

**Savitribai Phule Pune University, Pune**

**Revised Syllabus 2020-21**

**Course Design**

CBCS: 2020-2021

T. Y. B. Sc. **Environmental Science**

**Course Structure**

Course	Course Code	Name of the Course	Course Code	Name of the Course	Credit
Semester V			Semester VI		
DSEC	EVS-301	Terrestrial Ecosystem and Management	EVS-301	Aquatic Ecosystem and Management	2+2
DSEC	EVS-302	Wildlife biology and Management	EVS-302	Nature Conservation	2+2
DSEC	EVS-303	Water and Soil quality	EVS-303	Air and Noise quality	2+2
DSEC	EVS-304	Atmospheric and Global Climate change	EVS-304	Issues in Environmental Science	2+2
DSEC	EVS-305	Environmental legislation and policy	EVS-305	Environmental governance: EMS, EIA & ISO14000	2+2
DSEC	EVS-306	Environmental Biotechnology-I	EVS-306	Environmental Biotechnology-II	2+2
DSEC	EVS-307	Practical-I	EVS-307	Practical-I	2+2
DSEC	EVS-308	Practical-II	EVS-308	Practical-II	2+2
DSEC	EVS-309	Practical-III	EVS-309	Project	2+2
SEC	EVS3011	Remote sensing, GIS and modeling	EVS3013	Solid Waste Management	2+2
SEC	EVS3012	Soil Health Management	EVS3014	Urban Ecosystem	2+2

## Savitribai Phule Pune University, Pune

Semester – V, Paper –I

EVS –301 Terrestrial Ecosystem and Management

Credits – 02

Lectures - 30

Unit. No.	Course contents	Number of lectures
1	<b>Terrestrial Ecology</b> <ul style="list-style-type: none"> <li>• Introduction to Terrestrial Environment</li> <li>• Parameters of terrestrial environment</li> <li>• The terrestrial biota and biogeographic regions of India</li> <li>• The Soil subsystem</li> <li>• Hotspots in India: Western Ghats, Eastern Himalaya, Andaman Nicobar</li> </ul>	5
2	<b>Terrestrial Biodiversity</b> <ul style="list-style-type: none"> <li>• Introduction, concept, types of Biomes</li> <li>• Biogeographic regions of the world</li> <li>• General structure of terrestrial communities</li> <li>• Distribution, Patterns</li> <li>• Structure, Classification</li> <li>• Keystone species</li> <li>• Interspecies relationships</li> </ul>	5
3	<b>Terrestrial ecosystem services</b> <ul style="list-style-type: none"> <li>• Aesthetic benefits</li> <li>• Cultural benefits,</li> <li>• Tourism and recreation, industry, drugs and medicines,</li> <li>• Carbon pool and sequestration potential</li> </ul>	4
4	<b>Methods of terrestrial ecosystem management</b> <ul style="list-style-type: none"> <li>• Remote sensing,</li> <li>• Geographical information system,</li> <li>• Community based forest management, traditional methods,</li> <li>• Forest fire: reasons, effects, control measures and management</li> </ul>	6
5	<b>Methods of vegetation sampling and data analysis</b> <ul style="list-style-type: none"> <li>• Sampling approaches,</li> <li>• Quadrature methods,</li> <li>• Line and belt transect,</li> <li>• Point frame method</li> </ul>	5
6	<b>Exploitation and Sustainable Utilisation</b> <ul style="list-style-type: none"> <li>• Reasons, Threats of exploitation</li> <li>• Sustainable management methods</li> <li>• Role of People, NGO's Community and Local Government</li> <li>• Community Based terrestrial ecosystem management methods</li> <li>• Case studies related</li> </ul>	5

**Semester – VI, Paper –II**

EVS –301 Aquatic Ecosystem and Management

**Credits – 02**

**Lectures - 30**

Unit. No.	Course contents	Number of lectures
1	<b>Limnology</b> <ul style="list-style-type: none"><li>• Introduction, The Aquatic environment,</li><li>• Aquatic Biota, Parameters</li><li>• Energy flow in aquatic ecosystem</li><li>• Major environmental factors and ecosystem processes</li><li>• Ramsar convention and Ramsar sites in India</li></ul>	5
2	<b>Distribution of major aquatic ecosystems</b> <ul style="list-style-type: none"><li>• Classification</li><li>• Structure</li><li>• Patterns</li><li>• Types of Interactions</li><li>• Stratification and Zonation</li><li>• Impact of Climate change on aquatic ecosystems</li></ul>	5
3	<b>Freshwater ecology</b> <ul style="list-style-type: none"><li>• The freshwater environment: types</li><li>• Limiting factors;</li><li>• Ecological classification of freshwater organisms,</li><li>• the freshwater biota (flora and fauna), lentic (lakes and ponds) and lotic (rivers, streams, springs, etc) communities, planktons.</li><li>• Biodiversity, negative and positive feedbacks and resilience.</li></ul>	5
4	<b>Marine and Estuarine ecology</b> <ul style="list-style-type: none"><li>• The marine environment</li><li>• The marine biota(floraand fauna),</li><li>• Zonation in the sea, study of planktons,</li><li>• Communities in the marine environment.</li><li>• Food Production potential</li><li>• Mangrove Vegetation</li><li>• Coral reefs</li><li>• Ecological significance</li></ul>	5
5	<b>Methods of aquatic ecosystem management:</b> <ul style="list-style-type: none"><li>• Remote sensing,</li><li>• Geographical information system,</li><li>• Eco-development program,</li><li>• Traditional methods,</li><li>• Methods of aquatic sampling and data analysis: sampling approaches, species association.</li></ul>	5

