

**M. C. E. Society's**

**Abeda Inamdar Senior College**

Of Arts, Science and Commerce, Camp, Pune-1 (Autonomous)

Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

### **Program Objectives:**

1. To develop conscience towards social responsibility, human values and sustainable development through curriculum delivery and extra-curricular activities
2. To develop scientific temperament with strong fundamental knowledge of the subject
3. To develop analytical thinking and problem-solving skills needed for various entrance and competitive examinations and Post Graduate Studies
4. To train students in laboratory skills and handling equipment along with soft skills needed for placement
5. To educate the students about instrumentation handling.

### **Program Outcomes:**

- 1) The students will graduate with holistic development.
- 2) The students will be qualified to continue higher studies in their subject.
- 3) The students will be eligible to appear for various competitive examinations and pursue higher education.
- 4) The students will be able to apply for the jobs with a minimum requirement of B. Sc. Program.

### **Program Specific Objectives and Outcomes**

#### **Program Specific Objectives:**

The B.Sc. Environmental Science Program will enable the students;

PSOB-1. To develop basic understanding of fundamental concepts and management of the various resources of mother Earth.

PSOB-2. To bring sensitization towards the environment and also increase student competency & employability

PSOB-3. To inculcate a sense of responsibility among students about various principles and laws of nature.

PSOB-4. To encourage students about applicability of knowledge and Interdisciplinary approach in day to day life.

**Program Specific Outcomes:**

After successful completion of B.Sc. Environmental Science Course, student will have:

**PSOC-1.** Fundamental and Advanced knowledge of theory and practical courses in Environmental science.

**PSOC-2.** Students will understand about how the subject knowledge helps in solving various social, economic and environment related problem

**PSOC-3.** Knowledge about various Environmental laws, ISO series, EMS, Standards and Ethics **required to peruse higher education in the field.**

**PSOC-4.** Knowledge about Environmental (Resource, Energy) Management, Monitoring, introductory aspects of Environmental Biotechnology and Microbiology

**PSOC-5.** Skills in laboratory techniques and experience in instrument handling.

**PSOC-6:** Knowledge about wild life management, Atmospheric sciences, global climate change, Environment Health and Safety, Soil health management, urban town planning, Solid waste management, pollution control technology

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**FACULTY OF SCIENCE**

**Name of BOS -- Life science**

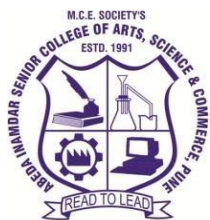
**B.Sc. Program Structure (Choice Based Credit System, Under NEP Guidelines)**

**T.Y.B.Sc. Environmental Science (NEP) Program structure and Syllabus**

**To be implemented from 2025-2026**

| <b>Sr. no.</b> | <b>Program</b> | <b>Sem</b> | <b>Offered as</b>      | <b>Course Code</b> | <b>Course title</b>                                 | <b>No. of Credits</b> | <b>Exam (I/E)</b> | <b>Marks</b> |
|----------------|----------------|------------|------------------------|--------------------|-----------------------------------------------------|-----------------------|-------------------|--------------|
| 1.             | T.Y.B.Sc.      | V          | Major-Theory           | 23SBEV51MM         | Terrestrial & Aquatic Ecosystem Mngt.               | 2                     | I + E             | 20 +30       |
| 2.             | T.Y.B.Sc.      | V          | Major-Theory           | 23SBEV52MM         | Global Climate Change, Adaptation & Mitigation      | 2                     | I + E             | 20 +30       |
| 3.             | T.Y.B.Sc.      | V          | Major-Theory           | 23SBEV53MM         | Environmental Legislation and policies              | 2                     | I + E             | 20 +30       |
| 4.             | T.Y.B.Sc       | V          | Major-Practical        | 23SBEV54MM         | Practicals - I                                      | 2                     | I + E             | 20 +30       |
| 5.             | T.Y.B.Sc       | V          | Major-Practical        | 23SBEV55MM         | Practicals - II                                     | 2                     | I + E             | 20 +30       |
| 6.             | T.Y.B.Sc       | V          | Major-Vocational Skill | 23SBEV51VS         | Practicals – III<br>(Vocational Skill Course)       | 2                     | I + E             | 20 +30       |
| 7.             | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV51MEA        | Environmental Health & Safety<br>(Major Elective)   | 2                     | I + E             | 20 +30       |
| 8.             | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV51MEB        | Industrial Wastewater Treatment<br>(Major Elective) | 2                     | I + E             | 20 +30       |
| 9.             | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV52MEA        | Environmental Biotechnology<br>(Major Elective)     | 2                     | I + E             | 20 +30       |
| 10.            | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV52MEB        | Urban Town Planning<br>(Major Elective)             | 2                     | I + E             | 20 +30       |

| <b>Sr. no.</b> | <b>Program</b> | <b>Sem</b> | <b>Offered as</b> | <b>Course Code</b> | <b>Course title</b>                          | <b>No. of Credits</b> | <b>Exam (I/E)</b> | <b>Marks</b> |
|----------------|----------------|------------|-------------------|--------------------|----------------------------------------------|-----------------------|-------------------|--------------|
| 1.             | T.Y.B.Sc.      | VI         | Major-Theory      | 23SBEV61MM         | Environmental Governance: EMS and ISO 14000  | 2                     | I + E             | 20 +30       |
| 2.             | T.Y.B.Sc.      | VI         | Major-Theory      | 23SBEV62MM         | Sustainable Development                      | 2                     | I + E             | 20 +30       |
| 3.             | T.Y.B.Sc.      | VI         | Major-Theory      | 23SBEV63MM         | Wild life Management                         | 2                     | I + E             | 20 +30       |
| 4.             | T.Y.B.Sc       | VI         | Major-Practical   | 23SBEV64MM         | Practicals-III                               | 2                     | I + E             | 20 +30       |
| 5.             | T.Y.B.Sc       | VI         | Major-Practical   | 23SBEV65MM         | Project work                                 | 2                     | I + E             | 20 +30       |
| 6.             | T.Y.B.Sc.      | VI         | Major-Elective    | 23SBEV61MEA        | Environmental Monitoring<br>(Major Elective) | 2                     | I + E             | 20 +30       |
| 7.             | T.Y.B.Sc.      | VI         | Major-Elective    | 23SBEV61MEB        | Environmental Toxicology<br>(Major Elective) | 2                     | I + E             | 20 +30       |
| 8.             | T.Y.B.Sc.      | VI         | Major-Elective    | 23SBEV62MEA        | GIS and Remote Sensing<br>(Major Elective)   | 2                     | I + E             | 20 +30       |
| 9.             | T.Y.B.Sc.      | VI         | Major-Elective    | 23SBEV62MEB        | Solid Waste Management<br>(Major Elective)   | 2                     | I + E             | 20 +30       |
| 10.            | T.Y.B.Sc.      | VI         | Major             | 23SBEV6OJT         | Internship ( On-Job Training)                | 2                     | I + E             | 20 +30       |



