

Syllabus of T. Y. B. Sc. Environmental Science

(Under Faculty of Science))

**SEMESTER-V**

Course	Course Code	Name of the Course	Credit
DSCC T	<b>BSC-EN501 T</b>	Terrestrial Ecosystem and Management	2
DSCC T	<b>BSC-EN502T</b>	Wildlife biology and Management	2
DSCC T	<b>BSC-EN503T</b>	Water and Soil quality	2
DSCC T	<b>BSC-EN504T</b>	Atmospheric and Global Climate change	2
DSCC T	<b>BSC-EN505T</b>	Environmental legislation and policy	2
DSCC T	<b>BSC-EN506T</b>	Introduction To Environmental Biotechnology	2
DSCC P	<b>BSC-EN507P</b>	Practical based on EN-501 and EN-502	2
DSCC P	<b>BSC-EN508P</b>	Practical based on EN-503 and EN-504	2
DSCC P	<b>BSC-EN509P</b>	Practical based on EN-505 and EN-506	2
SEC T	<b>BSC-EN510T</b>	Basics in Remote sensing, GIS	2
SEC P	<b>BSC-EN511P</b>	Urban Ecosystem and Management	2
		Total	22

**SEMESTER-VI**

Course	Course Code	Name of the Course	Credit
DSCC T	BSC-EN601T	Aquatic Ecosystem and Management	2
DSCC T	BSC-EN602 T	Nature Conservation	2
DSCC T	BSC-EN603 T	Air and Noise quality	2
DSCC T	BSC-EN604T	Issues in Environmental Science	2
DSCC T	BSC-EN605T	Environmental governance: EMS, EIA & ISO14000	2
DSCC T	BSC-EN606T	Advances in Environmental Biotechnology	2
DSCC P	BSC-EN607P	Practical based on EN-601 and EN-602	2
DSCC P	BSC-EN608P	Practical based on EN-603 and EN-604	2
DSCC P	BSC-EN609P	Practical based on EN-605 and EN-606	2
SEC T	BSC-EN610T	Solid Waste Management	2
SEC PR	BSC-EN611 PR	Project	2
		Total	22

Semester -V	Paper -I
Course Code: BSC-EN-501T	Title of the Course: Terrestrial Ecosystem and Management
Credits: 02	Teaching Hours: 30

**Course Outcomes (Cos):**

1. Understand the theories and fundamental concepts of Terrestrial Environment.
2. Understand importance of biodiversity and its distribution on earth
3. Gain knowledge about distribution of life on earth
4. Understand the potential of terrestrial ecosystem
5. Acquire knowledge sampling approach and data analysis

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>• 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> </ul>	5

	<ul style="list-style-type: none"> <li>• Quadrature methods,</li> <li>• Line and belt transect,</li> <li>• Point frame method</li> </ul>	
6	<p><b>Exploitation and Sustainable Utilization</b></p> <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

**Reference Books:**

1. Terrestrial Ecosystem – Ashok Malik – Rajat Publishers
2. Environmental Biodiversity – Dr. Aaron Harris – Random exports , New Delhi
3. Integrated Environmental Management – Arvind Kumar –Daya Publishers house , New Delhi.
4. Handbook of Ecological Restoration Vol. I and II - Martin R. Perrow and Anthony J. Davy – Cambridge University Press.
5. Biodiversity and Conservation – P.C. Joshi and Namita Joshi - APH Publishing Corporation
6. Biodiversity Conservation – Ramphal Sharma , RBSA Publishers
7. Biodiversity ( A text book) - DR. D. K. Thakur , Manisha Prakashan
8. Environmental Science - Arms Karen
9. Principles of Environmental Science-Watt, K. E. F. (1973) McGraw-Hill Book Company.
10. Environmental Science –Noble, B .J. Kormandy, E.J. (1981). The way world works, Prentice-Hall Inc., N .J.
11. Environmental Science-Turk A. , Turk J. Wittes J.T. and Wittes, R.E.
12. Environmental Issues: Measuring, Analyzing, Evaluating, Abel, Daniel C. McConnell, Robert L. Abel, Daniel C. Edi. 2 Prentice Hall Publication
13. Chaudhuri AB and Sarkar DD (2003) Mega diversity Conservation, Flora, Fauna and Medicinal Plants of India's Hotspots. Daya Publishing House, New Delhi.
14. Gary K Meffe and Ronald Carroll C (1994) Principles of Conservation Biology. Sinauer Associates Inc., Massachusetts.
15. Groombridge B (Ed.) (1992) Global Biodiversity Status of the Earths Living Resources. Chapman & Hall, London.
16. IUCN (1992) Global Biodiversity and Strategy.
17. Sharma P D (2000) Ecology and Environment. Rastogi Publications, Meerut, India.
18. Singh MP, Singh BS and Soma S. Dey (2004) Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi.