	<ul style="list-style-type: none"> <li>Case studies</li> </ul>	
6	<b>Exploitation and Consequences of wetlands,</b> <ul style="list-style-type: none"> <li>Sustainable management</li> <li>Role of Local Government and people in conservation,</li> <li>Impact of Tourism, Eco-tourism</li> <li>Conservation and Sustainable use of India's aquatic resources</li> </ul>	5

#### References:

- Groom. B. & Jenkins. M. 2000. *Global Biodiversity: Earth's Living Resources in the 21st Century*. World Conservation Press, Cambridge, UK, Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002.
- The Ecology of Plants*. Sinauer Associates Incorporated. Loreau, M. & Inchausti, P. 2002.
- Biodiversity and Ecosystem Functioning: Synthesis and Perspectives*. Oxford University Press, Oxford, UK, Odum, E. P. 1971.
- Fundamentals of Ecology*. W. B. Saunders, Pandit, M. K., White, S. M. & Pocock, M. J. O., 2014. The Contrasting Effects of Genome Size, Chromosome Number and Ploidy Level on Plant Invasiveness: A Global Analysis.
- New Phytologist* 203: 697-703. Pimentel, D. (Ed.). 2011.
- Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal and Microbe Species*. CRC Press. Singh, J. S., Singh, S. P. & Gupta, S. R. 2006.
- Ecology, Environment And Resource Conservation*. Anamaya Publications.
- Wilson, E. O. 1985. The Biological Diversity Crisis. *Bioscience* 35: 700-706.

#### Semester – V, Paper –II

EVS –302 Wildlife Biology and Management

**Total Lectures- 30**

Sr.No.	Name of Unit	Content	Lecture
1	<b>Introduction to Wildlife Biology</b>	<ul style="list-style-type: none"> <li>Introduction to wildlife Biology</li> <li>Definition of Wildlife Biology</li> <li>Study of Different characteristics of wildlife Habitat in Biosphere:               <ol style="list-style-type: none"> <li>Aquatic Habitat: Marine, Fresh water, and Estuaries.</li> <li>Terrestrial Habitat: Forest, Grassland, Desert, Landscape.</li> </ol> </li> </ul>	5
2	<b>Groups of wildlife species</b>	<ul style="list-style-type: none"> <li>Plant Classification: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms (Monocot and Dicot)</li> <li>Animal Classification:               <ol style="list-style-type: none"> <li>Arthropods (Insect, Arachnids, Crustaceans, Millipedes, Centipedes),</li> <li>Vertebrates (Mammals, Birds, Fish, Reptiles, Amphibians)</li> </ol> </li> </ul>	5
3	<b>Threats to wildlife</b>	Habitat Destruction, Developmental projects, Urbanization, Agriculture expansion, Poaching, Human Wildlife conflict, Deforestation, Exploitation of animals and plants	5
4	<b>Habitat Analysis and Population Assessment Techniques</b>	<ul style="list-style-type: none"> <li>Standard Evaluation processes for habitat: HEP &amp; HIS.</li> <li>Population Assessment technique (wildlife sensus)               <ol style="list-style-type: none"> <li>Direct count : Block count, Transect methods, Point count, Visual encounter survey, Waterhole survey</li> <li>Indirect count: Pugmark, camera trap, DNA finger</li> </ol> </li> </ul>	5

		printing, Call count, track and sign, pellet count 3. Marking wildlife : Ringing, Tagging, Clipping, Colouring.	
5	<b>Modern Wildlife management Techniques</b>	<ul style="list-style-type: none"> <li>● Bio- telemetry;</li> <li>● Management practices :Monitoring Wildlife Populations, Habitat Improvement, Hunting Regulations,Artificial Stocking, Controlling or Preventing Disease and Its Spread, Management Funds/Programs, captive breeding and propagation.</li> </ul>	5
6	<b>Sustainable Wildlife management</b>	<ul style="list-style-type: none"> <li>● Eco tourism / wild life tourism in forests;</li> <li>● Reasons for Biodiversity formation, contribution to adaptive evolution, Landraces of crop plants, conservation of genetic resources, highly productive habitats.</li> <li>● Various Environmental movements in India: Chipko Movement, Appiko movement, Silent valley movement.</li> </ul>	5

References:

- 1.Principles of Environmental science - Cunningham and Cunningham
2. Ecology, Environment and Resource Conservation (2006): Singh JS, Singh SP and Gupta SR; Anamaya Publ, New Delhi.
3. Fundamental of Ecology (1971): EP Odum; WB Saunders Company.
4. Plant Diversity Hotspots in India (1997): PK Hajra and V. Mudgal; Botanical Survey of India
5. Environmental Management (2005): Bala Krishnamoorthy; Prentice-Hall of India Pvt. Ltd., New Delhi.

## Semester – VI, Paper –II

EVS –302 Nature Conservation

Total Lectures- 30

Sr.No.	Name of Unit	Content	Lecture
1	<b>Introduction to Nature Conservation</b>	<ul style="list-style-type: none"> <li>● Introduction,</li> <li>● Concept of nature conservation</li> <li>● Objectives</li> <li>● Challenges</li> </ul>	5
2	<b>Insitu Conservation</b>	<ul style="list-style-type: none"> <li>● Concept and principle of Insitu Conservation.</li> <li>● Types : Biosphere reserve, National Parks, Wildlife sanctuaries, Biodiversity Hotspots, Gene Sanctuary, Community reserves, Sacred groves</li> <li>● Challenges, merits and Demerits</li> </ul>	5
3	<b>Exsitu conservation</b>	<ul style="list-style-type: none"> <li>● Concept and principle</li> <li>● Types : Cryopreservation, Seed banks, Field gene banking, Cultivation Collections</li> <li>● Challenges, merits and Demerits</li> </ul>	5
4	<b>International and National Efforts for conservation</b>	<ul style="list-style-type: none"> <li>● Role if IUCN, WWF for naure conservation.</li> <li>● Introduction to Protocol and Conventions for Nature conservation.</li> <li>● National Efforts: BNHS, Tiger, Crocodile, Reindeer, Whaling mission.</li> <li>● Administrative Setup: MoEFCC, SPCB, CPCB, etc</li> <li>● Role of NGO</li> <li>● Species conservation efforts</li> </ul>	10

