <li>• Environmental budgets to minimize environmental impacts</li> </ul>	<b>8</b>
8	<p style="text-align: center;"><b>Environmental Audit</b></p> <ul style="list-style-type: none"> <li>• Scope and objectives of audit</li> <li>• Importance for industries</li> <li>• Environment Compliance</li> <li>• Types of audits</li> <li>• Audit tools and technology /general audit methodology and basic structure of audit</li> <li>• Elements of an audit process and its importance.</li> <li>• Environment Audit in India-Development of environmental auditing in India</li> <li>• Concept of ISO 14000</li> <li>• Requirements of Rule 14 for environmental audit under EPA, 1986.</li> <li>• Terminologies under audit methodologies</li> </ul>	<b>8</b>

**References:**

- 1) Environmental Impact Assessment: A Guide to Best Professional Practices (2011): Charles H. and Eccleston. CRC Press.
- 2) Environmental Impact Assessment: A Comparative Review (2014): Chris Wood. Routledge.
- 3) Environmental Impact Assessment-Theory and Practice (2015): Peter Wathern. Taylor & Francis.
- 4) Introduction to Environmental Impact Assessment (2005): John Glasson. Spon Press.
- 5) Environmental Impact Assessment (2004): P. R. Trivedi. Laurier Books.
- 6) Environmental Impact Assessment (2014): N. S. Raman, A.R. Gajbhiye and S.R. Khandeshwar. I K International Publishing House Pvt. Ltd.
- 7) Environmental Impact Assessment Methodologies (2010): Y. Anjaneyulu. B.S. Publications.
- 8) Environmental Impact Assessment: Theory and Practice (2016): M. Anji Reddy. B. S. Publications
- 9) Environmental Impact Assessment (1996): L. W. Canter. McGraw Hill, New York.
- 10) Environmental Impact Assessment: A Practical Guide (1997): Betty Bowers Marriott. McGraw-

Hill Education Publisher

- 11) Environmental Impact Analysis Handbook (1980): John G. Rau, David C. Wooten. McGraw Hill Higher Education.
- 12) Environmental Impact Assessment (2012): R.R. Barthwal. New Age International Private Limited.
- 13) The Theory and the Practice of Environmental Impact Assessment (2003): S. A. Abbasi and N. Ramesh. DPH, New Delhi, 2003
- 14) Handbook of Environmental Impact Assessment (2005): Petts, J., Volume 1 and 2. Blackwell Publishers, UK.
- 15) Introduction to Environmental Impact Assessment (2006): Glasson, J. Therivel, R. and Chadwick, A., Routledge, London.
- 16) EIA reports for various sectors available on the official website of Ministry of Environment, Forest and Climate Change ([www.envfor.nic.in](http://www.envfor.nic.in))
- 17) United Nations Reports and Guidelines on Environmental Impact Assessment.

**EVS5303: Remote Sensing and GIS (Credits 4)**

<b>Units No.</b>	<b>Title and Contents</b>	<b>No. of Lectures</b>
1	<p><b>Basics of Remote Sensing</b></p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Electromagnetic Remote Sensing Process</li> <li>• Physics of Radiant Energy               <ul style="list-style-type: none"> <li>Nature of Electromagnetic Radiation</li> <li>Electromagnetic Spectrum</li> </ul> </li> <li>• Energy Source and its Characteristics</li> <li>• Atmospheric Interactions with Electromagnetic Radiation               <ul style="list-style-type: none"> <li>Atmospheric Properties</li> <li>Absorption of Ozone</li> <li>Atmospheric Effects on Spectral Response Patterns</li> </ul> </li> <li>• Energy Interactions with Earth's Surface Materials               <ul style="list-style-type: none"> <li>Energy Matter Interaction: Absorption, Emission, Transmission, Emission</li> <li>Spectral Reflectance Curves or Spectral Signature</li> </ul> </li> </ul>	8
2	<p><b>Platforms and Sensors</b></p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Sensor Types: Active and Passive</li> <li>• Sensor Parameters               <ul style="list-style-type: none"> <li>Spatial Resolution</li> <li>Spectral Resolution</li> <li>Radiometric Resolution</li> </ul> </li> <li>• Imaging Sensor Systems               <ul style="list-style-type: none"> <li>Multispectral Imaging Sensor Systems</li> <li>Thermal Sensing Systems</li> <li>Microwave Image Systems</li> </ul> </li> <li>• Platforms               <ul style="list-style-type: none"> <li>Airborne remote sensing</li> <li>Spaceborn remote sensing</li> </ul> </li> <li>• Earth Resources Satellites               <ul style="list-style-type: none"> <li>Landsat Satellite Programme</li> <li>SPOT Satellite Programme</li> <li>Indian Remote Sensing Satellite (IRS)</li> <li>AEM Satellites</li> </ul> </li> <li>• OCEANSAT -1 (IRS-P4)</li> <li>• IKONOS Satellite Series</li> <li>• GNSS and GPS</li> <li>• Latest Trends in Remote Sensing Platforms and sensors               <ul style="list-style-type: none"> <li>Quick Bird</li> <li>Cartosat-1</li> <li>Resourcesat-1 and 2 and recent progress</li> </ul> </li> </ul>	8
3	<b>Visual Image Interpretation</b>	6