<b>Semester -V</b>	<b>Paper -II</b>
<b>Course Code: BSC-EN-502T</b>	<b>Title of the Course: Wildlife Biology and Management</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

**Course Outcomes (Cos):**

1. Understand the characteristics of wildlife.
2. Understand importance of classification of wildlife animals and plants
3. Understand the potential of threat to wildlife
4. Acquire knowledge about sustainable wildlife management.

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 ,Study of Different characteristics of wildlife Habitat in Biosphere:               <ol style="list-style-type: none"> <li>1. Aquatic Habitat: Marine, Fresh water, and Estuaries.</li> <li>2. Terrestrial Habitat: Forest, Grassland, Desert, Landscape.</li> <li>3. International Convention (CITES),</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>1.Arthropods (Insect, Arachnids, Crustaceans, Millipedes, Centipedes),</li> <li>2.Vertebates (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 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>1. Direct count : Block count, Transect methods, Point count, Visual encounter survey, Waterhole survey</li> <li>2. Indirect count: Pugmark, camera trap, DNA finger printing, Call count, track and sign, pellet count</li> <li>3. Marking wildlife : Ringing, Tagging, Clipping,</li> </ol> </li> </ul>	5

		Coloring.	
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 in forests;</li> <li>● Reasons for Biodiversity formation, contribution to adaptive evolution, Landraces of plants, conservation of genetic resources, highly productive habitats.</li> <li>●</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.

<b>Semester -V</b>	<b>Paper -III</b>
<b>Course Code: BSC-EN-503T</b>	<b>Title of the Course: Water and Soil quality</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

**Course Outcomes (COs):**

1. Understand the sources characteristics of water resources.
2. Understand importance of classification of water pollution
3. Understand the remedial management practices of water pollution
4. Acquire knowledge about soil and its characteristics
5. Understand the remedial management practices of soil pollution

<b>Unit No.</b>	<b>Course Content</b>	<b>Number of Lectures</b>
<b>1</b>	Introduction <ul style="list-style-type: none"> <li>• Distribution of Water resources on Earth, Water cycle , Water resources sources and Uses</li> <li>• Characteristics of Water –Physical, Chemical and Biological</li> <li>• Water Inventory</li> <li>• Sewage water –its characteristics and effects</li> </ul>	<b>05</b>
<b>2</b>	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</li> <li>• Eutrophication Water Pollution with respect to Indian Rivers</li> <li>• Water Borne diseases</li> <li>• Water stress Index</li> </ul>	<b>05</b>
<b>3</b>	Water Pollution Management <ul style="list-style-type: none"> <li>• Water Quality Standards for drinking water, different uses and by different agencies</li> <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 )and National River Action Programme</li> <li>• Role of National and International agencies in Water health and Sanitation</li> </ul>	<b>05</b>

	<ul style="list-style-type: none"> <li>• Application of GIS and Remote sensing for management of Water Resources</li> </ul>	
<b>4</b>	<b>Soil</b> <ul style="list-style-type: none"> <li>• Introduction to soil and its importance</li> <li>• Soil types, formation, Classification and Soil Survey techniques</li> <li>• characteristics of Soil- 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 ,</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>	<b>Soil Pollution and Management</b> <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> <b>Soil Conservation techniques</b>	<b>05</b>