5	<b>Awareness about conservation</b>	<ul style="list-style-type: none"> <li>• Need and Importance of awareness.</li> <li>• State Symbols (Animal and Plants)</li> <li>• Role of NGO in Awareness</li> </ul>	5
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References:

1.Agrawal K. C., 2009. Biodiversity: Concept. Conservation and Management, Concept Publishing Company Pvt. Ltd, New Delhi.

2.Ahluwalia V. K., Malhotra S. 2008.Environmental Science,doi, 13: 978-1-42007-069-9.

3.Anderson A., David .,2010. Environmental economics and Natural resource Management. The USA and Canada by Routledge 270 Madison Avenue, New York.

4.Balvanera P., Daily G. C., Ehrlich P. R., Ricketts T. H., Bailey S. A., Kark S., Kremen C., Pereira H., 2001. Conserving Biodiversity and Ecosystem Services. Science, 291, 5511: 2047

5.Botkin D. B., Keller E. A., 2010. Environmental Science.

6.Central Zoo Authority (CZA) report., 2011. Important zoo in India. [www.cza.nic.in](http://www.cza.nic.in)

7.Chaturvedi, Mahendra, .2010. Biodiversity and Conservation. D.P.S. Publishing House ,New Delhi,

8.Convention on International Trade in Endangered Species of Wild Fauna and For a (CITES) [www.cites.org](http://www.cites.org)

9ENVIS. Environmental Information system. [www.envis.nic.in](http://www.envis.nic.in)

10. Gadgil M., Berkes F., Folke C., 1993. Indigenous knowledge for biodiversity conservation. Biodiversity: Ecology, Economics, Policy, 22 ( 2/3), 151-156

**Semester – V, Paper –III**

**EVS –303 Water and Soil quality**

**Total Lectures- 30**

Unit No.	Course Content	Number of Lectures
1	Introduction <ul style="list-style-type: none"> <li>• Uses, Water resources sources , distribution of Water resources on Earth, Water cycle</li> <li>• Characteristics of Water –Physical, Chemical and Biological</li> <li>• Water Inventory</li> <li>• Sewage water –its characteristics and effects</li> </ul>	05
2	Water Pollution <ul style="list-style-type: none"> <li>• Water Pollution definition, types of water pollution based on Point and Non- point sources</li> <li>• Types of Water Pollution- Lake water pollution, River water pollution, Groundwater pollution, Sea water pollution with Case studies</li> <li>• Eutrophication process with Case study</li> <li>• Water Pollution with respect to Indian Rivers</li> <li>• Water Borne diseases</li> <li>• Water stress Index</li> </ul>	05
3	Water Pollution Management <ul style="list-style-type: none"> <li>• Water Quality Standards for drinking water, different uses and by</li> </ul>	

	<p>different agencies</p> <ul style="list-style-type: none"> <li>• Water treatment Process- Primary, Secondary &amp; Tertiary treatment , nutrient removal</li> <li>• Laws related to Water Pollution Control in India</li> <li>• GAP (Ganga Action Plan )&amp; National River Action Programme</li> <li>• Role of National and International agencies in Water health and Sanitation</li> <li>• Application of GIS and Remote sensing for management of Water Resources</li> </ul>	<b>05</b>
<b>4</b>	<p>Soil</p> <ul style="list-style-type: none"> <li>• Introduction to soil and its importance in ecosystem and Agriculture</li> <li>• Composition of soil</li> <li>• Soil types and their formation</li> <li>• Soil Horizons, Texture, Soil structure , fertility</li> <li>• Factors influencing soil –Soil aeration, Soil temperature etc</li> </ul>	<b>05</b>
<b>5</b>	<ul style="list-style-type: none"> <li>• Soil Reactions –Acid base reactions, Ion exchange, Micro and Macro nutrients , Nitrogen pathways , NPK in soil</li> <li>• Soil Analysis –pH, Lime ,Silica ,phosphorous , Total nitrogen, Total Sulphur, Manganese, Soluble salts, Pesticides and Environmental friendly technologies</li> </ul>	<b>05</b>
<b>6</b>	<p>Soil Pollution and Management</p> <ul style="list-style-type: none"> <li>• Soil sickness &amp; Soil Toxicology</li> <li>• Soil as waste disposal</li> <li>• Remediation of Contaminated site</li> <li>• GIS &amp; Remote sensing application in soil resource management</li> </ul> <p>Soil Conservation techniques</p>	<b>05</b>