	<ul style="list-style-type: none"> <li>• Introduction</li> <li>• Image Understanding and Interpretation</li> <li>• Human Vision</li> <li>• Interpretation elements</li> <li>• Stereoscopic vision</li> </ul>	
4	<p><b>Digital Image Processing and Interpretation</b></p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Principles of Image classification</li> <li>• Image Classification Process <ul style="list-style-type: none"> <li>Preprocessing <ul style="list-style-type: none"> <li>Geometric Correction</li> <li>Radiometric Correction</li> <li>Atmospheric Correction</li> </ul> </li> <li>Image Registration</li> <li>Image Enhancement Techniques</li> <li>Spatial Filtering Techniques <ul style="list-style-type: none"> <li>Low Pass Filters</li> <li>High Pass Filters</li> <li>Filtering for Edge Enhancement</li> </ul> </li> <li>Image Transformations</li> <li>Image Classification : Supervised and Unsupervised</li> </ul> </li> <li>• Accuracy assessment</li> </ul>	8
5	<p><b>Basics of GIS</b></p> <ul style="list-style-type: none"> <li>• Definition and Objectives of GIS, Concept of space and time, components of GIS, basic entities of GIS: line point and polygon.</li> <li>• Map Projection: Conical, Azimuthal and Cylindrical. LCC Projection, UTM and Polyconic projections.</li> <li>• Types of datum</li> </ul>	8
6	<p><b>Data Structures in GIS</b></p> <ul style="list-style-type: none"> <li>• Spatial data: Raster data, Vector data, comparative overview.</li> <li>• Non-spatial data - Hierarchical, Network and relational data.</li> <li>• Concept and type of topology</li> </ul>	6
7	<p><b>Spatial Analysis</b></p> <ul style="list-style-type: none"> <li>• Vector based: Overlays operations- point in polygon, line in polygon, polygon in polygon;</li> <li>• Single layer operations and Multilayer operations.</li> <li>• Raster based: Map algebra, Grid based operations.</li> <li>• Buffering, Network Analysis, Terrain Analysis, Digital Terrain models and generation of Thematic maps.</li> </ul>	8
8	<p><b>Applications of RS and GIS</b></p> <ul style="list-style-type: none"> <li>• Landuse-land cover changes</li> <li>• Natural hazards and hazard management: Floods, landslides and other hazards</li> <li>• Monitoring water quality and soil quality</li> <li>• Mineral exploration,</li> <li>• Lithological and structural mapping</li> </ul>	8

	<ul style="list-style-type: none"> <li>• Use of GIS to represent environmental status and highlight environmental issues</li> </ul>	
	<p><b>References:</b></p> <p><b>Ebooks</b></p> <ul style="list-style-type: none"> <li>• Alan S. Belward and Carlos R. Valenzuela (1991) Remote Sensing and Geographical Information Systems for Resource Management in Developing Countries</li> <li>• M. Anji Reddy (2008) Textbook of Remote Sensing and Geographical Information Systems Third Edition</li> <li>• Norman Kerle Lucas L. F. Janssen Gerrit C. Huurneman Principles of Remote Sensing An introductory textbook. ITC Educational Textbook Series. version of 23rd September 2004.</li> <li>• Fundamentals of Remote Sensing. A Canada Centre for Remote Sensing Remote Sensing Tutorial</li> </ul> <p><b>Books</b></p> <ul style="list-style-type: none"> <li>• B. Bhatta (2008) Remote Sensing and GIS, Oxford University press.</li> <li>□ □ Lillisand, T. M. and Keifer, R. W. (1990): Remote Sensing and Image interpretation, John Willey and Sons, New York</li> <li>□ □ Joseph G. (2003): Fundamentals of Remote Sensing, Universities Press, Hyderabad.</li> <li>□ □ Haywood, Ian (2000): Geographical Information Systems, Longman</li> <li>□ □ Chang, Kangtaung (2002): Introduction to Geographic Information Systems, Tata McGraw-Hill.</li> <li>□ □ Burroughs, P. A (1986): Principles of Geographical Information Systems for land Resource Assessment, Oxford University Press.</li> <li>□ □ Gupta, R. P. 2003. Remote sensing geology, Springer, New York</li> <li>□ □ Barrett, E. C. and Curtis, L. F.1999. Introduction to environmental remote sensing. Chapman and Hall</li> </ul>	
	<p><b>Practicals</b></p> <ul style="list-style-type: none"> <li>• Interpretation and classification satellite Image</li> <li>• Interpretation and classification Arial Image</li> <li>• GPS handling and acquisition of data</li> <li>• Georeferencing using Toposheet/Satellite image/GPS</li> <li>• Subsetting and classification of Satellite data</li> <li>• Preparation Spatial data: Poin, Line, polygon</li> <li>• Geoprocessing od Spatial data: Buffering, Clip, Crop</li> <li>• Preparation of DEM</li> </ul>	

<b>EVS5305: ENVIRONMENTAL SCIENCE PRACTICAL (4 Credits)</b>		
	<b>Practical Based On EVS5301: Environmental Pollution II: Air, Noise and Radiation</b>	
1.	Types of air sampling	
2.	Estimation of atmospheric dust (PM, SPM, RPM) from college campus	
3.	Estimation of SO <sub>x</sub> from college campus	
4.	Estimation of NO <sub>x</sub> from college campus	
5.	Measurement of annoyance to find out Noise pollution	
6.	Estimation of Equivalent Noise level	
	<b>Practicals based on EVS5302: Environmental Impact Analysis and Environmental Audit</b>	
1.	Evaluation of EIA by using Leopold Matrix Technique	
2.	Preparation of draft of EIA report on selected developmental project	
3.	Collection of secondary data based on impacts and analysis by using online softwares	
4.	Preparation of draft environmental audit report for selected industry	
5.	Field visit to affected areas due to developmental activities and study EIA aspects in relation with notification	
6.	Environmental and social survey based on questionnaire of the impact area	
7.	Study of physical, chemical and biological analysis of the impact area based on soil and water parameters	
8.	Submission of documentary of affected area due to developmental activities	
9.	Preparation of environmental management plan for selected industry	
	<b>Practicals based on EVS5303: Remote Sensing and GIS</b>	
1.	Interpretation and classification satellite Image	
2.	Interpretation and classification Arial Image	
3.	GPS handling and acquisition of data	
4.	Geoprocessing of Spatial data: Buffering, Clip, Crop	
5.	Georeferencing using Toposheet/Satellite image/GPS	
6.	Subsetting and classification of Satellite data Preparation Spatial data: Poin, Line, polygon	
7.	Preparation f DEM	