## References

1. Water pollution by Dr. Anuradha Salpekar
2. Environmental pollution Analysis by S.M. Khopkar
3. Textbook of Practical Chemistry by Vogel, A.I Tatchell and Furnis
4. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A., (2011), Practical skills in Chemistry, 2nd Ed., Prentice Hall, Harlow
5. Hydrology – Principles, analysis and Design – H. M Ragunath, New age International Publications.(1996)
6. Standard Methods for the examination of water and waste water – APHA (American Public Health Association), AWWA (American Water Works Association), WEF (Water Environmental Federation)
7. Low cost waste water treatment technologies – R. K. Trivedy and SiddharthKaul
8. Pollution and Bioremediation- P. C. Trivedi
9. Soil, Plant, Water and Fertilizer analysis – P. K. Gupta 2<sup>nd</sup> edition
10. Soil Quality and Contamination – Pawan Kumar Bharti and Avinash Chauhan DPH Publishers
11. Soil and Solid waste analysis ( A laboratory manual ) P.K Behera Dominant and Distributors
12. Soil Science Treatise 3<sup>rd</sup> edition – Eetela Sathyanarayana et. al. – Jaya Publishing house.
13. An Introduction to Environmental pollution- B. K. Sharma and H. Kaur
14. Microbiology – Micheal J. Pelczar, E. C. S. Chan, Noel R. Krieg.
15. Textbook of Microbiology – R. Ananthanarayan and C. K. Jayaram Paniker
16. Soils and soil fertility, Troch, F.R. And Thompson, L.M. Oxford Press.

17. Fundamentals of soil science, foth, H.D. Wiley Books. 3. Soil Science and Management, Plaster, Edward J., Delmar Publishers.
18. 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 -V	Paper -IV
Course Code: BSC-EN-504T	Title of the Course: Atmospheric and Global Climate change
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. Understand the evolution theories of earth atmosphere and its structure.
2. Understand pattern of atmospheric circulation
3. Understand the importance of meteorological parameters and atmospheric stability
4. Acquire knowledge about global climate change and its effects
5. Understand the Climate change and policies

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; greenhouse gases (GHGs); greenhouse effect.	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	6
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, fertilization and agriculture; impact on economy and spread of human diseases.	8



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
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## References

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.
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Semester -V	Paper -V
Course Code: BSC-EN-505T	Title of the Course: T Environmental Legislation and policy
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. Understand the importance of environmental governance
2. Understand fundamental rights and ethics
3. Understand the role of various national agencies
4. Acquire knowledge about international laws, policies and agreements
5. Understand the environmental laws in India

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 of forests and wildlife. Fundamental rights and duties as per the Constitution of India Environmental Ethics: Introduction, Concept, Development of environmental ethics.	8
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 of National Green Tribunal (NGT)	6
4	<b>International Laws and Policy</b> Stockholm Conference 1972, United Nations Conference on Environment and Development 1992, Montreal Protocol 1987; Rio de Janeiro (Rio Declaration, Agenda 21), Kyoto Protocol 1997, Copenhagen and Paris summits, Ramsar convention.	6

5	<b>National 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>• The Public Liability Insurance Act 1991</li> <li>• The Biological Diversity Act 2002</li> <li>• Hazardous Waste Management Rules, 2016.</li> <li>• EIA policy 2006</li> </ul>	6
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### 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. & Rosencrantz, A. 2001. *Environmental Law and Policy in India*. Oxford University Press.
4. Divan, S. & Rosencrantz, A. 2002. *Environmental Law and Policy in India: Cases, Material 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.