#### References

1. Principles of Environmental Science-Cunningham & Cunningham
2. Ecology ,Environment and Resource Conservation (2006) : Singh JS, Singh SP, Gupta SR, AnamayaPubl, New Delhi
3. Fundamentals of Ecology (1971) :EP Odum ,WB Saunders Company
4. RS Ramalho ,1983 Introduction to Waste water Treatment Process, Academic press, New York
5. Qunag, EAR ,Principles of Waste waster Treatment Vol I, Biological process,National Science Development Board ,Manila,Phillipines
6. Water pollution by Dr. AnuradhaSalpekar
7. Environmental pollution Analysis by S.M. Khopkar
8. Textbook of Practical Chemistry by Vogel, A.I Tatchell and Furnis
9. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., &Jones, A., (2011), Practical skills in Chemistry, 2nd Ed., Prentice Hall, Harlow
10. Hydrology – Principles, analysis and Design – H. M Ragunath, New age International Publications.(1996)
11. Standard Methods for the examination of water and waste water – APHA (American Public Health Association), AWWA (American Water Works Association), WEF (Water Environmental Federation)
12. Low cost waste water treatment technologies – R. K. Trivedy and SiddharthKaul
13. Pollution and Bioremediation- P. C. Trivedi
14. An Introduction to Environmental pollution- B. K. Sharma and H. Kaur
15. Environmental Chemistry – A. K. De
16. Microbiology – Micheal J. Pelczar, E. C. S. Chan, Noel R. Krieg.
17. Textbook of Microbiology – R. Ananthanarayan and C. K. JayaramPaniker
18. Soils and soil fertility, Troch, F.R. And Thompson, L.M. Oxford Press.
19. Fundamentals of soil science, foth, H.D. Wiley Books. 3. Soil Science and Management, Plaster, Edward J., Delmar Publishers.

20. Principles of Soil Chemistry (2Wed.) Marcel Dekker Inc., New York. 5. Handbook of Agricultural Sciences, S.S.Singh, P.Gupta, A.k.Gupta, Kalyani Publication.

**Semester – VI, Paper –III**

**EVS –303 Air and Noise Quality**

**Total Lectures- 30**

<b>Unit No.</b>	<b>Course Content</b>	<b>Number of Lectures</b>
<b>1</b>	Atmosphere and its nature Atmosphere: Composition of Atmosphere, Chemical and photochemical reactions in the atmosphere, Human Activities and meteorology, factors influencing the pollutant mix in the atmosphere and the resultant impacts of pollution, Transport of Pollution in Atmosphere Global Warming, Ozone Hole, El Nino, La Nina Phenomenon.	<b>05</b>
<b>2</b>	Air pollution Air pollution: Meaning and definition, Sources and Types of air pollutants, major air pollutants; types of air pollution – indoor air pollution, vehicular pollution, industrial pollution; Status of Air pollution in India, Effects of air pollution on plants; animals; human; and materials, Smog and Acid rains, Control of air pollution. Emission Standards Air quality Index (AQI) and air pollution tolerance index (APTI)	<b>05</b>
<b>3</b>	Analytical Methods for Monitoring Air Pollutants Analytical Methods for Monitoring Air Pollutants; Sampling, : Stack sampling, instrumentation and methods of analysis of SO <sub>2</sub> , CO etc, Monitoring, and, Hydrogen Sulphide, Hydrocarbons, Methane ,Particulate Matter,	<b>05</b>
<b>4</b>	Air Pollution control Air Pollution control- at source-equipment for control of air pollution-For particulate matter-Settling chambers-Fabric filters-Scrubbers-Cyclones Electrostatic precipitators, For Gaseous pollutants-control by absorption-adsorption scrubbers-	<b>05</b>
<b>5</b>	Noise pollution Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; causes of noise, outdoor and indoor noise propagation; psycho-acoustics and noise criteria	<b>05</b>



<b>6</b>	Effects of noise on health, annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices	<b>05</b>
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#### References

- Rao and Rao: Air Pollution Control Engineering.
- Environmental Pollution Control Engineering-CS Rao, Wiley Eastern Ltd., New Delhi, 1996.
- C.S. Rao, Air pollution and control
- Environmental Noise Pollution-PE Cunniff, McGraw Hill, New York, 1987

#### Semester – V, Paper – IV,

EVS –304 Atmospheric and Global Climate change

**Total Lectures- 30**

Unit No	Course Content	Number of Lectures
1	Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere in making the Earth. Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green house gases (GHGs); greenhouse effect; global conveyor belt.	4
2	Atmospheric circulation: Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; tropical cyclone; Indian monsoon and its development, changing monsoon in Holocene in the Indian subcontinent, its impact on agriculture and Indus valley civilization; effect of urbanization on micro climate; Asian brown clouds.	6
3	Meteorology and atmospheric stability Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model	4
4.	Global warming and climate change: Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO <sub>2</sub> fertilization and agriculture; impact on economy and spread of human diseases.	6
5	Climate change and policy: Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.	6
6.	Climate change and policy: Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997;	4

	Convention on Climate Change; carbon credit and carbon trading; clean development mechanism	
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1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. & Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.

#### Semester – VI, Paper – IV,

EVS –304 Environmental Issues

**Total Lectures- 30**

Unit No	Course Content	Number of Lectures
1	Global Environmental issues - ozone depletion, global warming and climatic change., Energy crisis and conservation, Biodiversity conservation, Hotspots , Bio-resources and their impact on local economy.	4
2	The green revolution, food crisis and population explosion, Pastoralism.Rehabilitating degraded lands, The Gender and environment debate	6
3	Ecological conflicts and the environmental movements in India: Narmada Bachao Andolan, Appiko Movement, Chipko movement, Silent Valley Movement, Tehri Dam conflicts, Almatti dam, Bhopal gas tragedy, Soil Erosion, Formation and reclamation of Usar, Alkaline and Saline Soil	4
4.	Waste lands and their reclamation. Desertification and its control. Vehicular pollution and urban air quality. Depletion of Nature resources	6
5	Waste disposal, recycling and power generation. Fly ash utilization. Water Crises- Conservation of water. Environmental Hazards. Eutrophication and restoration of Indian lakes. Rain water harvesting. Wet lands conservation. Epidemiological issues (e.g. Corona pandemic Goitre, Fluorosis, Arsenic)	6
6.	International trade and economic reforms on the environment, industrial growth, environmental and ecology in India, major issues in sustaining growth and development	4

#### References:

1.Environmental Governance: The Global Challenge; By Lamont C. Hempel; Island Press (1996) 72. 2.Environmental Issues in India – A Reader; By Mahesh Rangrajan; Pearson-Longman Publ. (2007)

3.Introduction to Environmental Biotechnology; by AK Chatterji (2002); Prantice-Hall of India.