<b>EVS5306: Green Technologies</b>			
<b>Units No.</b>	<b>Chapter Title</b>	<b>Title and Contents</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Introduction to Green Technologies</b>	<ul style="list-style-type: none"> <li>• Definition and concept of green technology</li> <li>• Sustainable consumption of resources</li> <li>• Individual and community level participation and Research</li> <li>• Green technologies in historical and contemporary perspectives</li> <li>• Successful green technologies and advances: wind turbines, solar panels; 3 R's of green technology: recycle, renew and reduce;</li> <li>• 'Cradle to grave' approach in technology development</li> <li>• Emphasis on research and innovations for green future</li> </ul>	<b>(6 lectures)</b>
<b>2</b>	<b>Green Infrastructure, Planning and Economy</b>	<p><b>Green Buildings</b></p> <ul style="list-style-type: none"> <li>• Advances in green buildings and materials of high efficiency</li> <li>• Construction and cost and benefit analysis</li> <li>• Outlined examples of green buildings of the world</li> <li>• LEED certification of buildings and future</li> <li>• Eco-mark certification, scope and implementation</li> </ul> <p><b>Concept of Green Cities:</b></p> <ul style="list-style-type: none"> <li>• Technologies in waste management in cities and case studies throughout world.</li> <li>• Green cities of world and plans</li> <li>• Role of informal sector in waste management and need for training</li> <li>• Common public transport: ideas and plans</li> <li>• Green belt development under various climatic conditions</li> </ul> <p><b>Green Economy:</b></p> <ul style="list-style-type: none"> <li>• UNEP's green economy initiative</li> <li>• Inclusive economic growth of the society</li> <li>• UN REDD+ initiative and cap and trade concept</li> <li>• Green banking and success stories.</li> <li>• Green practices to conserve natural resources</li> </ul>	<b>(8 lectures)</b>
<b>3</b>	<b>Applications of Green Technologies</b>	<p><b>Increase in Energy Efficiency:</b></p> <ul style="list-style-type: none"> <li>• Cogeneration, motor system optimization</li> <li>• Oxy-fuel firing, isothermal melting process, energy efficient fume hoods,</li> <li>• Compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats).</li> </ul>	<b>(8 lectures)</b>

		<p><b>Green House Gas (GHG) emissions reduction:</b></p> <ul style="list-style-type: none"> <li>• Carbon capture and storage (CCS) technologies</li> <li>• Purchase and use of carbon offsets,</li> <li>• Promotion and/or subsidy of alternative forms of transportation for employees</li> <li>• Fuel efficient vehicles and mass transit</li> <li>• Methane emissions reduction and/or reuse).</li> </ul> <p><b>Pollution reduction and removal:</b></p> <ul style="list-style-type: none"> <li>• Flue Gas Desulfurization (FGD) methods</li> <li>• Catalytic or thermal destruction of NOX</li> <li>• Fluidized Bed Combustion</li> <li>• Dioxins reduction and removal methods,</li> <li>• Thermal Oxidizers or Wet Scrubbers to neutralize chemicals or heavy metals</li> <li>• Solvent recovery systems</li> </ul>	
4	<p><b>Green Chemistry and Green Future</b></p>	<p><b>Green Chemistry</b></p> <ul style="list-style-type: none"> <li>• Introduction to green chemistry</li> <li>• Principles and recognition of green criteria in chemistry</li> <li>• Biodegradable and bio-accumulative products in environment</li> <li>• Nanotechnology and its environmental applications</li> <li>• Development of biodegradable and ecofriendly products</li> <li>• Current research areas in green chemistry</li> <li>• Waste reduction technologies in industries</li> </ul> <p><b>Green Future</b></p> <ul style="list-style-type: none"> <li>• Agenda of green development for future of earth</li> <li>• Importance and advances in ecological footprint</li> <li>• Need of green technologies towards a sustainable future</li> <li>• Major challenges and their resolution</li> <li>• Advances in science and technology for environmental friendly technologies: Developed and developing world</li> </ul>	(8 lectures)
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Anastas, P.T. &amp; Warner, J.C. 1998. <i>Green Chemistry: Theory &amp; Practice</i>. Oxford University Press.</li> <li>2. Arceivala, S.L. 2014. <i>Green Technologies: For a Better Future</i>. Mc-Graw Hill Publications.</li> <li>3. Baker, S. 2006. <i>Sustainable Development</i>. Routledge Press.</li> <li>4. Hrubovcak, J., Vasavada, U. &amp; Aldy, J. E. 1999. <i>Green technologies for a more sustainable agriculture</i> (No. 33721). United States Department of Agriculture, Economic Research Service.</li> <li>5. Thangavel, P. &amp; Sridevi, G. 2015. <i>Environmental Sustainability: Role of Green Technologies</i>. Springer Publications.</li> <li>6. Woolley, T. &amp; Kimmins, S. 2002. <i>Green Building Handbook</i> (Volume 1 and 2). Spon Press.</li> </ol>			

<b>EVS5307: Environmental Biotechnology Elective Course (2 credits)</b>		
<b>Units No.</b>	<b>Title and Contents</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Environmental Biotechnology</b> <ul style="list-style-type: none"> <li>• Meaning, objectives, need, scope of environmental biotechnology</li> </ul>	<b>2</b>
<b>2</b>	<b>Biotechnology for sustainable agriculture</b> <ul style="list-style-type: none"> <li>• Biopesticides: Classification of biopesticides. Microbial bio pesticides Production process, stabilization, formulation, mode of action .Plant Product as biopesticides e.g. neem pesticides.</li> <li>• Biofertilizers- types, production and role in soil fertility, agro based solid waste &amp; its use.</li> <li>• Composting: Composting technology, Design aspect, composting process, Temp. Trend and influencing factors</li> <li>• Vermicomposting: Earthworm life cycle, chemical characteristic of vermicompost, Operating process.</li> </ul>	<b>6</b>
<b>3</b>	<b>Bioremediation</b> <ul style="list-style-type: none"> <li>• Microbial remediation process: Principles of bioremediation, Concept of bioaugmentation and biostimulation.</li> <li>• Factors affecting bioremediation process: microbial metabolism, Enzymatic biodegradative pathways, Genetic Engineering Approach, environmental conditions, nature of pollutant.</li> <li>• Types of Bioremediation: i) In situ- Biosparging, bioventing, injection recovery. ii) Ex situ- Land farming, composting, bioreactor.</li> </ul>	<b>8</b>
<b>4</b>	<b>Natural resource recovery:</b> <ul style="list-style-type: none"> <li>• Oil recovery-i) Microbially Enhanced Oil recovery (MOER), ii) Methods used and role of microorganism in MEOR.</li> <li>• Metal Recovery: i)Types and methods of bioleaching ii) Microorganisms in bioleaching.</li> <li>• Advantages and disadvantages of bioleaching.</li> </ul>	<b>6</b>
<b>5</b>	<b>Biopolymers, Biosensors and Bioindicators</b> <ul style="list-style-type: none"> <li>• Biopolymers and bioplastics: What are biopolymers? Types of biopolymers and its applications.</li> <li>• Biosensors: What is a biosensor? Applications of biosensors in environmental monitoring.</li> <li>• Bioindicators: What are bioindicators? Plankton community as indicators of water pollution Microbiological quality of potable waters, indicator organisms,coliforms and E.coli, fecal streptococci, clostridia, heterotrophic plate counts etc. lichens as air pollution indicators.</li> </ul>	<b>8</b>