<b>Semester -V</b>	<b>Paper -VI</b>
<b>Course Code: BSC-EN-506T</b>	<b>Title of the Course: T Introduction to Environmental Biotechnology</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

**Course Outcomes (COs):**

1. To know about biotic and abiotic environment and its microbial characteristics
2. Understand fundamental rights and ethics
3. Understand the importance of meteorological parameters and atmospheric stability
4. Acquire knowledge about global climate change and its effects
5. Understand the Climate change and policies

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>	6
3	Genetically Modified Organisms	<ul style="list-style-type: none"> <li>• Introduction,</li> <li>• Principles and Advantages and Measures</li> <li>• Examples</li> <li>• Risk to Environment.</li> <li>• Biosafety (Cartagena Protocol)</li> </ul>	7
4	Microbes	<ul style="list-style-type: none"> <li>• Collection and Enumeration of microbes</li> <li>• Ecological Relation of microbes,</li> <li>• Nutritional requirements &amp; Nutrient media</li> <li>• Growth conditions</li> <li>• Nutritional types</li> <li>• Types of microbes.</li> <li>• Xenobiotic components.</li> </ul>	6
5	Agricultural biotechnology, Bio-fertilizers	<ul style="list-style-type: none"> <li>• Introduction,</li> <li>• Detection and diagnosis,</li> <li>• Micro-propagation.</li> <li>• Bio-fertilizers: Types and Role</li> <li>• Waste and Uses</li> </ul>	6

**References;**

1. Erickson, LE and DY Fung. 1988. Handbook on Anaerobic fermentations. Marcel and Dekker Inc. New York.
- 2.. Holland, KT, J S Knapp and JG Shoemith. 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 D.L. Crawford. 1996. Bioremediation - Principles and Applications. Cambridge University Press, London
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EN-TY-2022

Semester -V	Paper -VII
Course Code: BSC-EN-507P	Title of the Course: Practical based on EN-501 and EN502
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. Understand the Flora and Fauna of terrestrial Ecosystem
2. Understand the Importance and Interspecies relationships in ecosystem.
3. Study the measurement of diversity and population technique.
4. To Awareness of diversity under various environmental conditions

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 -V	Paper -VIII
Course Code: BSC-EN-508 P	Title of the Course: Practical based on EN-503 and EN-504
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. To understand collection and preservation of water and soil sample
2. To understand analysis of water and soil sample
3. To understand the management of sewage water
4. To understand importance of macro and micro nutrient in soil

Sr No	Name of Practical	No. of Practical
1.	Sampling of Waste water from different sites	01
2.	Sampling , collection and storage techniques of Soil from different sites	01
3.	Tools and techniques of water/ soil sampling , collection and storage	01
4.	Determination of total solids / total dissolved solids from Water sample	01
5.	Determination of color, odour, acidity, of water sample	01
6.	Determination of Soil Bulk density	01
7.	Determination of Sludge Volume Index	01
8.	Determination of potassium / sulfur from soil sample	01
9.	Determination of manganese from soil sample	01
10.	Determination of boron from soil sample	01
11.	Determination of from soil sample	01
12.	Determination of Particle size composition	01
13.	Visit to soil survey Laboratory	01
14.	Visit to Sewage Treatment Plant / ETP	01

Semester -V	Paper -VIII
Course Code: BSC-EN-509 P	Title of the Course: Practical based on EN-505 and EN-506
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. Understand the guidelines for biosafety from DBT.
2. Learn about microbial techniques to isolate, identify microbial species.
3. To understand the structure and functions of national agencies
4. To aware about the EIA policy and its merits and demerits

Unit No	Course Content	Number of Lectures
1	Introduction to Microbiology Laboratory & Instrumentation	1
2	Study of instrumentation and safety standards in microbial laboratory.	1
3	Guidelines for Biosafety – Department of Biotechnology(Ministry of Science and Technology)	1
4	Study of Microscope and preparation of smear.	1
5	Preparation of solid and liquid laboratory media for cultivation of bacteria.	1
6	Isolation of bacteria by Streak Plate Method, Pour Plate Method, Spread Plate Method.	1
7	Study of bacterial colony characters.	1
8	Observation of microorganisms using Monochrome staining, Negative staining, Gram (Differential) Staining.	1
9	Briefly write the salient features of EPA- 1986	1
10	Role, functions and penalties in Air pollution act, 1981	1
11	Explain the role of Ministry of Environment ,Forest and Climate change	1
12	Write the role, importance and functioning of National Green Tribunal	1
13	Write the merits and demerits between the EIA policy of 2006 and 2020	1
14	Write the Role of UNFCCC in combating the global climate change	1