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|                             |                                       |
|-----------------------------|---------------------------------------|
| <b>Course / Paper Title</b> | Terrestrial & Aquatic Ecosystem Mngt. |
| <b>Course Code</b>          | 23SBEV51MM                            |
| <b>Semester</b>             | V                                     |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)         |

### Aims & Objectives of the Course

| Course Objectives |                                                                                                                                       |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1.                | To know about importance of hotspots of biodiversity, Biomes and the biogeographic zones of the country.                              |
| 2.                | To enumerate the services, benefits and values of Terrestrial and Aquatic ecosystems to mankind.                                      |
| 3.                | To address and evaluate ecological issues related to processes and structures of fresh environments                                   |
| 4.                | To understand the concept of various communities based terrestrial ecosystem management methods.                                      |
| 5.                | To integrate the role of people in sustainable utilization of terrestrial and aquatic ecosystems with case studies.                   |
| 6                 | To outline the key aspects of aquatic environments and the importance of Ramsar convention sites in context to climate change impacts |

| Course outcomes |                                                                                                                                                                                                       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.              | Students will learn the role of hotspots in maintaining the balance of nature and their wellbeing and will recognize the direct and indirect values of ecosystems and sustainable management methods. |
| 2.              | Students will learn to apply the terrestrial ecosystem sustainable utilisation                                                                                                                        |

|    |                                                                                                                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | approach from case studies.                                                                                                                                                                                                       |
| 3. | Students will get exposure of Remote sensing and GIS methods for better management aspect and will learn to use integrated techniques for controlling and monitoring aquatic ecosystems.                                          |
| 4. | Students will compare the effects of conservation and management on the main ecosystem processes and components; analyze ecological theories, using understanding of plant and animal biology, and environmental interactions     |
| 5. | Students will understand the various values of wetlands and the significance of convention and will be able to formulate goals and objectives in aquatic ecosystems management and choose appropriate approaches to achieve them. |

## Syllabus

| Unit No. | Title with Contents                                                                                                                                                                                                                                                                                                                                                                                                                               | No. of Lectures |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Terrestrial Ecology</b> <ul style="list-style-type: none"> <li>• Introduction to Terrestrial Environment, Parameters, terrestrial biota</li> <li>• General structure of terrestrial communities</li> <li>• Hotspots in India: Western Ghats and Eastern Himalaya</li> <li>• Concept of Keystone species with examples</li> </ul>                                                                                                               | 04              |
| 2        | <b>Terrestrial Biomes</b> <ul style="list-style-type: none"> <li>• Introduction, Concept</li> <li>• Biogeographic regions of India and world</li> <li>• Types of Biomes</li> <li>• Forest fire: reasons, effects, control measures, management and case studies</li> <li>• Community Based terrestrial ecosystem management methods ( JFM, EDP), Case studies related</li> <li>• Role of People, NGO's ,Community and Local Government</li> </ul> | 06              |
| 3        | <b>Terrestrial ecosystem services &amp; Management</b> <ul style="list-style-type: none"> <li>• Direct and Indirect services / Values</li> <li>• Concept of Carbon sequestration with respect to soil and trees</li> <li>• Methods of terrestrial ecosystem management</li> </ul>                                                                                                                                                                 | 04              |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|   | <ul style="list-style-type: none"> <li>• Eco development program, Community based forest management, traditional methods</li> <li>• Concept of exploitation and sustainable utilization</li> <li>• Impact of Tourism, Eco-tourism—concept , significance</li> </ul>                                                                                                                                                                                                                                                                                                       |    |
| 4 | <b>Aquatic Ecosystem Ecology</b> <ul style="list-style-type: none"> <li>• Structure and Stratification of Aquatic ecosystems of Aquatic ecosystems, Energy Flow</li> <li>• Ramsar sites in India and their importance</li> <li>• Impacts of Climate change on aquatic ecosystems</li> <li>• Mangrove Vegetation and its significance</li> <li>• Coral reefs and Ecological significance</li> <li>• Importance of Estuaries</li> <li>• Methods of aquatic sampling and data analysis: sampling approaches</li> <li>• Need for conservation of aquatic resources</li> </ul> | 08 |
| 5 | <b>Exploitation and Need for wetland conservation</b> <ul style="list-style-type: none"> <li>• Exploitation and consequences of wetland degradation and Sustainable management of wetlands</li> <li>• Role of Local Government and people in conservation, Case studies</li> <li>• Impact of Tourism, Significance of Eco-tourism</li> <li>• Conservation and Sustainable use of India's aquatic resources</li> <li>• Application of Remote sensing and Geographical information system in aquatic ecosystem management</li> </ul>                                        | 08 |

**Suggested Readings:**

1. 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.
2. The Ecology of Plants. Sinauer Associates Incorporated. Loreau, M. & Inchausti, P. 2002.
3. Biodiversity and Ecosystem Functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK, Odum, E. P. 1971.
4. 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.

5. New Phytologist 203: 697-703. Pimentel, D. (Ed.). 2011.

6. 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.

7. Ecology, Environment and Resource Conservation. Anamaya Publications.

8. Wilson, E. O. 1985. The Biological Diversity Crisis. Bioscience 35: 700-706.





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|                             |                                                |
|-----------------------------|------------------------------------------------|
| <b>Course / Paper Title</b> | Global Climate Change, Adaptation & Mitigation |
| <b>Course Code</b>          | 23SBV52MM                                      |
| <b>Semester</b>             | V                                              |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)                  |

| <b>Course Objectives</b> |                                                                                                      |
|--------------------------|------------------------------------------------------------------------------------------------------|
| 1.                       | To know about importance of Atmospheric sciences and the current knowledge related to it             |
| 2.                       | To discuss about various issues related to climate change and significance of its studies            |
| 3.                       | To inculcate the understanding of Climate Change impacts and possible mitigation measures            |
| 4.                       | To understand the concept of Global Warming, Ozone Depletion and Climate Change                      |
| 5.                       | To understand Laws, Policies and Legislations, Protocols and treaties associated with Climate Change |

| <b>Course Outcomes</b> |                                                                                                                                   |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1.                     | Students will learn the role of climate in maintaining the balance of atmosphere                                                  |
| 2.                     | Students will recognize the direct and indirect impact of Global Climate Change, Ozone layer depletion                            |
| 3.                     | Students will learn to apply the sustainable approach from case studies to maintain atmospheric balance and tackle climate change |

|           |                                                                                                                    |
|-----------|--------------------------------------------------------------------------------------------------------------------|
| <b>4.</b> | Students will get exposure of various methods handle and tackle global climate change issue, Ozone layer depletion |
|-----------|--------------------------------------------------------------------------------------------------------------------|