<b>EVS5308: Environment Management Systems Elective Course (2 credits)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<p><b>Environmental management</b>            Organization approach to environment            Basics, advantages of environmental management            The system of environmental management, The projecting of environment management system – planning, implementation and management, general requirements, control tasks            Differences between EMS and EMAS, EMAS requirements, Eco balance in E-management, evaluation of environmental performance, environmental indicators selection</p>	<b>6</b>
<b>2</b>	<p><b>Life Cycle Analysis</b>            Concept, Phases, Types and applications</p>	<b>8</b>
<b>3</b>	<p><b>Introduction to ISO 14001</b>            Concept, TC, Guidelines for implementation of ISO14001 standard</p>	<b>8</b>
<b>4</b>	<p><b>Cleaner Production</b>            National systems of environmental labeling, environmental labels and proclamations, the institutions of E-evaluation and labeling             Definitions and characteristics of cleaner production, the tool for cleaner production evaluations, eco design. Remote sensing and GIS applications in Environment Management.</p>	<b>8</b>

**EVS5309: Self-Learning Course 3**

**1 Credit**

Deccan Education Society's  
**FERGUSON COLLEGE, PUNE**  
**(AUTONOMOUS)**

**SYLLABUS UNDER AUTONOMY**

**M.Sc. - II**  
**Environmental Science**

**SEMESTER – IV**

**Academic Year 2017-2018**



<b>EVS5401: Environmental Toxicology, Health and Safety (Credits 4)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Safety, Health and Environment</b> <ul style="list-style-type: none"> <li>• Historical developments in EHS, Perspectives and concerns,</li> <li>• Interrelationship and interactive approach on EHS,</li> <li>• Development projects and related aspects of safety and health,</li> <li>• Implementation of EHS practices in MNCs.</li> <li>• International agreements on EHS, Case studies</li> </ul>	<b>6</b>
<b>2</b>	<b>Safety and Health Hazards</b> <ul style="list-style-type: none"> <li>• Identification of potential safety and health hazards in industrial and development projects,</li> <li>• Reduction strategies for hazards,</li> <li>• Radiation and Industrial Hazards</li> <li>• Occupational Health Hazards</li> <li>• Electrical Hazards and Hazards in Construction Industry</li> <li>• Fire Hazards</li> <li>• Vibration and Noise associated hazards</li> <li>• National and international policies and legislation on safety in industries,</li> <li>• Safety standards and management systems, ISO 18000.</li> <li>• Industrial health safeguards and implementation mechanisms.</li> </ul>	<b>8</b>
<b>3</b>	<b>Health and Safety Risk Management</b> <ul style="list-style-type: none"> <li>• Risk identification,</li> <li>• Allocation and mitigation strategies,</li> <li>• Responsibilities and authority,</li> <li>• Principles of accidents prevention</li> <li>• Potential of health risks in industrial and development processes</li> <li>• Local and national policies, public awareness and participation in prevention procedures.</li> <li>• Industrial environmental conditions</li> <li>• Emissions and noise abatement.</li> </ul>	<b>8</b>
<b>4</b>	<b>Toxic and hazardous waste management</b> <ul style="list-style-type: none"> <li>• Classification of toxic materials. Industrial toxicants and hazardous materials</li> <li>• Product Stewardship</li> <li>• Methods used for toxic and hazardous waste management</li> <li>• Disaster management</li> </ul>	<b>6</b>
<b>5</b>	<b>Human Environment and Health Status in Urban and Rural India</b> <ul style="list-style-type: none"> <li>• Water and sanitation situation in urban and rural context,</li> <li>• Historical perspective,</li> <li>• WHO and other bodies and their role in public health projects</li> </ul>	<b>8</b>