Semester -V	Paper -X
Course Code: BSC-EN-510T	Title of the Course: Basics in Remote sensing and GIS
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. To know about remote sensing, satellite and types of platforms
2. Understand Interaction of EMR with the earth's surface and atmosphere
3. Understand the importance of aerial photography and air Photo Interpretation
4. Acquire knowledge about Geographical Information Systems
5. Understand the application of GIS and RS in various fields

Unit No	Course Content	Number of 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.	6
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.	8
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.	6

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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.
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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.
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Semester -V	Paper -XI
<b>Course Code: BSC-EN-511T</b>	<b>Title of the Course: Urban Ecosystem</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

### Course Outcomes (COs):

1. To know about issues related with urban sprawl
2. Understand settlement nature and challenges with resources
3. Understand the sustainable planning for urban ecosystem
4. Acquire knowledge about open space and its importance
5. Understand the modern techniques application in urban settlements

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	6

environmental management; introduction to green buildings; urban governance; political complexity of applying ecological science to urban policy and planning, smart cities.	
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1. D'Monte, Darryl. 1985. *Industry versus Environment Temples or Tombs. Three Controversies*, Delhi, CSE.
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  3. Gaston, K.J. 2010. *Urban Ecology*. Cambridge University Press, New York.
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  5. Hinchliffe, S. & Whatmore, S. 2006. Living cities: Towards a politics of conviviality. *Science as Culture* 15: 123–138.
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# SEMESTER-VI

Semester -VI	Paper -I
Course Code: BSC-EN-601T	Title of the Course: Aquatic Ecosystem and Management
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. To know about basics in limnology
2. Understand pattern, classification and structures of aquatic ecosystem
3. Understand the characteristics and importance of freshwater and marine ecosystem
4. Acquire knowledge about mapping and sampling techniques
5. Understand the sustainable practices for conservation of aquatic ecosystem

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> </ul>	5
2	<b>Patterns 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> </ul>	5

	<ul style="list-style-type: none"> <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>	
4	<p><b>Marine and Estuarine ecology</b></p> <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	<p><b>Methods of aquatic ecosystem management:</b></p> <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> <li>• Ramsar convention and Ramsar sites in India</li> </ul>	5
6	<p><b>Exploitation and Consequences of wetlands,</b></p> <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> <li>•</li> </ul>	5

**References:**

1. Biodiversity of Tropical Aquatic Ecosystem – S.K. Kulhreshtha – Anmol Publications Pvt. Ltd.
2. Environmental management and Conservation – Dr. R.K. Khitoliya – APH Publishing corporation
3. Sustainable Agroecosystem Management ( Integrating Ecolgy, Economics and Society ) – Patrick J. , Bohlen and Gar House – CRC press .