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | No. of lectures |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Concept of Global Warming and Climate Change</b> <ol style="list-style-type: none"> <li>1. Trends of global warming and climate change –Natural and Anthropogenic</li> <li>2. Potential of different greenhouse gases (GHGs) causing the climate change, Impact of climate change on environment</li> <li>3. Introduction to Carbon dating, pollen, Coral shells, Ice core, Tree ring data analysis</li> <li>4. Weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO<sub>2</sub>, fertilization and agriculture</li> </ol> | 08              |
| 2        | <b>Ozone Layer Depletion</b> <ol style="list-style-type: none"> <li>1. Importance of Ozone layer, ODS substances</li> <li>2. Reactions involving depletion of Ozone layer in Stratosphere</li> <li>3. Effects of Ozone layer on the Environment and Human beings</li> <li>4. Control measures related to Ozone layer depletion</li> </ol>                                                                                                                                                                                                                                                  | 05              |
| 3        | <b>International, National Legislations and Policies related to Climate Change</b> <ol style="list-style-type: none"> <li>1. International Agreements related to Climate change</li> <li>2. National Agreements and Legislations related to Climate Change</li> <li>3. Concept of Carbon Trading, Carbon Credits, Clean Development Mechanism (CDM)</li> <li>4. Sustainable Development goals related to Climate change</li> </ol> India's initiatives and Commitment to tackle Climate change                                                                                             | 07              |
| 4        | <b>Adaptations and Mitigation methods for reducing Climate change</b> <ol style="list-style-type: none"> <li>1. Role of Forest and Deforestation, SRI Cultivation-no tillage, Conservation agriculture, Integrated farming, Rainwater harvesting</li> </ol>                                                                                                                                                                                                                                                                                                                                | 10              |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  | <ol style="list-style-type: none"> <li>2. Renewable energy sources for reducing Climate changes</li> <li>3. CSR, Polluter pay principle for Industries</li> <li>4. Role of GIS and Remote sensing to tackle Climate change</li> <li>5. Disaster Prediction and Management</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
|  | <p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.</li> <li>2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers</li> <li>3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley &amp; Sons</li> <li>4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall</li> <li>5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group</li> <li>6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications</li> <li>7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.</li> <li>8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &amp; Sen, K. 2004. Climate Change and India. Universities Press, India</li> <li>9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications</li> </ol> |  |



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|                             |                                        |
|-----------------------------|----------------------------------------|
| <b>Course / Paper Title</b> | Environmental Legislation and Policies |
| <b>Course Code</b>          | 23SBV53MM                              |
| <b>Semester</b>             | V                                      |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)          |

| <b>Course Objectives</b> |                                                                                               |
|--------------------------|-----------------------------------------------------------------------------------------------|
| 1.                       | To understand various laws related to Environment                                             |
| 2.                       | To understand duties of citizen towards Environmental protection and Management through laws  |
| 3.                       | To understand the concept of Environmental Ethics                                             |
| 4.                       | To understand various International laws, policies , conferences for Environmental protection |

| <b>Course Outcome</b> |                                                                                                  |
|-----------------------|--------------------------------------------------------------------------------------------------|
| 1.                    | To understand the applications of the laws related to Environment in our daily lives             |
| 2.                    | To understand various International and National laws related to Environmental protection        |
| 3.                    | To understand the role of Judiciary in Environmental protection                                  |
| 4.                    | To understand the rights and duties of Citizen towards Environmental protection and Conservation |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | No. of lectures |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction to Environmental Legislation</b><br><br>1. Legal definitions: Environmental pollution, natural resource, Biodiversity, forest, Sustainable Development.<br><br>2. Article 48A and 51A (g)<br><br>3. Importance and needs of Environmental legislation<br><br>4. History of Environmental Legislation in India<br><br>5. The protection and improvement of environment and safeguarding of forests and wildlife.<br><br>6. Fundamental rights and duties as per the Constitution of India<br><br>7. Environmental Ethics: Introduction, Concept, Development of Environmental ethics<br><br>8. Establishment & Role of National Green Tribunal (NGT)<br><br>9. Establishment & Role of MOEFCC | 10              |
| 2        | <b>International Laws and Policy</b><br><br>1. Stockholm Conference 1972<br><br>2. United Nations Conference on Environment and Development 1992<br><br>3. Rio de Janeiro (Rio Declaration, Agenda 21)<br><br>4. Kyoto Protocol 1997<br><br>5. Copenhagen (CoP's, their major outcomes and recent updates and World summits, Brutland report)<br><br>Montreal Protocol                                                                                                                                                                                                                                                                                                                                       | 10              |
| 3        | <b>Environmental Acts</b><br><br>1. The Air (Prevention and Control of Pollution) Act 1981<br><br>2. The Water (Prevention and Control of Pollution )Act 1974<br><br>3. Environmental Protection Act 1986<br><br>4. Wildlife Protection Act 1972<br><br>5. The Forests (Conservation) Act 1980<br><br>6. The Public Liability Insurance Act 1991<br><br>7. The Biological Diversity Act 2002                                                                                                                                                                                                                                                                                                                 | 10              |

**Suggested Readings**

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). LexisNexisIndia.
7. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International
8. P. Leelakrishnan. 2016. Environmental Law in India. 4th edition. Publisher: Lexis Nexi
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



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|-----------------------------|------------------------------------------|
| <b>Course / Paper Title</b> | Environmental Health & Safety (Elective) |
| <b>Course Code</b>          | 23SBEV51MEA                              |
| <b>Semester</b>             | V                                        |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)            |

| <b>Course Objectives</b> |                                                                                                                                |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>1.</b>                | To understand various Safety measures in Environment.                                                                          |
| <b>2.</b>                | To train and motivate students in maintaining and improving the quality of the environment                                     |
| <b>3.</b>                | To educate students how to reduce work place hazardous and to encourage the standard of safety health and environment problem. |
| <b>4.</b>                | To understand various laws of EIA, LCA & ISO standards                                                                         |