	<p>development</p> <ul style="list-style-type: none"> <li>• Policies and legal aspects on health and sanitation</li> <li>• Eradication programs of diseases and health management</li> <li>• Development impacts in urban and rural sectors, psychological impacts</li> <li>• Public awareness of sanitation and hygiene issues</li> <li>• Role of NGOs in environmental protection.</li> </ul>	
<b>6</b>	<p><b>Toxicology</b></p> <ul style="list-style-type: none"> <li>• Basic principles of toxicology: Concept of toxicants and xenobiotics , Route of exposure,</li> <li>• Environmental Toxicology</li> <li>• Classification of toxic materials. Industrial toxicants and hazardous materials</li> <li>• Physiological and metabolic effects of toxicants, 1)e.g. VOC and organic solvents, used in industry 2) Heavy metals such as Hg, Pb, AS, Cd etc.</li> </ul>	<b>8</b>
<b>7</b>	<p><b>Evaluation of toxicity</b></p> <ul style="list-style-type: none"> <li>• Concept of Toxicokinetics and Toxicodynamics Bioconcentration ,Bioaccumulation, Biomagnification and Bioavailability.</li> <li>• Factors determining adverse effects of toxicants: Intrinsic toxicity, dose, exposure conditions, response of host</li> <li>• Parameters of toxicity testing: Acute toxicity, Chronic toxicity ,TU, ICp TER,NOEC,LOEC LC 50, LD50 , TLm</li> <li>• Toxicity test: Range finding, Screening, Definitive toxicity test</li> <li>• Interaction of toxicants in combination</li> <li>• Mutagenic and Teratogenic agents</li> <li>• Carcinogenic compound. Anti cancer drugs.</li> </ul>	<b>8</b>
<b>8</b>	<p><b>Water and airborne Diseases</b></p> <ul style="list-style-type: none"> <li>• Potential and widespread effects of Water and airborne bacteria and viruses: Endemic, Epidemic and pandemic diseases.</li> <li>• Waterborne bacterial and viral Diseases: causative agent, Spread of disease symptoms preventive and curative measures. Case Studies.</li> <li>• Waterborne bacterial and viral Diseases: causative agent, Spread of disease symptoms preventive and curative measures. Case Studies.</li> <li>• Human immune-system and its vulnerability to these bacteria and viruses</li> <li>• Biological warfare and protective measures.</li> <li>• Safeguarding water sources and ambient air quality.</li> </ul>	<b>8</b>
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1) Principles of Environmental Toxicology (1998): I. C. Shaw and J. Chadwick; Taylor&amp;Francis Ltd.</li> <li>2) Basic Environmental Health (2001): AnnaleeYassi, TordKjellstom, Theo de Kok, Tee Guidotti.Oxford University Press.</li> </ol>	

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| <ol style="list-style-type: none"> <li>3) Environmental Health (2005): Dade W. Moeller , Harvard University Press. USA</li> <li>4) Handbook of Environmental Health and Safety: Principle and practices. Herman Koren and Michael S. Bisesi. Lewis Publishers.</li> <li>5) Essentials of Environmental Health (2006): Robert Friis. Jones &amp; Bartlett Publishers</li> <li>6) Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. (2001): Principles of Ecotoxicology. 2<sup>nd</sup>Ed. Taylor &amp; Francis, London.</li> <li>7) Environmental Biology and Toxicology (2014): P. D. Sharma, Rastogi Publications.</li> <li>8) Environmental Pollution and Toxicology (2007): M.K. Rao. Manglam Publishers &amp; Distributors.</li> <li>9) Environmental Pollution: Health and Toxicology (2011): S.V.S. Rana. Narosa Publishing House.</li> <li>10) Toxicology (1999): A.Sood, Sarup and sons New Delhi, 1999</li> <li>11) Environmental Epidemiology (1995): Anisa Basheer, Rawat Publication Jaipur, New Delhi</li> <li>12) Industrial Hygiene &amp; Chemical Safety (2008): M.H.Fulekar, I. K. International Publishing House, New Delhi.</li> <li>13) Principles of Fire Safety Engineering: Understanding Fire and Fire Protection (2014): Akhil Kumar Das. Prentice Hall India Learning Private Limited.</li> <li>14) Industrial Safety and Environment (2013): Anupama Prashar. S.K. Kataria &amp; Sons.</li> <li>15) Occupational Safety Management and Engineering (2001): Willie Hammer, Dennis Price, Prentice Hall.</li> <li>16) Fundamentals of Occupational Safety and Health, Mark A. Friend, James P. Kohn, Government Institutes, 16-Aug-2010</li> <li>17) Industrial Safety, Health Environment and Security (2013): Basudev Panda. Laxmi Publications.</li> <li>18) Occupational Hygiene (1995): Blackwell Science, Harrington, J.M. &amp; K. Gardiner. Oxford.</li> <li>19) Industrial Safety , Health and Environment Management Systems (2006): R.K. Jain and Sunil S. Rao. Khanna publishers, New Delhi.</li> <li>20) Industrial Safety -National Safety Council of India. Reports and Survey Papers. The Factories Act with amendments. Govt. of India Publications DGFASLI, Mumb</li> </ol> |  |
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<b>EVS5402: Restoration and Watershed Management (Credits 4)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Restoration Ecology</b> <ul style="list-style-type: none"> <li>• Eco Restoration</li> <li>• Definition and principles,</li> <li>• Significances</li> <li>• Guidelines</li> <li>• Principles of Restoration</li> <li>• Applications of Restoration Ecology</li> </ul>	<b>06</b>
<b>2</b>	<b>Restoration of urban eco-system -</b> <ul style="list-style-type: none"> <li>• Ponds, lakes, river banks, avenue trees,</li> <li>• Biodiversity restoration through gardens, park, restoration of dumping grounds,</li> <li>• Restoration of eco system on hills,</li> <li>• Restoration of soil in urban areas,</li> <li>• Ground water resource – replenishment,</li> <li>• Sewage or wastewater – recycling for supporting ecosystems</li> <li>• Case studies</li> </ul>	<b>08</b>
<b>3</b>	<b>Eco-restoration and industrial environment</b> <ul style="list-style-type: none"> <li>• Eco-restoration of mines (open cast), restoration of solid waste dumping sites,</li> <li>• Improving aesthetics by partial restoration at industrial sites</li> <li>• Case studies</li> </ul>	<b>08</b>
<b>4</b>	<b>Restoration of other natural habitats/eco-systems lectures</b> <ul style="list-style-type: none"> <li>• Mangroves,</li> <li>• grasslands,</li> <li>• wetlands,</li> <li>• restoration of streams,</li> <li>• degraded forest patches,</li> <li>• coastal ecosystems,</li> <li>• Case Studies</li> </ul>	<b>08</b>
<b>5</b>	<b>Concept of watershed management</b> <ul style="list-style-type: none"> <li>• Definition, principle, objectives,</li> <li>• Water shed morphology</li> <li>• characterization(with respect to size, elevation &amp; slope, aspects &amp; orientation, watershed shape, drainage network)</li> </ul>	<b>08</b>
<b>6</b>	<b>Watershed functions and surveys</b> <ul style="list-style-type: none"> <li>• Collection, storage, dispersal, habitat, Attenuation response, flushing, etc.</li> <li>• Engineering surveys involved in watershed development:</li> </ul>	<b>08</b>