4.. Handbook of Environmental Law, Acts, Guidelines, Compliances, and Standards: Vol. I and II; by R.K. Trivedy; BS publ (2004).

5. International Environmental Law, Fairness, Effectiveness and World Order; by Elli Louka, Cambridge, (2006)

6. Global Environmental Governance: A Reform Agenda; by Adil Najam, Mihaela Papa, and Nadaa Taiyab (2006), International Institute for Sustainable Development (IISD), Canada

7. Environmental Governance and Regulation in India: by Atiyah Curmally; (Environment and Rehabilitation) India Infrastructure Report 2002

### Semester – V, Paper –V

EVS –305 Environmental Legislation and policy

**Total Lectures- 30**

Unit No	Course Content	Number of Lectures
1	<b>Introduction to Law and Policy:</b> Concept of law and policy, environmental governance. Importance and elements of environmental governance.	4
2	<b>Environmental Legislation:</b> Legal definitions:Environmental pollution, natural resource, biodiversity, forest, sustainable development. Article 48A:The protection and improvement of environment and safeguarding offorests and wildlife. Fundamental rights and duties as per the Constitution of India Environmental Ethics: Introduction, Concept, Development of environmental ethics.	4
3	<b>Government Institutions</b> Role of Ministry of Environment, Forests & Climate Change Role of Central Pollution Control Board (CPCB) Role of State Pollution Control Boards Role ofNational Green Tribunal (NGT)	4
4	<b>International Laws and Policy</b> Stockholm Conference 1972, United Nations Conference on Environment and	4

	Development 1992, Montreal Protocol 1987; Rio de Janeiro (Rio Declaration, Agenda 21), Kyoto Protocol 1997, Copenhagen and Paris summits, Ramsar convention.	
5	<b>Environmental Acts</b> <ul style="list-style-type: none"> <li>• The Environment (Protection) Act, 1986,</li> <li>• The Forests (Conservation) Act 1980</li> <li>• The Wildlife (Protection) Act 1972</li> <li>• The Water (Prevention and Control of Pollution) Act 1974</li> <li>• The Air (Prevention and Control of Pollution) Act 1981</li> <li>• Motor Vehicle Act 1988</li> <li>• The Public Liability Insurance Act 1991</li> <li>• Noise Pollution (Regulation and Control) Rules 2000</li> <li>• The Biological Diversity Act 2002</li> <li>• Hazardous Waste Management Rules, 2016.</li> </ul>	14

**References:**

1. Abraham, C.M. 1999. *Environmental Jurisprudence in India*. Kluwer Law International.
2. Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. *Bulletin of the National Institute of Ecology* **15**: 227-238.
3. Divan, S. & Rosencranz, A. 2001. *Environmental Law and Policy in India*. Oxford University Press.
4. Divan, S. & Rosencranz, A. 2002. *Environmental Law and Policy in India: Cases, Materials and Statutes* (2nd edition). Oxford University Press.
5. Gupta, K.R. 2006. *Environmental Legislation in India*. Atlantic Publishers and Distributors.
6. Leelakrishnan, P. 2008. *Environmental Law in India* (3rd edition). LexisNexis India.
7. Naseem, M. 2011. *Environmental Law in India Mohammad*. Kluwer Law International.
8. P. Leelakrishnan. 2016. Environmental Law in India. 4th edition. Publisher: Lexis Nexis
9. T S Doabia. 2017. Environmental and Pollution Laws In India. (3rd Edition). Publisher: Lexis
10. Venkat, A. 2011. *Environmental Law and Policy*. PHI Learning Private Ltd.

**Semester –VI, Paper –VI**

EVS –305 Environmental Governance: EMS, EIA & ISO14000

**Total Lectures- 30**

Unit No.	Name of the Unit	Content	Lectures
1	Environmental Governance	Introduction, Importance, objective and attributes of Governance <ul style="list-style-type: none"> <li>• Elements of governance :Institutional and structural, ,rules and regulation</li> <li>• Environmental governance in India</li> </ul>	5

		- Issues and challenges	
2	ISO 14000 standards	Overview of ISO 14000- Management system benefits and scopes Implementation and certification ISO/207 TC function Environmental management and sustainability aspects	7
3	EIA and Audits	Introduction ,Needs and Goals ,Advantages and Disadvantages Life cycle assessment , Societal response and Responsibilities (Public participation),EIA Notification, 2006 Methods of data collection :Net work, Checklist, Matrix, Overlay & GIS , Cost –benefit analysis, Concept of Audit: Definition and Types, Benefits and objectives of environmental audit, onsite , offsite audit , report preparation	6
4	Basic of EMS and EMP	Elements of EMS andEMP Planning and selection of appropriate resources management Benefits of EMS and EMP system	4
5	Case studies based on Developmental Project	Assessment of impact on development activities on <ul style="list-style-type: none"> <li>• vegetation and wildlife,</li> <li>• deforesrtration and mining</li> </ul>	4