| <b>Course Outcomes</b> |                                                                                                                    |
|------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>1.</b>              | To understand importance of health & safety while working in industry.                                             |
| <b>2.</b>              | To understand various laws related to employee in Industry.                                                        |
| <b>3.</b>              | To ensure 0% accidents and 100% safety in different industries in which Safety management plays an important role. |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | No. of lectures |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction to Environmental Health and Safety.</b> <ol style="list-style-type: none"> <li>1. Key elements of safety and health management system.</li> <li>2. Scope and Importance.</li> <li>3. Training of Employee</li> <li>4. Safety &amp; Health Management system records.</li> <li>5. Workplace precautions and Control measures</li> </ol>                                                                                                                                                                                                                                                    | 05              |
| 2        | <b>Industrial Safety.</b> <ol style="list-style-type: none"> <li>1. Importance of Safety.</li> <li>2. Classification of Accidents—Transpiration system, accidents and control measures, Radiation hazards</li> <li>3. Management's responsibility.</li> <li>4. Employee state insurance act 1948</li> <li>5. Industrial noise and noise control.</li> <li>6. Safety with respect to plant and Machinery,</li> <li>7. Personal protective equipment.</li> <li>8. Pollution released from industry.</li> <li>9. ISO related to Industrial safety.</li> </ol>                                                | 05              |
| 3        | <b>Occupational Health Safety</b> <ol style="list-style-type: none"> <li>1. Definition of Occupational Health as per WHO/ILO.</li> <li>2. Occupational Health and Environmental Safety Management - Principles practices.</li> <li>3. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.</li> <li>4. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit</li> </ol> | 05              |



|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |    |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 4 | <b>Occupational and Environment Management</b> <ol style="list-style-type: none"> <li>1. Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM.</li> <li>2. Importance of Industrial safety, role of safety department, Safety committee and function, Role and responsibilities of safety officer</li> </ol>                                                              | 05 |
| 5 | <b>Role of Management &amp; EHS officer.</b> <ol style="list-style-type: none"> <li>1. Conducting risk analysis.</li> <li>2. Ensuring proper solution to avoid the risk and hazard.</li> <li>3. Inspection of machines, tools and equipment's.</li> <li>4. Environment Audit reports—Green audit, Energy audit, Carbon audit, Water audit.</li> <li>5. Enforcement of rules &amp; regulations.</li> <li>6. Monitoring of employee.</li> <li>7. Introduction and enforcement of safety gears.</li> <li>8. Providing technical advice and training.</li> </ol>    | 10 |
|   | <b>Suggested Readings</b> <ol style="list-style-type: none"> <li>1. Risk assessment- A Practical Guide, 1993, Institution of Occupational Safety and Health, United Kingdom</li> <li>2. Rao CS (2006)- Environmental Pollution Control—New Age International Pvt. Ltd Publishers</li> <li>3. Manjunath D.L. (2007) – Environmental Studies – Pearson Education Publishers</li> <li>4. Benny Joseph (2005) Environmental Studies –Tata Mc Graw Hill – Publishers</li> <li>5. Yaji R.K (2006) – Text Book of Environmental Studies – United Publishers</li> </ol> |    |



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|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Course / Paper Title</b> | Industrial Waste Water Treatment |
| <b>Course Code</b>          | 23SBEV51MEB                      |
| <b>Semester</b>             | V                                |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)    |

| <b>Course Objectives</b> |                                                                                                            |
|--------------------------|------------------------------------------------------------------------------------------------------------|
| <b>1.</b>                | To study about wastewater generation from various industries                                               |
| <b>2.</b>                | To study about Conventional Waste water treatment measures used in Industries and treatment of Waste water |
| <b>3.</b>                | To study about Advanced waste water technologies                                                           |

| <b>Course Outcomes</b> |                                                                  |
|------------------------|------------------------------------------------------------------|
| <b>1.</b>              | Identify the characteristics of industrial waste waters          |
| <b>2.</b>              | Describe pollution effects of disposal of industrial effluent    |
| <b>3.</b>              | Identify and design treatment options for industrial waste water |
| <b>4.</b>              | Formulate environmental management plan                          |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | No. of lectures |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | Introduction to Industrial Wastewater<br>Wastewater Characteristics, Standards of Disposal, Treatment Objective and Strategies, Layouts of Primary, Secondary and Advanced Treatment Units.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 03              |
| 2        | Preliminary and Primary Treatment Operations: Screens, Grit Chambers, Skimming Tank, Primary and Secondary Sedimentation Tanks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 05              |
| 3        | Biological Treatment Processes:<br>Trickling Filters (Standard Rate, High Rate), Bio-filters, Rotating Biological Contactors, Activated Sludge Process, Oxidation Ponds, Lagoons.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10              |
| 4        | Sludge Treatment and Disposal: Sludge Thickening, Aerobic and Anaerobic Sludge Digestion Processes, Design of Digester Tank, Sludge Dewatering, Ultimate Disposal, Sludge Drying Beds, Other Methods of Sludge Treatment                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 07              |
| 5        | Sources, characteristics, treatment and recycling of waste water from Paper and pulp, Tanneries, Textiles, Fertilizers and Pharmaceutical industries Power plants, Oil refineries, Cement and Steel factories.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 05              |
|          | <b>Suggested Readings</b> <ol style="list-style-type: none"> <li>1. Wastewater Treatment – Concepts and Design Approach, by G L Karia and R A Christian, Prentice Hall of India,2006</li> <li>2. Environmental Engineering – A Design Approach by A. P. Sincero and G A Sincero, Prentice Hall of India,2014</li> <li>3. Wastewater Engineering - Collection, Treatment, Disposal and Reuse by Metcalf and Eddy, , McGraw Hill Education (India) Pvt Ltd,2013</li> <li>4. Industrial Waste Treatment by Nelson Leonard Nemerow, ButterworthHeinemann, 2007</li> <li>5. Biological Process Designs for Wastewater Treatment by Benefield L.D. and Randall C.D. Prentice Hall Pub.Co., 1980</li> </ol> |                 |



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|                            |                                        |
|----------------------------|----------------------------------------|
| <b>Course/ Paper Title</b> | Environmental Biotechnology (Elective) |
| <b>Course Code</b>         | 23SBEV52MEA                            |
| <b>Semester</b>            | V                                      |
| <b>No. of Credits</b>      | 2 (30 Lectures of 60 minutes)          |

| <b>Course Objectives</b> |                                                                                                                                   |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1                        | To know about importance, services, applications, benefits of Environmental Biotechnology and the current knowledge related to it |
| 2                        | To discuss about various issues related to Environmental Biotechnology , GMOs and significance of its studies                     |
| 3                        | To apply core scientific concepts and practical techniques to Environmental Biotechnology                                         |
| 4                        | To understand the concept of Environmental Biotechnology, Composting and role of microorganisms                                   |

| <b>Course outcomes</b> |                                                                                                                                           |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Students will learn the role of Environmental Biotechnology to control pollution                                                          |
| 2                      | Students will recognize the direct and indirect impact of Genetically Modified Organisms                                                  |
| 3                      | Students will learn to apply the sustainable approach from case studies to maintain Environment with the help of Biotechnological methods |
| 4                      | Students will get exposure of various methods handle current Environmental Issues                                                         |