	<ul style="list-style-type: none"> <li>• Topographical survey,</li> <li>• drainage line survey,</li> <li>• contour survey,</li> <li>• common instruments used for survey.</li> <li>• Hydrological survey: Methodology for groundwater investigation, investigation of surface springs,</li> <li>• vertical distribution of ground water</li> <li>• Case studies</li> </ul>	
<b>7</b>	<p><b>Water balance studies and harvesting methods</b></p> <ul style="list-style-type: none"> <li>• Water balance and hydrologic equation, inflow to the watershed, outflow from the watershed.</li> <li>• Water harvesting methods: traditional water harvesting structures such as <i>nadis</i>, <i>Khadin</i>, <i>Rapats</i>, Lakes, etc. contour bunding, graded bunds /field bunds, land leveling or terracing, farm ponds;</li> <li>• Water harvesting in streams: Biological measures, check dam, gully plug, Gabion structure, Overflow weir, earthen dam, Underground <i>bandhara</i>.</li> <li>• Soil and water conservation aspects: contour trenches, continuous contour benches, live hedges, infiltration pit, <i>in situ</i> conservation through appropriate cultivation practices</li> </ul>	<b>08</b>
<b>8</b>	<p><b>Watershed management</b></p> <ul style="list-style-type: none"> <li>• Factors, problems associated with watershed management,</li> <li>• Project monitoring and result indicators</li> <li>• Repair and maintenance, etc.</li> <li>• Success stories of watershed management/water harvesting projects in India and world.</li> </ul>	<b>06</b>
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Restoration of Nature by Prakash Gole</li> <li>2. Restoration Ecology the new frontier – edited by Jelte Van Andel and James Aronson – Wiley-Blackwell publication ISBN 9781444336368</li> <li>3. A source book for Ecological Restoration by Foundation for Ecological Security 2008</li> <li>4. Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series) - Donald A. Falk, Margaret Palmer, Joy Zedler, Richard J. Hobbs</li> <li>5. Watershed manual by BK Kakde (BAIF and LEAD India publication)</li> <li>6. Water Harvesting and Sustainable Supply in India by RN Athavale Centre for Environment Education ISBN: 8170337526</li> <li>7. Watershed Hydrology by Peter Black ; Lewis Publishers: ISBN 1575040271</li> <li>8. Soil and water conservation engineering by R. Suresh – Standard Publishers and Distributors ISBN 8180140008</li> </ol>	

<b>EVS5403: Renewable and Non-Renewable Energy (Credits 4)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<p><b>Energy and Environment</b></p> <ul style="list-style-type: none"> <li>• Energy consumption as a measure of prosperity,</li> <li>• Global energy use pattern and impacts on the environment;</li> <li>• Energy use pattern in India;</li> <li>• Sources of energy and their classification;</li> <li>• Energy forms and transformation.</li> <li>• Sun as source of energy and solar spectrum,</li> <li>• Solar radiations: Absorption, reflection, scattering and diffusion in the atmosphere,</li> <li>• Renewable energy integration and decentralized generation systems,</li> <li>• Energy modeling and project management</li> </ul>	<b>8</b>
<b>2</b>	<p><b>Solar Energy</b></p> <ul style="list-style-type: none"> <li>• Harnessing of solar energy,</li> <li>• Photovoltaics,</li> <li>• Solar energy collectors and concentrators,</li> <li>• Solar thermal energy,</li> <li>• Solar electricity generation,</li> <li>• Solar heaters, dryers, and cookers;</li> <li>• Solar energy storage methods</li> <li>• Applications of solar energy</li> </ul>	<b>8</b>
<b>3</b>	<p><b>Hydroelectricity</b></p> <ul style="list-style-type: none"> <li>• Principle, Generating methods</li> <li>• Sizes, types and capacities of hydroelectric facilities</li> <li>• Potential of hydroenergy: world and India</li> <li>• Hazard related to hydropower generation and distribution,</li> <li>• Environmental impacts of hydroelectricity production</li> </ul>	<b>8</b>
<b>4</b>	<p><b>Geothermal and Hydrothermal Energy</b></p> <ul style="list-style-type: none"> <li>• Natural geothermal fields,</li> <li>• Exploration and drilling</li> <li>• High temperature and low temperature aquifers,</li> <li>• Prospects of geothermal energy: World/India</li> <li>• Hydrothermal energy: Vapour and liquid system;</li> <li>• Operation and environmental problems.</li> <li>• Applications of Geothermal</li> </ul>	<b>8</b>
<b>5</b>	<p><b>Fossil Fuels</b></p> <ul style="list-style-type: none"> <li>• Classification and composition</li> <li>• Formation, reserves, exploration/ mining of fossil fuel</li> <li>• Uses of Coal, Oil and Natural gas</li> </ul>	<b>6</b>

	<ul style="list-style-type: none"> <li>• Environmental problems associated with fossil fuel</li> <li>• Exploration / mining, processing, transportation and uses</li> </ul>	
6	<p><b>Bio-energy</b></p> <ul style="list-style-type: none"> <li>• Biomass composition and types</li> <li>• Conversion processes – pyrolysis , charcoal production, compression, gasification and liquefaction</li> <li>• Energy plantation</li> <li>• Biogas: production and uses, anaerobic digestion;</li> <li>• Energy from Solid Wastes: Sources, types, energy production.</li> <li>• Bio-energy and Waste to Energy Conversion Systems,</li> <li>• Energy Conservation and Management and Energy Laboratory.</li> </ul>	8
7	<p><b>Nuclear energy</b></p> <ul style="list-style-type: none"> <li>• Energy generation from fossil fuels : Nuclear Fission and fusion reaction.</li> <li>• Nuclear fuel production and processing – Mining and processing of Uranium , concentration, refining, enrichment, fuel fabrication and fuel cycle</li> <li>• Nuclear waste generation sources , classification, treatment and disposal of radioactive waste.</li> <li>• Environmental implications.</li> </ul>	8
8	<p><b>Wind energy</b></p> <ul style="list-style-type: none"> <li>• Harnessing of wind energy, factors affecting wind energy generation</li> <li>• Power generation by wind mills: concentrators, wind characteristics and siting,</li> <li>• Environmental considerations</li> <li>• Wind energy potential in India.</li> <li>• Numerical Methods and Computational Techniques, Wind Energy Conversion.</li> </ul>	6