#### References

- EIA notification published by Ministry of Environment, Forests and Climate Change, Government of India
- Environmental Impact Assessment, Canter R.L., McGraw Hill International Edition.
- Environmental Impact Assessment: Practical Guide for Professional Practices by Rathi AKA, Publisher: Gujarat Akar Unlimited, 2016
- Preventive Environmental Management: An Indian Perspective by Dr. Shyam R. Asolekar& Dr. R. Gopichandran

#### Semester – V , Paper –VI

#### **EVS –306 Environmental Biotechnology-I**

**Total Lectures- 30**

Unit No	Name of Unit	Content	Lectures
1	Introduction	<ul style="list-style-type: none"> <li>• Introduction and Meaning of Environmental Biotechnology,</li> <li>• Necessity and scope,</li> <li>• History and objectives,</li> <li>• Importance and Applications.</li> </ul>	5
2	Composting Technology	<ul style="list-style-type: none"> <li>• Classification,</li> <li>• Manufacturing,</li> <li>• Formulation,</li> <li>• Mode of action of composting technology.</li> <li>• Vermicomposting.</li> </ul>	5

3	Genetically Modified Organisms	<ul style="list-style-type: none"> <li>• Introduction,</li> <li>• Principles and Advanages,</li> <li>• Measures,</li> <li>• Examples,</li> <li>• Risk to Environment.</li> <li>• Biosafety (Cartagena Protocol)</li> </ul>	5
4	Agricultural biotechnology, Biofertilizers	<ul style="list-style-type: none"> <li>• Introduction,</li> <li>• Detection and diagnosis,</li> <li>• Micropropagation.</li> <li>• Types and Role</li> <li>• Waste and Uses</li> </ul>	5
5	Microbes	<ul style="list-style-type: none"> <li>• Collection and Enumeration of microbes,</li> <li>• Ecological Relation of microbes,</li> <li>• Nutritional requirements,</li> <li>• Nutrient media,</li> <li>• Growth condtions,</li> <li>• Nutritional types,</li> <li>• Types of microbes.</li> <li>• Xenobiotic components.</li> </ul>	10
			30

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1. Erickson, LE and DY Fung. 1988. Handbook on Anaerobic fermentations. Marcel and Dekker Inc. New York.
- 2.. Holland, KT, JS Knapp and JG Shoesmith. 1990. Anaerobic bacteria. Blackie Publications. New York.
3. Ramasamy, K., G. Kalaichelvan and B. Nagamani. 1992. Working with anaerobes: Methanogens. Fermentation Laboratory, TNAU, Coimbatore.
4. Gerhardt, P., RGE Murray, WA Wood and NR Krieg. 1994. Methods for General and Molecular Bacteriology. ASM Publications, Washington.
5. Jogdand, SN 1995. Environmental Biotechnology. Himalaya Publishing House, Mumbai.
- 6.. Erickson, LE and DY Fung. 1988. Handbook on Anaerobic fermentations. Marcel and Dekker Inc. New York.
7. Ramasamy, K, G Kalaichelvan and B Nagamani. 1992. Working with anaerobes: Methanogens. Fermentation Laboratory, TNAU, Coimbatore.
8. Crawford, RL and DLCrawford. 1996. Bioremediation - Principles and Applications. Cambridge University Press, London

#### Semester – V, Paper –VII

#### EVS –307      Practicals based on ENV- 301 and 302

Sr. No.	Title	No. of practical
1	Study of Flora of Urban terrestrial ecosystem	1
2	Study of Fauna of Urban terrestrial ecosystem	1
3	Estimation of Biomass of Grassland by harvest method	1
4	Study of various types of Interspecies relationships in ecosystem	1
5	Estimation of Chlorophyll content	1
6	Study of threat assessment model for an ecosystem	1
7	Estimation of Grassland by harvest method	1
8	To find out the diversity within an ecosystem using Shannon and Simpson's diversity indices	1

9	Study of any one population assessment technique for Animal/plant/bird	1
10	Identification of different groups of wild species (Flora and Fauna)	1
11	Study of different Ecotourism activities	1
12	Vegetation mapping by using aerial photographs	1
13	Interpretation techniques for aerial photographs and satellite imageries	1
14	Vegetation mapping by using satellite imageries	1

**Semester – VI, Paper –VII**  
**EVS –307      Practicals based on ENV- 301 and 302**

Sr. No.	Title	No. of practical
1	Identification and Classification of phytoplankton and zooplankton from water sample	1
2	Quantitative analysis of phytoplankton by Lackey's Drop count method	1
3	Study of Wetland ecosystem	1
4	Study of swamp (Mangrove) ecosystem	1
5	Study of Aquatic Weeds, Insects, Birds	1
6	Study of Benthic fauna	1
7	Study of Macrophytes and microorganisms as Bioindicator of pollution	1
8	Determination of pH, EC and temperature of waste water	1
9	Estimation of Dissolved oxygen and CO <sub>2</sub> of water sample	1
10	Determination of BOD of waste water sample	1
11	Determination of COD of waste water sample	1
12	Testing the bacteriological quality of drinking water	1
13	Jar test for Coagulation and Flocculation	1
14	Determination of Sludge Volume Index	1
15	Study of various disinfection methods for water	1

**Semester – V, Paper –VIII**  
**EVS –308      Practicals based on ENV- 303 and 304**

Sr No	Name of Practical	No. of Practical
1	Sampling of Waste water from different polluted sites	01
2	Sampling of Soil from different polluted sites	01
3	Analzing p H, Temperature and EC of different waste water	01
4	Estimation of DO & free CO <sub>2</sub>	01
5	Determination of COD in water sample	01
6	Determination of BOD in water sample	01
7	Visit to Sewage Treatment Plant/ETP	01
8	Determination of Nitrates from Water sample	01
9	Determination of Phosphates from Water sample	01
10	Determination of MPN from drinking water	01
11	Determination of Soil Bulk density	01
12	Determination of Sludge Volume Index	01