## Syllabus

| Unit No. | Title with Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | No. of Lectures |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction</b> <ul style="list-style-type: none"> <li>History and Necessity of Environmental Biotechnology</li> <li>Objectives, Importance and Applications</li> <li>Biotechnological approach to address environmental problems</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 02              |
| 2        | <b>Composting Techniques</b> <ul style="list-style-type: none"> <li>Classification, Methods of Composting, Preparation of Compost</li> <li>Manufacturing, Equipment, Development</li> <li>Types—Bangalore and Indore methods</li> <li>Commercial application</li> <li>Biofertilisers-Types, Role, preparation method and Commercial aspects</li> <li>Agricultural Waste and its Uses</li> </ul> <b>Biomethanation</b> <ul style="list-style-type: none"> <li>Anaerobic treatment for gas generation, microbiology and biochemistry, factors affecting on Biomethanation</li> <li>Design of Anaerobic digester biomethanation in industries</li> <li>Potential of biomethanation from MSW, Biomass gasification, Problems in Biomethanation</li> </ul> | 08              |
| 3        | <b>Genetically Modified Organisms</b> <ul style="list-style-type: none"> <li>Introduction, Examples</li> <li>Principles and Advantages</li> <li>Risk to Environment</li> <li>Cartagena Protocol on Biosafety</li> <li>Xenobiotics in environment; toxic and anoxic degradation of xenobiotics</li> </ul> <b>Bioleaching and Bio mining</b> <ul style="list-style-type: none"> <li>History, advantages and disadvantages of Bioleaching</li> <li>Microbes used for bioleaching; Biochemical extraction from</li> </ul>                                                                                                                                                                                                                                 | 08              |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |    |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|   | <p>mixture</p> <ul style="list-style-type: none"> <li>• Types of bioleaching, methods of bioleaching and metal precipitation; Biosorption of metals</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |
| 4 | <p><b>Bioremediation</b></p> <ul style="list-style-type: none"> <li>• History, Principles of bioremediation; Types of Bioremediation; Concept of bioaugmentation and biostimulation.</li> <li>• Microbial Remediation: - Factors affecting bioremediation process: microbial metabolism, environmental conditions and nature of pollutant.</li> <li>• Phytoremediation: - Concept and types of phytoremediation, factors affecting on phytoremediation, plants useful for phytoremediation, removal of metals and organic pollutants; phytoextraction, Phytostabilisation, Rizofiltration, Phytotransformation, phytovolatilization.</li> </ul> | 06 |
| 5 | <p><b>Aerobic biological treatments</b></p> <ul style="list-style-type: none"> <li>• Activated sludge, biofilm reactors and biological filters, Membrane Technology ,Sequential batch reactor</li> <li>• Anaerobic biological treatments UASB, Removal of specific pollutants- nitrate, phosphates, heavy metals, etc.;</li> <li>• Biosorption techniques for removal of pollutants</li> <li>• Biopolymers: - concept and types of biopolymers/bio plastics and its applications</li> <li>• Biosensors: - concept and applications of biosensors in environmental monitoring.</li> </ul>                                                        | 06 |
|   | <p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1. Introduction to Environmental Biotechnology; by AK Chatterji (2002); Prantice-Hall of India.</li> <li>2 Erickson, LE and DY Fung. 1988. Handbook on Anaerobic fermentations. Marcel and Dekker Inc. New York.</li> <li>3. Holland, KT, JS Knapp and JG Shoesmith. 1990. Anaerobic bacteria. Blackie Publications. New York.</li> <li>4. Ramasamy, K., G. Kalaichelvan and B. Nagamani. 1992. Working with anaerobes: Methanogens. Fermentation Laboratory,</li> </ol>                                                                                                |    |

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|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>TNAU, Coimbatore.</p> <p>5. Gerhardt, P., RGE Murray, WA Wood and NR Krieg. 1994. Methods for General and Molecular Bacteriology. ASM Publications, Washington.</p> <p>6. Jogdand, SN 1995. Environmental Biotechnology. Himalaya Publishing House, Mumbai.</p> <p>7. Erickson, LE and DY Fung. 1988. Handbook on Anaerobic fermentations. Marcel and Dekker Inc. New York.</p> <p>8. Ramasamy, K, G Kalaichelvan and B Nagamani. 1992. Working with anaerobes: Methanogens. Fermentation Laboratory, TNAU, Coimbatore.</p> <p>9. Crawford, RL and DL Crawford. 1996. Bioremediation - Principles and Applications. Cambridge University Press, London</p> |
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|                             |                                |
|-----------------------------|--------------------------------|
| <b>Course / Paper Title</b> | Urban Town Planning (Elective) |
| <b>Course Code</b>          | 23SBEV52MEB                    |
| <b>Semester</b>             | V                              |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)  |

| <b>Course Objectives</b> |                                                                                                                          |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>1.</b>                | To understand the concept of Town planning and ensuring that new and existing facilities are complimentary to each other |
| <b>2.</b>                | To develop Sustainable Building and its Management                                                                       |
| <b>3.</b>                | To create awareness about location of Industries, Recreational areas                                                     |
| <b>4.</b>                | To create awareness about the traffic management within the town                                                         |

| <b>Course Outcomes</b> |                                                                                                                    |
|------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>1.</b>              | To solve the real time problems by keeping in view of social, environmental and health issues in a sustainable way |
| <b>2.</b>              | To focus on the various recreational requirements of the town and preparation of master plan                       |
| <b>3.</b>              | Predict the difficulties and obstacles in re- planning of towns                                                    |
| <b>4.</b>              | Plan safe and rapid road transit system by proper design of roadways and effective traffic management              |