4. Understanding Environment; Chokkar K. B., Pandya M. and Raghunathan M.; Centre for Environment Education; Sage Publication, New Delhi.
  5. An Advanced Textbook on Biodiversity – Principles and Practice; Krishnamurthy K.V.; Oxford and IBH Publishing Co. Pvt. Ltd.; New Delhi.
  6. Ecology-Principles and Applications; Chapman J. L. and Reiss M. J., Cambridge University Press.
  7. Fundamentals of Ecology; Odum P.E.; Natraj Publishers; Dehradun; 3 Edt..
  8. Ecology, Environment and Resource Conservation; Singh J.S., Singh S.P. and Gupta S.R.; Annamaya Publishers; New Delhi.
  9. Ecology and Environment; Sharma P.D.; Rastogi Publication; Meerut; 11 Rev. Edt..
  10. Environment Science; Tyler M.G.; Wadsworth Publishing Co.; 1997.
  11. Environmental Science; Santra S.C.; New Central Book Agency (P) Ltd.; 2 Edt. .
  12. Perspectives in Environmental Studies ; Anubha Kaushik and C.P. Kaushik; New Age International Publishers., New Delhi
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  14. Ecology and Environmental Science; S.V.S. Rana 5<sup>th</sup> Edition, PHI Learning private Limited, New Delhi.
  15. Environmental Biology; Verma P.S. and Agarwal V.K.; S.Chand Company LTD. Publishers, New Delhi.
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<b>Semester -VI</b>	<b>Paper -II</b>
<b>Course Code: BSC-EN-602T</b>	<b>Title of the Course: Nature Conservation</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

**Course Outcomes (COs):**

1. To know about Concept of nature conservation
2. Understand *in-situ* and *ex-situ* conservation techniques
3. Understand the role international, national, local and NGO in nature conservation
4. Significance of public participation in awareness programme

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>In-situ 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>Ex-situ 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 nature conservation.</li> <li>• Introduction to Protocol and Conventions for Nature conservation.</li> </ul>	10

		<ul style="list-style-type: none"> <li>• National Efforts: Man &amp; Biosphere Programme (MAB) BNHS, Tiger, Crocodile, Rhino and Vulture</li> <li>• Role of NGO</li> </ul>	
5	<b>Awareness and 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> <li>• Merits and demerits of public participation in awareness programme</li> </ul>	5

**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.

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

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<b>Semester -VI</b>	<b>Paper -III</b>
<b>Course Code: BSC-EN-603T</b>	<b>Title of the Course: Air and Noise Quality</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

**Course Outcomes (COs):**

1. To know about structure of atmosphere
2. Understand types, effect and control techniques of air pollution
3. To acquire information about various analytical techniques used for sampling and analysis of air pollutant.
4. To understand the noise pollution, genesis, its effect and remedial measures

<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>

### References

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- 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 -VI	Paper -IV
<b>Course Code: BSC-EN-604T</b>	<b>Title of the Course: Environmental Issues</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

**Course Outcomes (COs):**

1. To know about the major global environmental issues
2. Understand importance of green revolution and land management
3. understand the various environmental issues related movements and conflicts.
4. To know about the solid waste management practices and its demerits
5. understand importance of international trade and environmental issues.

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.	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 Goiter, 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
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Semester -VI	Paper -V
Course Code: BSC-EN-605T	Title of the Course: Environmental Governance: EMS, EIA & ISO14000
Credits: 02	Teaching Hours: 30

**Course Outcomes (COs):**

1. To know about the importance of environmental governance
2. Understand importance of management standard practices
3. understand the EIA and audit procedures .
4. To know about the basics of EMS and EMP in development activities

Unit No.	Name of the Unit	Content	Lectures
1	Environmental Governance	<ul style="list-style-type: none"> <li>• Introduction, Importance,</li> <li>• objective and attributes of Governance</li> <li>• Elements of governance: Institutional and structural, rules and regulation</li> <li>• Environmental governance in India</li> <li>• Issues and challenges</li> </ul>	5
2	ISO 14000 standards	<ul style="list-style-type: none"> <li>• Overview of ISO 14000-</li> <li>• Management system benefits and scopes</li> <li>• Implementation and certification</li> <li>• ISO/207 TC function</li> <li>• Environmental management and sustainability aspects</li> </ul>	7