<b>EVS5404: Environmental Law Ethics and Policy (Credits 4)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Environmental Law and Policy</b> Introduction to Law, Policy; Meaning, Basic difference and Importance. Indian Constitution and Environment Role of Constitution in Environment Protection, Fundamental Rights and Duties, Article 48A, 51A (g) and 58A	8
<b>2</b>	<b>Principles and Frameworks</b> Stockholm conference, Nairobi Declaration, Rio Conference, Kyoto Protocol, World Summit on Sustainable Development (Rio + 10), Convention on Biological Diversity, Convention on Climate Change, Role of UN authorities in protection of Global Environment.	8
<b>3</b>	<b>Environmental Laws in India</b> The Water (Prevention and Control of Pollution) Act – 1974 The Air (Prevention and Control of Pollution) Act – 1981 Indian Forests Act (Revised) 1982. The Environment (Protection) Act, 1986 The Indian Wildlife (Protection) Act – 1972 amended 1991 The Public liability Insurance Act, 1991 The National Environmental Tribunal Act, 1995 The Biological Diversity Act, 2002	8
<b>4</b>	<b>Regulations and Policies</b> Hazardous waste management and Handling rules, Solid waste management and Handling rules, biomedical waste regulations, Motor Vehicle rules, National Environmental Policy National Forest Policy, National Water Policy, Policies on Renewable and Non renewable energy resources.	8
<b>5</b>	<b>Environmental Ethics</b> Introduction, concept, ethical theories applied to the environment. The ethical dilemma, Environmental ethics and population, pollution. Human life and its environment – The art of ethics and an ethical dilemma, Challenges of world environmental ethics.	8
<b>6</b>	<b>Sustainable Development</b> Definition of sustainability – Environmental, Economical and Social dimensions of sustainability Sustainable Development Models – Strong and Weak Sustainability Defining Development- Millennium Development Goals Mindsets for Sustainability : Earthly, Analytical, Precautionary, Action and Collaborative– Syndromes of Global Change: Utilization Syndromes, Development Syndromes, and Sink Syndromes – Core problems and Cross Cutting Issues of the 21 Century - Global, Regional and Local	8



	environmental issues – Social insecurity - Resource Degradation – Climate Change – Desertification	
<b>7</b>	<b>Sustainable Livelihood</b> World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty -Millennium Development Goals, Indicators, Targets, Status and intervention areas - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.	8
<b>8</b>	<b>Case Studies</b> Recent Case studies based on Environmental Laws and Policies	4

**EVS5405: Dissertation and Project Work**

**4 Credits**

<b>EVS5406: Environmental Economics (Credits 2)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Environmental Economics</b> The Economy and the Environment: Two Parts of a Whole – Interlinkages between the economy and the environment. Conventional Economics and its limitations Micro Foundations of Environmental Economics - Theory of Public goods, Externalities and Market failure – The Problem of Social Cost - Design of Environmental Policy.	<b>6</b>
<b>2</b>	<b>Economic Instruments for Environmental Protection</b> Command & Control versus Incentives and Subsidies Available Policy Options Effectiveness of these instruments International Comparisons	<b>6</b>
<b>3</b>	<b>Economics of Natural Resource Management</b> Renewable and Non-Renewable Resources Methods of valuation of Environmental Costs and Benefits. Economic Growth and the Environment Foreign Direct Investment Inflow and the Environmental quality	<b>6</b>
<b>4</b>	<b>Sustainable Development</b> Concept of and issues in Sustainable Development, Strategic Planning for Sustainable Development Economic reforms and sustainable development	<b>6</b>
<b>5</b>	<b>Climate Change and India</b> Vulnerability of regions and populations Adaptation options Case studies on Climate Change	<b>6</b>
<p><b>References:</b> Hanley, Nick, Jason F. Shogren &amp; Ben White: <i>Environmental Economics in Theory and Practice</i>, New Delhi: Macmillan –India, 1997. James, D.E., <i>Economic Approaches to Environmental Problems: Techniques and Results of Empirical Analysis</i>, Elsevier Scientific Publishing Co., 1978. Nash, R.F., <i>The Rights of Nature: A History of Environmental Ethics</i>, University of Wisconsin, 1989. Whytte, Anne, V. and Ian Burton (eds), <i>Environmental Risk Assessment</i>, John Wiley &amp; Sons, 1980. Arrow, K.J. and Scitovsky, T., <i>Readings in Welfare Economics</i> Part III, 1969. Coase, R.H., The Problem of Social Cost in <i>Readings in Micro Economics</i> by Breit and Hochman, 1951 Allen V. Kneese and James L. Sweeney, eds. <i>Handbook of Natural Resource and Energy Economics</i>, Chapters 2,12,14,17, North Holland, 1985.</p>		

Fisher, A.C., Environment and Resource Economics, Selected readings, *New Horizon in Environmental Economics*, Ed. W.E. Oates, 1995.

Oates, W.E., *Economics of the Environment*, 1992.

Field, B.C., *Environmental Economics: An Introduction*, McGraw Hill, 1994

Baumol, W.J. and W.E. Oates, `The Theory of Environmental Policy', Cambridge University Press, 1988.

Bohm, P. and Russell, C., `Comparative Analysis of Alternative Policy Instruments', Chap. 10 in *Handbook of Natural Resource and Energy Economics*, Vol.I Ed. A.V. Kneese and J.L. Sweeney, 1985. Mehta, S., S. Mundle and U. Sankar, `Incentives and Regulation for Pollution Control', Sage, 1997.

Sankar, U. (ed.) Environmental Economics, New Delhi: Oxford University Press, 2001.