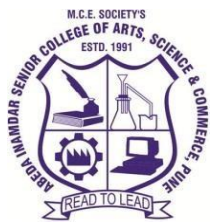


## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | No. of lectures |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction</b> <ol style="list-style-type: none"> <li>1. Objects of town planning, principles of town planning</li> <li>2. Origin and growth of towns – development of towns, Modern town planning in India</li> <li>3. Socio – Economic aspects of town planning. Selection of site for an ideal town</li> <li>4. Smart City Guidelines –Case study of Pune</li> </ol>                                                                                                                                            | 05              |
| 2        | <b>Surveys &amp; Planning</b> <ol style="list-style-type: none"> <li>1. Various types of surveys to be conducted for town planning project</li> <li>2. Data's to be collected in different types of town planning survey. Types of planning, -a brief note on urban, rural and regional planning</li> <li>3. Zoning: Definition – objects and principles of zoning<br/>Advantages of zoning, Special Economic Zone (SEZ), Maps for zoning.</li> </ol>                                                                   | 05              |
| 3        | <b>Housing</b> <ol style="list-style-type: none"> <li>1. Classification of residential building as per HUDCO norms, Housing in villages, Low-Cost Housing, Housing policy</li> <li>2. Different types of housing agencies involved in housing, investment in Housing, Housing Problems in India</li> </ol> <b>Slums</b> <ol style="list-style-type: none"> <li>1. Causes, growth, characteristics, effects</li> <li>2. Rehabilitation, prevention of slum formation, financial assistance for slum clearance</li> </ol> | 05              |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 4 | <b>Public buildings &amp; Industries</b> <ol style="list-style-type: none"> <li>1. Classification – location, Design Principles of public building, grouping of public buildings.</li> <li>2. Effects of Industries on towns and cities, classification of industries, regulation of their location</li> </ol> <b>Recreation measures</b> <ol style="list-style-type: none"> <li>1. Parks- park ways, Playgrounds, Theme parks, boulevards and their space standards, knowledge of Landscape, sketches for Green Buildings. (IGBC)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 05 |
| 5 | <b>Urban Roads</b> <ol style="list-style-type: none"> <li>1. Objects, requirements, classification, types of street systems, through and bypass roads, outer and inner ring roads, expressways, freeways</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 05 |
| 6 | <b>Traffic Management</b> <ol style="list-style-type: none"> <li>1. Objectives, traffic surveys, traffic congestion, traffic control, road junctions and intersections, parking, road accidents</li> <li>2. Traffic capacity of roads, traffic islands, roundabouts, traffic signals, road signs, road markings, street lighting in a town</li> <li>3. Case studies from developed countries for Traffic management</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 05 |
|   | <b>Suggested Readings</b> <ol style="list-style-type: none"> <li>1.D'Monte, Darryl. 1985. Industry versus Environment Temples or Tombs. Three Controversies, Delhi, CSE</li> <li>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.</li> <li>3.Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York</li> <li>4.Grimm, N. B., Faeth, S. H., et al. 2008. Global Change and the Ecology of Cities. Science, 319: 756-760</li> <li>5.Hinchliffe, S. &amp; Whatmore, S. 2006. Living cities: Towards a politics of conviviality. Science as Culture 15: 123–138</li> <li>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</li> <li>7.Montgomery, M.R. 2009. Urban Transformation of the developing world.</li> </ol> |    |

|  |                                                                                                                                                                                            |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Science 319: 761- 764</p> <p>8.Town Planning By Rangwala, Charotar Publication, 1980</p> <p>9.Richter, M. &amp; Weiland, U. (ed.). 2012. Applied Urban Ecology. Wiley-Blackwell, UK</p> |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



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|                             |                |
|-----------------------------|----------------|
| <b>Course / Paper Title</b> | Practicals - I |
| <b>Course Code</b>          | 23SBEV54MM     |
| <b>Semester</b>             | V              |
| <b>No. of Credits</b>       | 2              |

| <b>Course Objectives</b> |                                                                                                 |
|--------------------------|-------------------------------------------------------------------------------------------------|
| 1                        | To understand the Urban environment and the interspecies relationships.                         |
| 2                        | To know the importance of Shannon- Simpsons diversity index in understanding the phytosociology |
| 3                        | To learn the Interpretation techniques for aerial photographs and satellite imageries           |
| 4                        | To study the wild life population assessment techniques.                                        |

| <b>Course outcomes</b> |                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Students will learn how to interpret the satellite images and aerial photographs and will understand the status of land use patterns |
| 2                      | Students will come to know the impacts of pollution on the productivity and chlorophyll content                                      |
| 3                      | Students will recognize the importance of responsible tourism and related aspects.                                                   |

## Syllabus

| Sr. No. | Title                                                                                                 | No. of practical |
|---------|-------------------------------------------------------------------------------------------------------|------------------|
| 1       | Study of Flora of Urban terrestrial ecosystem                                                         | 01 (Field based) |
| 2       | Study of Fauna of Urban terrestrial ecosystem                                                         | 01 (Field based) |
| 3       | Estimation of Productivity of Grassland by harvest method                                             | 01 (Field & Lab) |
| 4       | Study of various types of Interspecies relationships in ecosystem                                     | 01               |
| 5       | Estimation of Chlorophyll content from the leaves of plants growing in clean and polluted environment | 01               |
| 6       | Study of threat assessment model for an ecosystem                                                     | 01               |
| 7       | To find out the diversity within an ecosystem using Shannon and Simpson's diversity indices           | 01               |
| 8       | Study of any one population assessment technique for Animal/plant/bird                                | 01               |
| 9       | Identification of different groups of wild species (Flora and Fauna)                                  | 01               |
| 10      | Study of different Ecotourism activities                                                              | 01               |
| 11      | Vegetation mapping by using aerial photographs                                                        | 01               |
| 12      | Interpretation techniques for aerial photographs and satellite imageries                              | 01               |
| 13      | Vegetation mapping by using satellite imageries                                                       | 01               |
|         | <b>Note: Visits along with submission of visit report is compulsory.</b><br><br><b>References:</b>    |                  |

|  |                                                                                                                                              |
|--|----------------------------------------------------------------------------------------------------------------------------------------------|
|  | 1) Manual for Field Ecology; Mishra R.<br><br>2) Handbook of Methods in Environmental Studies Vol-I &II; Mailti S.K.; ABD Publishers; Jaipur |
|--|----------------------------------------------------------------------------------------------------------------------------------------------|



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|                            |                |
|----------------------------|----------------|
| <b>Course/ Paper Title</b> | Practical - II |
| <b>Course Code</b>         | 23SBV55MM      |
| <b>Semester</b>            | V              |
| <b>No. of Credits</b>      | 2              |

| <b>Course Objectives</b> |                                                                                                                                  |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 1                        | To understand the sampling techniques for water and soil                                                                         |
| 2                        | To know the impacts of sewage water on environmental components and the physical, chemical and biological methods for treatment. |
| 3                        | To learn the analysis methods for soil and waste water samples.                                                                  |

|                        |
|------------------------|
| <b>Course outcomes</b> |
|------------------------|

|   |                                                                                                                                  |
|---|----------------------------------------------------------------------------------------------------------------------------------|
| 1 | Students will understand the sewage water / Effluent treatment processes.                                                        |
| 2 | Students will assess the extent of pollution of aquatic resources.                                                               |
| 3 | Students will recognize the various parameters by using standard sophisticated instrumentation techniques and well known methods |

### Syllabus

| Sr. No | Name of Practical                                                                        | No. of Practical |
|--------|------------------------------------------------------------------------------------------|------------------|
| 1      | Collection and Sampling of Waste water from different polluted sites                     | 01               |
| 2      | Collection and Sampling of Soil samples from different polluted sites                    | 01               |
| 3      | Analysis of pH, Temperature and Electrical Conductivity of different waste water samples | 01               |
| 4      | Estimation of Dissolved Oxygen of waste water sample                                     | 01               |
|        | Estimation of free Carbon di-oxide of waste water sample                                 |                  |
| 5      | Determination of Soil Organic Carbon and Organic matter                                  | 01               |
| 6      | Determination of Water acidity                                                           | 01               |
| 7      | Visit to Sewage Treatment Plant / Effluent Treatment Plant                               | 01               |
| 8      | Determination of Nitrates from Water sample                                              | 01               |
| 9      | Determination of Phosphates from Water sample                                            | 01               |
| 10     | Testing the potability of drinking water using MPN test                                  | 01               |
| 11     | Determination of Soil Bulk density                                                       | 01               |
| 12     | Determination of MLSS and Sludge Volume Index                                            | 01               |
| 13     | Estimation of Na and K using Flame Photometer                                            | 01               |
| 14     | Demonstration of Water Purifiers( Working Principle) of pollutes water                   | 01               |
|        | <b>Note: Visits along with submission of visit report is compulsory.</b>                 |                  |