### Semester – VI, Paper –VIII

#### EVS –308 Practicals based on ENV- 303 and 304

Sr No	Name of Practical	No. of Practical
1	Principle and functioning of high volume air sampler	1
2	Sampling of waste water from different polluted sites	1
3	Estimation of SPM from atmosphere	1
4	Determination of SO <sub>x</sub>	1
5	Determination of NO <sub>x</sub>	1
6	Visit to pollution control laboratories	1
7	Determination of MPN from drinking water resource for potability	1
8	Study of phytoremediation techniques to remove pollutants	1
9	Study of Safety instructions	1
10	Testing the bacteriological quality of drinking water	1
11	Examination of sewage water for microbial pathogens	1
12	Methods of disinfection in waste waters	1
13	Use of macrophytes as bio-indicators for water/soil pollution monitoring	1
14	Use of microorganisms as bio-indicators for water/soil pollution monitoring	1

Semester – V, Paper

#### r –IX EVS –309 Practicals based on ENV- 305 and 306

Unit No	Course Content	Number of Lectures
1	Determining the factors influencing the composting process, nutrients, moisture, temperature and air, microbial populations	1
2	Study of micro organisms by Standard Plate Count (SPC) method	1
3	Microbial analysis of flocs in activated sludge system	1
4	Biological de-colorization using microbial columns	1
5	Isolation of bacteria from soil and decaying matter	1
6	Survey of plants in and around air polluted sites	1



7	Determination of hydrogen sulfide (H <sub>2</sub> S) from sewage sample	1
8	Analysis of residual pesticides in agricultural land and crops	1
9	Study of Eutrophication parameters & its effects on water bodies	1
10	Study of instrumentation and safety standards in microbial laboratory	1
11	Isolation and characterization of soil microorganisms from polluted sites	1
12	Analysis of residual pesticides in agricultural land and crops	1
13	Study of Eutrophication parameters & its effects on water bodies	1
14	Survey of plants in and around air polluted sites	1

**Semester – VI, Paper –IX**  
EVS –309 Project

**Credits-2**

Unit No	Name of Unit	Content	Lectures
1	Project	<ul style="list-style-type: none"> <li>• Introduction</li> <li>• Aim</li> <li>• Objective</li> <li>• Methodology</li> <li>• Progress report</li> <li>• Results</li> <li>• Conclusion</li> <li>• Progress report</li> <li>• Final presentation</li> </ul>	

**Semester – V, Paper – IV,**

**SEC–3011 Remote sensing, GIS and modeling**

**Total Lectures- 30**

Unit No	Course Content	Number of
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		Lectures
1	Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors Types of platform; Geostationary orbit and Sun-synchronous Polar orbit; Multi spectral scanning	4
2.	Interaction of EMR with the earth's surface and atmosphere, Energy response mechanism: Reflection, Absorption, Transmission, Scattering, Refraction, Reflectance, Emission and scattering, Atmospheric windows.	4
3.	Aerial photography and Air Photo Interpretation: Basic geometric characteristics of aerial photographs. Scale, resolution, overlaps, flight planning, Measurement of height on aerial photograph, Principle of relative tonality, minimum mapping unit, Photo interpretation elements for visual interpretation.	6
4	Geographical Information Systems: definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.	6
5	Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.	4
6	Basic elements of statistical analyses: sampling; types of distribution – normal, binomial, poisson; measurements of central tendency and dispersion; skewness; kurtosis; hypothesis testing; parametric and non-parametric tests; correlation and regression; curve fitting; analysis of variance; ordination.	6

#### References

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2. Joseph G. (2003): Fundamentals of Remote Sensing, Universities Press, Hyderabad.
3. Haywood, Ian (2000): Geographical Information Systems, Longman
4. Chang, Kang-taung (2002): Introduction to Geographic Information Systems, Tata McGraw-Hill.
5. Burroughs, P. A (1986): Principles of Geographical Information Systems for land Resource Assessment, Oxford University Press.
6. Edmondson, A. & Druce, D.1996.Advanced Biology Statistics. Oxford University Press.
7. . Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons. 8
8. . Richards, J. A. & Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.
9. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman

#### Semester – V, Paper – IV,

#### SEC-3012 Soil Health Managment

Total Lectures- 30

Unit No	Course Content	Number of Lectures
1	<ul style="list-style-type: none"> <li>• Composition of soil, Soil Fertility – Concept and Evaluation</li> <li>• Nutrition &amp; Essential Plant Nutrient Elements and their deficiency.</li> <li>• Concept of Integrated Plant Nutrient Management(IPNM),</li> </ul>	4
2.	<b>1.Biological measures</b> – contour cultivation – strip cropping – cropping systems – vegetative barriers - windbreaks and shelterbelts - shifting cultivation – <b>2.Mechanical measures</b> – contour bund – graded bund – broad beds and furrows – basin listing – random tie ridging	8