<b>EVS5407: Wildlife and Habitat Management (Credits 2)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Wildlife and zoogeography of India and the Indian Subcontinent</b> <ul style="list-style-type: none"> <li>• Wild flora and fauna of India</li> <li>• Zoogeography of India.</li> <li>• The convergence of zoogeographical regions in the Indian Subcontinent.</li> <li>• Our neighboring zoogeographical regions.</li> </ul>	<b>6</b>
<b>2</b>	<b>Wildlife Management</b> <ul style="list-style-type: none"> <li>• Introduction to wildlife management.</li> <li>• Laws, Acts and rules for wildlife conservation and management.</li> <li>• Protected Areas of India.</li> <li>• Community Conservation Areas.</li> <li>• Biodiversity Registers.</li> <li>• The Indian Forest Service. State Forest Services.</li> </ul>	<b>6</b>
<b>3</b>	<b>Major wildlife habitats and conservation areas in India</b> <ul style="list-style-type: none"> <li>• Himalayas</li> <li>• North- East</li> <li>• West and East Coastal Islands in the Indian Ocean</li> <li>• Deserts and semi-arid regions</li> <li>• Western Ghats and the Eastern Ghats</li> <li>• Satpuras and the Vindhyas</li> <li>• Rivers of India.</li> </ul>	<b>6</b>
<b>4</b>	<b>Major National Parks and Wildlife Sanctuaries in India</b> <ul style="list-style-type: none"> <li>• Corbett</li> <li>• Kanha - Bandavgarh</li> <li>• Tadoba - Nawegaon-Nagzira</li> <li>• Mudumalai - Bandipur</li> <li>• Namdapha - Keoladeo Ghana</li> <li>• Mundanthurai - Point Calimere</li> <li>• Periyar - Chambal among others.</li> </ul>	<b>6</b>
<b>5</b>	<b>Conservation breeding and zoo management</b> <ul style="list-style-type: none"> <li>• Captive breeding,</li> <li>• In situ vs ex situ conservation,</li> <li>• Major zoological parks of India,</li> <li>• Central Zoo Authority.</li> <li>• Role of modern genetics and biosciences in captive breeding of endangered species.</li> </ul>	<b>6</b>
<b>References:</b>		
	<ol style="list-style-type: none"> <li>1. Rajesh Gopal, Fundamental of Wildlife Management, Natraj Publishers, 2012, Second Revised edition, xii, 1288 p</li> <li>2. Gary E Davis, Science and Ecosystem Management in National Parks, The University of Arizona Press, Tucson, 1996</li> <li>3. India's 4<sup>th</sup> national reports on convention on Biodiversity, MOEF 2009.</li> <li>4. Maharashtra protection and preservation of trees Act, 1975, Govt of Maharashtra, modified upto 9th June 2004.</li> <li>5. Rosaleen Duffy (2010), Nature crime: how we are getting conservation wrong, Yale University Press, London,</li> <li>6. PriyaRanjan Trivedi and UttamKumar Singh, Environmental laws on</li> </ol>	

	<p>Wildlife, Commonwealth Publishers</p> <p>7. Rutwick Dutta, Wildlife Law: A ready reckonor, A guide to wildlife Protection Act, 1972, as amended in 2002. Wildlife Trust of India, 2004</p> <p>8. Tejaswini Apte, Kalpaviksha (2006). A simple guide to intellectual property rights, Biodiversity and traditional knowledge.</p> <p>9. S.K. Singh, Textbook of Wildlife Management</p>	
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<b>EVS5408: Hazardous Waste Management (2 Credits)</b>		
<b>Units No.</b>	<b>Title and Content</b>	<b>No. of Lectures</b>
<b>1</b>	<b>Hazardous waste management</b> <ul style="list-style-type: none"> <li>• Identification and sources</li> <li>• Characteristics and categorization</li> <li>• Collection, segregation, packaging, labeling, transportation and processing (3r)</li> <li>• Risk assessment and waste management treatment and disposal</li> <li>• Storage and leak detection</li> <li>• Site selection criteria</li> <li>• Indian scenario</li> <li>• Responsibilities of various authorities</li> <li>• E-waste and radioactive waste</li> <li>• Biomedical waste</li> </ul>	<b>15</b>
<b>2</b>	<b>Treatments and disposal</b> <ul style="list-style-type: none"> <li>• Waste processing,</li> <li>• Recovery of biological and chemical conversion products</li> <li>• Composting,</li> <li>• Biogasification,</li> <li>• RDF system,</li> <li>• Hydrolysis, and Pyrolysis,</li> <li>• Plasma gasification,</li> <li>• Incineration</li> <li>• Sanitary landfills.</li> </ul>	<b>15</b>
<b>References:</b>		
	<ul style="list-style-type: none"> <li>• Larry W. Canter, "Environment Impact Assessment", McGraw-Hill Book Company, New York</li> <li>• G.J. Rau and C.D. Weeten, "Environmental Impact Analysis Hand book, McGraw Hill, 1980.</li> <li>• Vijay Kulkarni and T V Ramchandra. "Environmental management" Capital Publishing Co</li> <li>• Mhaskar A.K., "Environmental Audit" Enviro Media Publications.</li> <li>• S.K. Dhameja, "Environmental Engineering and Management" S.K. Kalaria and Sons Publishers.</li> <li>• William Blackman , "Basic Hazardous Waste Management" , Taylor &amp; Francis, 1995</li> <li>• VanGuilder, Cliff , Hazardous Waste Management: An Introduction by, Mercury Learning and Information, 2011</li> <li>• M. S. Bhatt, Asheref Illiyan, Solid Waste Management: An Indian Perspective, Synergy Books India, 2012 William Blackman , "Basic Hazardous Waste Management" , Taylor &amp; Francis, 1995</li> <li>• VanGuilder, Cliff , Hazardous Waste Management: An Introduction by,</li> </ul>	

	<p>Mercury Learning and Information, 2011</p> <ul style="list-style-type: none"><li>• M. S. Bhatt, Asheref Illiyan, Solid Waste Management: An Indian Perspective, Synergy Books India, 2012</li><li>• Singh, Singh Anantpreet, Kaur Sukhjit, “Biomedical Waste Disposal”, Jaypee Brothers</li><li>• Ronald E. Hester, Roy M. Harrison, “ Electronic Waste Management”RSC Publishing</li></ul>	
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**EVS5409: Self Learning Course 4**

**1 Credit**