**References:**

1. Handbook of Methods in Environmental Studies: Vol.1 By Maiti, Subodh. (2003).
2. Handbook of Methods in Environmental Studies: Vol 2 (Air, noise, soil and overburden analysis). By Maiti, Subodh. (2003).
3. Waste Water Engineering, Metcalf and Eddy, INC, Tata McGraw Hills
4. Indian Standard for Drinking Water, BSI, New Delhi. Environmental Pollution Control, C. S. Rao, Wiley Eastern Ltd.,1993
5. Air Pollution Control and Engineering, De Nevers, McGraw Hills, 1993, 10.
6. Fundamentals of Air Pollution, Samuel, J. W., 1971, Addison Wesley Publishing
7. Fundamentals of Environmental Pollution, Krishnan Khannan, S. Chand and Company Ltd., 1994.
8. Noise Pollution, Vandana Pandey, Meerut Publishers, 1995.Environmental Pollution Control, C. S. Rao, Wiley Eastern Ltd., 1993.
9. Air Pollution Control and Engineering, De Nevers, McGraw Hills, 1993.
10. Fundamentals of Environmental Pollution, Krishnan Khannan, S. Chand and Company Ltd., 1994.
11. Environmental Chemistry, A. K. De., New Age Intl. Pub Co, New Delhi, 1990
12. Environmental Pollution Analysis - S. M. Khopka





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|                            |                |
|----------------------------|----------------|
| <b>Course/ Paper Title</b> | Practical- III |
| <b>Course Code</b>         | 23SBEV51VS     |
| <b>Semester</b>            | V              |
| <b>No. of Credits</b>      | 2              |

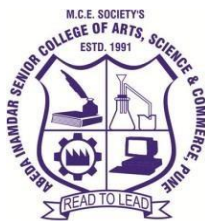
| <b>Course Objectives</b> |                                                                                                                                                                                   |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                        | To create biologically and technologically skilled minds for the understanding theoretical and practical knowledge essential for implementation from LAB to LAND                  |
| 2                        | to inculcate scientific temper and social attitude to solve various problems in the field of Environment                                                                          |
| 3                        | To Apply problem-solving and teamwork skills                                                                                                                                      |
| 4                        | To Retrieve and critically evaluate original scientific literature and Use critical analysis, synthesis and writing skills to produce a scientific report at a professional level |

| <b>Course outcomes</b> |                                                                                                                                             |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Students understand the important parameters to study microorganisms and various methods to Isolate them from different samples             |
| 2                      | Students will work with others to coordinate activities and practical to achieve group/team objectives                                      |
| 3                      | Students will be able to outline how to study microorganisms in the samples and how pollution can be treated using Biotechnological methods |

## Syllabus

| Unit No | Course Content                                                                                                              | Number of Lectures |
|---------|-----------------------------------------------------------------------------------------------------------------------------|--------------------|
| 1       | Determining the factors influencing the composting process, nutrients, moisture, temperature and air, microbial populations | 01                 |
| 2       | Study of microorganisms by Standard Plate Count (SPC) method                                                                | 01                 |
| 3       | Isolation of bacteria from soil and decaying matter                                                                         | 01                 |
| 4       | Survey of plants in and around air polluted sites                                                                           | 01                 |
| 5       | Study of Eutrophication parameters & its effects on waterbodies                                                             | 01                 |
| 6       | Study of instrumentation and safety standards in microbial laboratory                                                       | 01                 |
| 7       | Isolation and characterization of soil micro-organism from polluted sites                                                   | 01                 |
| 8       | Quantitative analysis of phytoplankton and determination of percentage composition by Lackey's drop count method            | 01                 |
| 9       | Identification and classification of bacteria by gram staining technique.                                                   | 01                 |
| 10      | Preparation of compost by using different methods of composting - Indore method & Bangalore method.                         | 01                 |
| 11      | Qualitative and quantitative estimation of compost and vermicompost.                                                        | 01                 |
| 12      | Study of phytoremediation techniques for removal of pollutants.                                                             | 01                 |
| 13      | Isolation of mineral leaching bacteria                                                                                      | 01                 |
| 14      | Isolation of Phosphate solubilizing microbes from Sewage                                                                    | 01                 |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 15 | Study visit to Biotechnology laboratory                                                                                                                                                                                                                                                                                                                                                                                                      | 01 |
| 16 | Design of ETP / STP by using given data                                                                                                                                                                                                                                                                                                                                                                                                      | 01 |
| 17 | Preparation of documentary on environmental issues and legal aspects associated with it                                                                                                                                                                                                                                                                                                                                                      | 01 |
|    | <p><b>Note: Visits along with submission of visit report is compulsory. Any relevant practical</b></p> <p><b>References:</b></p> <p>1. Microbiology by Michael J. Pelzer et.al. (5th ed), Tata McGraw Hill, New Delhi (1993).</p> <p>2. Microbiology for Environmental Scientists and Engineers by Gaudy, AF and Gaudy, ET MGH, New York (1980).</p> <p>3. Standard Methods for the Examination of Water and Wastewater (21st ed.)- AWWA</p> |    |



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### **Program Objectives:**

1. To develop conscience towards social responsibility, human values and sustainable development through curriculum delivery and extra-curricular activities
2. To develop scientific temperament with strong fundamental knowledge of the subject
3. To develop analytical thinking and problem-solving skills needed for various entrance and competitive examinations and Post Graduate Studies
4. To train students in laboratory skills and handling equipment along with soft skills needed for placement
5. To educate the students about instrumentation handling.

### **Program Outcomes:**

- 1) The students will graduate with holistic development.
- 2) The students will be qualified to continue higher studies in their subject.
- 3) The students will be eligible to appear for various competitive examinations and pursue higher education.
- 4) The students will be able to apply for the jobs with a minimum requirement of B. Sc. Program.

### **Program Specific Objectives and Outcomes**

#### **Program Specific Objectives:**

The B.Sc. Environmental Science Program will enable the students;

PSOB-1. To develop basic understanding of fundamental concepts and management of the various resources of mother Earth.

PSOB-2. To bring sensitization towards the environment and also increase student competency & employability

PSOB-3. To inculcate a sense of responsibility among students about various principles and laws of nature.