3	EIA and Audits	<ul style="list-style-type: none"> <li>• Introduction, Needs and Goals, Advantages and Disadvantages</li> <li>• Life cycle assessment, Societal response and Responsibilities (Public participation), EIA Notification, 2006</li> <li>• Methods of data collection: Network, Checklist, Matrix, Overlay &amp; GIS , Cost – benefit analysis,</li> <li>• Concept of Audit: Definition and Types, Benefits and objectives of environmental audit, onsite, offsite audit, report preparation</li> </ul>	6
4	Basic of EMS and EMP	<ul style="list-style-type: none"> <li>• Elements of EMS and EMP</li> <li>• Planning and selection of appropriate resources management</li> <li>• Benefits of EMS and EMP system</li> </ul>	4
5	Case studies based on Developmental Project	<ul style="list-style-type: none"> <li>• Assessment of impact on development activities on</li> <li>• vegetation and wildlife,</li> <li>• de-forestation 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
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<b>Semester -VI</b>	<b>Paper -IV</b>
<b>Course Code: BSC-EN-606T</b>	<b>Title of the Course: Advances in Environmental Biotechnology</b>
<b>Credits: 02</b>	<b>Teaching Hours: 30</b>

**Course Outcomes (COs):**

1. Learn about the basic principle, strategy and applications of biological processes.
2. Understanding the mechanism of biological digestion methods.
3. Understand the importance of biotechnology in conservation of biodiversity.
4. Learn about the Sustainable technology and pollution abatement.

Unit No.	Name of the Unit	Content	Lectures
1	Bioremediation	Principles of bioremediation; Types of Bioremediation: Concept of bioaugmentation and biostimulation. (A) Microbial Remediation: - <ul style="list-style-type: none"> <li>• Factors affecting bioremediation process: microbialmetabolism, environmental conditions and nature of pollutant.</li> </ul> (B) Phytoremediation: <ul style="list-style-type: none"> <li>• Concept and types of phytoremediation, factors affecting on phytoremediation,</li> </ul>	06

		<ul style="list-style-type: none"> <li>• plants useful for phytoremediation,</li> <li>• removal of metals and organic pollutants: phyto-extraction, phyto-stabilization, Rizo-filtration, Phyto-transformation, phyto-volatilization.</li> <li>• Current developments in the process ofbioremediation.</li> </ul>	
2	Biotechnology for the control of pollutants	<ul style="list-style-type: none"> <li>• Methods of bio filtration.</li> <li>• degradation of Xenobiotic</li> <li>• Biotechnology of solid waste disposal; Use of immobilized enzymes and microbes for pollution abatement; improvement of microbial strains by conventional and molecular biological techniques.</li> </ul>	07
3	Biodegradation Bio-metheanation Bio-leaching	<ul style="list-style-type: none"> <li>• Anaerobic treatment for gas generation,microbiology and biochemistry, factors affecting on bio-degradation.</li> <li>• Bio-methanation- Process, Design, Merits and Demerits</li> <li>• Bio-leaching- Process, Application and Environmental Impact.</li> </ul>	05
4	Aerobic biological treatments	<ul style="list-style-type: none"> <li>• Aerobic methods- Trickling filter, Oxidation pond, Rotating biological contractor, Fluidized bed reactor</li> <li>• Anaerobic methods- Anaerobic filter process, expanded-bed process, UASB.</li> <li>• Removal of specific pollutants- nitrate, phosphates, heavy metals, etc.; Bio-sorption techniques for removal of pollutants.</li> </ul>	05
5	Biopolymers, Biosensors and Bio-indicators	<ul style="list-style-type: none"> <li>• Biopolymers: - concept and types of biopolymers/bio-plastics and its applications.</li> <li>• Biosensors: - concept and applications of biosensors in environmental monitoring.</li> <li>• Bio-indicators: - Concept of bio-indicators, Plankton and microbial community as indicators of water pollution;</li> </ul>	07



## Reference Books-

1. Environmental biotechnology (2005) M.H. Fulekar, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi .
  2. Environmental Microbiology, Alan Scragg Oxford University Press. 2005
  3. Environmental Biology (2000) Varma & Agarwal S. Chand Limited, New Delhi
  4. Environmental biology and toxicology (2011) Sharma PD Rajpal And Sons Publishing, Delhi
  5. Environmental biotechnology(2010) Rana Rastogi Publications, New Delhi
  6. Environmental Science (2011) Santra S.C. New Central Book Agency, Kolkata
  7. A textbook of Biotechnology, Dr. R.C. Dubey , S. Chand Publication
  8. Environmental Biotechnology. Bhattacharya & Banerjee Oxford 2008
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EN-TY-2022