	<b>3.Mechanical measures for hill slopes</b> – contour trench – bench terrace – contour stone wall – Rain water harvesting – insitu soil moisture conservation – runoff water harvesting <ul style="list-style-type: none"> <li>• Farm ponds and percolation ponds - storage and its use for domestic and ground water recharge</li> <li>• Irrigation Scheduling and Agriculture Drainage System.</li> </ul>	
3.	<ul style="list-style-type: none"> <li>• Concept of Plant Diseases &amp; Pest, Classification of Plant Diseases &amp; Disease Triangle,</li> <li>• Methods of Pest Management-Biological, Cultural, Legislative, Physical &amp; Chemical, (Chlorinated Hydrocarbons, Organophosphates &amp; Carbamates),</li> <li>• Pesticide use &amp; Environment, Organic Crop Production , Agroforestry, Integrated Pest Management (IPM) &amp; Bio-pesticides.</li> <li>• Concept of Ecological Pest &amp; Disease Management-Energy Crops,</li> </ul>	8
4	<ul style="list-style-type: none"> <li>• Fertilizers, Classification of Fertilizers Effects due to use of excess fertilizer &amp; Their Management .</li> <li>• Concept &amp; importance of Bio-fertilizers, Types and Use.</li> <li>• Calculation of Recommended dose of fertilizer</li> </ul>	6
5	<ul style="list-style-type: none"> <li>• Schemes for water conservation</li> <li>• Scheme for fertilizer, seed, and other material purchase</li> <li>• Soil Health card</li> </ul>	4

### References:

- 1.Brady, N., and R. Weil. *The Nature and Properties of Soils*. 14th ed. Upper Saddle River, NJ: Prentice Hall, 2008.
- 2.Clark, A., ed. *Managing Cover Crops Profitably*. 3rd ed. Handbook Series No. 9. Beltsville, MD: Sustainable Agriculture Network, 2007.
3. Coleman, D. C., D. A. Crossley Jr., and P. F. Hendrix. *Fundamentals of Soil Ecology*. 2nd ed. Burlington, MA: Elsevier Academic Press, 2004.
- 4.Gugino, B. K., O. J. Idowu, R. R. Schindelbeck, H. M. van Es, B. N. Moebius-Clune, D. W. Wolfe, J. E. Thies, and G. S. Abawi. *Cornell Soil Health Assessment Training Manual*. Edition 2.0. Ithaca: Cornell University, 2009.
5. Hall, M., and G. Roth, eds. *The Penn State Agronomy Guide* .
6. Hooper, D., et al. "Interactions between aboveground and belowground biodiversity in terrestrial ecosystems: Patterns, mechanisms, and feedbacks." *BioScience* 50 (20): 1049–61.
7. Magdoff, F., and H. van Es. *Building Soils for Better Crops: Sustainable Soil Management*. 3rd ed. Handbook Series No. 10. Beltsville, MD: Sustainable Agriculture Network, 2009.
- 8 Tisdall, J. M., and J. M. Oades. "Organic matter and water-stable aggregates in soils." *Journal of Soil Science* 33 (1982): 141–63.
- 9 Tugel, A., A. Lewandowski, D. HappevonArb, eds. *Soil Biology Primer*. Rev. ed. Ankeny, Iowa: Soil and Water Conservation Society, 2000.
- 10 Zehnder, G. *Farmscaping: Making Use of Nature's Pest Management Services*

### Semester – V, Paper – IV,

SEC-3013 Solid Waste management

**Total Lectures- 30**

Unit No	Course Content	Number of Lectures
1	Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.	3
2.	Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.	4
3.	Different techniques used in collection, storage, transportation and disposal of solid	6

	waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques.	
4	Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant.	6
5	4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.	4
6	Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management.	6

### References

1. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report 570.
2. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.
3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.
4. McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.
5. US EPA. 1999. Guide for Industrial Waste Management. Washington D.C.
6. White, P.R., Franke, M. & Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic & Professionals.
7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C..

### Semester – V, Paper – IV,

SEC-3013 Urban Ecosystem

**Total Lectures- 30**

Unit No	Course Content	Number of Lectures
1	Introduction to urbanization; urban sprawl and associated environmental issues.	3
2.	<b>Environment in an urban setting:</b> Man as the driver of urban ecosystem; commodification of nature; metros, cities and towns as sources and sinks of resources; resource consumption and its social, cultural, economic and ecological perspectives; urban transformation; increasing challenges posed by modernity for the environment; urban pollution (air, water, soil).	4
3.	<b>Urban dwelling :</b> Housing scenario across a range of large-medium-small cities; poverty and slums in an urban context; Town planning Acts and their environmental aspects; energy consumption and waste disposal as well as accumulation; environmental costs of urban infrastructure.	6
4	<b>Urban interface with the environment:</b> Management of urban environment; alternative resources; policy and management decisions; urban settings as loci of sustainability; challenges associated with sustainability and urban future.	6
5	<b>Natural spaces in a city :</b> Concept of 'controlled nature'; scope, importance and threats to nature in the city; organization and planning of green spaces such as parks, gardens and public spaces; concept of green belts; urban natural forest ecosystem as green lungs.	4
6	<b>Planning and environmental management:</b> Urban planning and its environmental aspects from historical and contemporary perspectives; benefits of environmental management; introduction to green buildings; urban governance; political complexity of applying ecological science to urban policy and planning, smart cities.	6

## References

1. D'Monte, Darryl. 1985. Industry versus Environment Temples or Tombs. Three Controversies, Delhi, CSE.
2. Ernstson, H. 2011. Re-translating nature in post-apartheid Cape Town: The material semiotics of people and plants at Bottom Road. In: Heeks, R., (Ed.) Conference on "Understanding Development through Actor-Network Theory", London School of Economics, 30 June, London.
3. Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.
4. Grimm, N. B., Faeth, S. H., et al. 2008. Global Change and the Ecology of Cities. *Science* 319: 756-760.
5. Hinchliffe, S. & Whatmore, S. 2006. Living cities: Towards a politics of conviviality. *Science as Culture* 15: 123–138.
6. McIntyre, N.E. 2000. Urban ecology as an interdisciplinary field: differences in the use of 'urban' between the social and natural sciences. *Urban Ecosystems* 4: 5-24.
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