Semester -VI	Paper -VII
Course Code: BSC-EN-607P	Title of the Course: Practical based on EN:601 and 602
Credits: 02	Teaching Hours: 30

**Course outcome:**

1. Understand the Flora and Fauna of aquatic Ecosystem
2. Understand the Importance and Interspecies relationships in aquatic ecosystem.
3. Study the measurement of diversity and population technique.
4. To Awareness and diversity in aquatic ecosystem
5. Study of Plant Adaptations under various environment condition

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 Bio indicator of pollution	1
8	Determination of pH, EC and temperature of water	1
9	Estimation of Dissolved oxygen and CO <sub>2</sub> of water sample	1
10	Testing the bacteriological quality of drinking water	1
11	Study of aquatic macrophytes and macrophytons	1
12	Study the transparency by Sacchi Disc method.	1
13	Study of Turbidity by Nephelometric method.	1
14	Visit and study of Flora and Fauna to Wetlands / Mangrove / Esturine / ecosystem	1

Semester -VI	Paper -VII
Course Code: BSC-EN-608P	Title of the Course: Practical based on EN:603 and 604
Credits: 02	Teaching Hours: 30

Course outcome:

1. Learn the air monitoring instrumentation
2. Estimate the pollution causing parameter
3. Acquire the techniques for water and wastewater analysis
4. To know and collect information of bio indicators

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 portability	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 -VI	Paper -X
Course Code: BSC-EN-609P	Title of the Course: Practical based on EN:605 and 606
Credits: 02	Teaching Hours: 30

**Course outcome:**

1. To acquire knowledge about various bio-chemical test to identify micro-organisms.
2. To study the role of micro-organisms in environment protection like dye-degradation, heavy metal removal, composting methods.
3. Understand the Collection and interpretation of data
4. Study the co-relation among the parameters by Network method

Unit No	Course Content	Number of Lectures
1.	Perform biochemical test to identify micro-organisms.	1
2.	Preservation and Revival of Microbial culture.	1
3.	Biological de-colorization using micro-organisms.	1
4.	Determine the uptake of heavy metals by microorganisms.	1
5.	Isolation of mineral leaching bacteria.	1
6.	Preparation of compost by using different methods of composting – Indore method & Bangalore method	1
7.	Analysis of residual pesticides in agricultural land and crops.	1
8.	Determination of hydrogen sulfide (H <sub>2</sub> S) from sewage sample	1
9.	Collection of metrological parameter and its interpretation with respect to project activities.	1
10.	Prepare the inventory data of noise and interpret.	1
11.	Visit to MSW site and observe the impact on local people	1
12.	Collect the inventory data of a Road project by checklist methods	1
13.	Evaluate the post impact of the project by Matrix method.	1
14.	Prepare EMP for the college campus	1

15.	Visit to local Stone Quarry in your region and briefly prepare the report	1
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Semester -VI	Paper -X
Course Code: BSC-EN-610T	Title of the Course: Solid Waste management
Credits: 02	Teaching Hours: 30

**Course outcome:**

1. To understand the sources and types of waste
2. To study the consequences of solid waste on environment
3. To acquire knowledge about various methods and techniques of SWM

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 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.	6
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; 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..
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EN-TY-2022

Semester -VI	Paper -XI
Course Code: BSC-EN-611 PR	Title of the Course: Project
Credits: 02	Teaching Hours: 30

**Course outcome:**

1. To explore and initiate the research culture among student
2. Develop the ability to thoroughly examine the problem
3. To develop the scientific referencing of research paper
4. To develop the application skill of instrumentation and analysis
5. Training of scientific writing

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>	