PSOB-4. To encourage students about applicability of knowledge and Interdisciplinary approach in day to day life.

**Program Specific Outcomes:**

After successful completion of B.Sc. Environmental Science Course, student will have:

**PSOC-1.** Fundamental and Advanced knowledge of theory and practical courses in Environmental science.

**PSOC-2.** Students will understand about how the subject knowledge helps in solving various social, economic and environment related problem

**PSOC-3.** Knowledge about various Environmental laws, ISO series, EMS, Standards and Ethics **required to peruse higher education in the field.**

**PSOC-4.** Knowledge about Environmental (Resource, Energy) Management, Monitoring, introductory aspects of Environmental Biotechnology and Microbiology

**PSOC-5.** Skills in laboratory techniques and experience in instrument handling.

**PSOC-6:** Knowledge about wild life management, Atmospheric sciences, global climate change, Environment Health and Safety, Soil health management, urban town planning, Solid waste management, pollution control technology

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**FACULTY OF SCIENCE**

**Name of BOS -- Life science**

**B.Sc. Program Structure (Choice Based Credit System, Under NEP Guidelines)**

**T.Y.B.Sc. Environmental Science (NEP) Program structure and Syllabus**

**To be implemented from 2025-2026**

| <b>Sr. no.</b> | <b>Program</b> | <b>Sem</b> | <b>Offered as</b>      | <b>Course Code</b> | <b>Course title</b>                                 | <b>No. of Credits</b> | <b>Exam (I/E)</b> | <b>Marks</b> |
|----------------|----------------|------------|------------------------|--------------------|-----------------------------------------------------|-----------------------|-------------------|--------------|
| 1.             | T.Y.B.Sc.      | V          | Major-Theory           | 23SBEV51MM         | Terrestrial & Aquatic Ecosystem Mngt.               | 2                     | I + E             | 20 +30       |
| 2.             | T.Y.B.Sc.      | V          | Major-Theory           | 23SBEV52MM         | Global Climate Change, Adaptation & Mitigation      | 2                     | I + E             | 20 +30       |
| 3.             | T.Y.B.Sc.      | V          | Major-Theory           | 23SBEV53MM         | Environmental Legislation and policies              | 2                     | I + E             | 20 +30       |
| 4.             | T.Y.B.Sc       | V          | Major-Practical        | 23SBEV54MM         | Practicals - I                                      | 2                     | I + E             | 20 +30       |
| 5.             | T.Y.B.Sc       | V          | Major-Practical        | 23SBEV55MM         | Practicals - II                                     | 2                     | I + E             | 20 +30       |
| 6.             | T.Y.B.Sc       | V          | Major-Vocational Skill | 23SBEV51VS         | Practicals – III<br>(Vocational Skill Course)       | 2                     | I + E             | 20 +30       |
| 7.             | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV51MEA        | Environmental Health & Safety<br>(Major Elective)   | 2                     | I + E             | 20 +30       |
| 8.             | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV51MEB        | Industrial Wastewater Treatment<br>(Major Elective) | 2                     | I + E             | 20 +30       |
| 9.             | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV52MEA        | Environmental Biotechnology<br>(Major Elective)     | 2                     | I + E             | 20 +30       |
| 10.            | T.Y.B.Sc.      | V          | Major-Elective         | 23SBEV52MEB        | Urban Town Planning<br>(Major Elective)             | 2                     | I + E             | 20 +30       |

| Sr. no. | Program   | Sem | Offered as      | Course Code | Course title                                 | No. of Credits | Exam (I/E) | Marks  |
|---------|-----------|-----|-----------------|-------------|----------------------------------------------|----------------|------------|--------|
| 1.      | T.Y.B.Sc. | VI  | Major-Theory    | 23SBEV61MM  | Environmental Governance: EMS and ISO 14000  | 2              | I + E      | 20 +30 |
| 2.      | T.Y.B.Sc. | VI  | Major-Theory    | 23SBEV62MM  | Sustainable Development                      | 2              | I + E      | 20 +30 |
| 3.      | T.Y.B.Sc. | VI  | Major-Theory    | 23SBEV63MM  | Wild life Management                         | 2              | I + E      | 20 +30 |
| 4.      | T.Y.B.Sc  | VI  | Major-Practical | 23SBEV64MM  | Practicals-III                               | 2              | I + E      | 20 +30 |
| 5.      | T.Y.B.Sc  | VI  | Major-Practical | 23SBEV65MM  | Project work                                 | 2              | I + E      | 20 +30 |
| 6.      | T.Y.B.Sc. | VI  | Major-Elective  | 23SBEV61MEA | Environmental Monitoring<br>(Major Elective) | 2              | I + E      | 20 +30 |
| 7.      | T.Y.B.Sc. | VI  | Major-Elective  | 23SBEV61MEB | Environmental Toxicology<br>(Major Elective) | 2              | I + E      | 20 +30 |
| 8.      | T.Y.B.Sc. | VI  | Major-Elective  | 23SBEV62MEA | GIS and Remote Sensing<br>(Major Elective)   | 2              | I + E      | 20 +30 |
| 9.      | T.Y.B.Sc. | VI  | Major-Elective  | 23SBEV62MEB | Solid Waste Management<br>(Major Elective)   | 2              | I + E      | 20 +30 |
| 10.     | T.Y.B.Sc. | VI  | Major           | 23SBEV6OJT  | Internship ( On-Job Training)                | 2              | I + E      | 20 +30 |





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|                             |                                                  |
|-----------------------------|--------------------------------------------------|
| <b>Course / Paper Title</b> | Environmental Governance: EMS, EIA and ISO 14000 |
| <b>Course Code</b>          | 23SBEV61MM                                       |
| <b>Semester</b>             | VI                                               |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)                    |

| <b>Course Objectives</b> |                                                                      |
|--------------------------|----------------------------------------------------------------------|
| <b>1.</b>                | To understand the concept of Environmental Governance                |
| <b>2.</b>                | To understand the concept of ISO 14000 series and its importance     |
| <b>3.</b>                | To understand EIA , EMS , EMP and Environmental Audits               |
| <b>4.</b>                | To understand with case studies EIA and Environmental Audit benefits |

| <b>Course Outcomes</b> |                                                                                              |
|------------------------|----------------------------------------------------------------------------------------------|
| <b>1.</b>              | To understand the concept of Environmental Governance and its application in day to day life |
| <b>2.</b>              | To understand the importance of ISO 14000 series and its application                         |
| <b>3.</b>              | To understand the importance of EIA in developmental projects and Environmental conservation |
| <b>4.</b>              | To understand the importance applications and advantages of EMP and EMS in an organization   |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | No. of lectures |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Environmental Governance</b> <ol style="list-style-type: none"> <li>1. Introduction, Importance, Objective, and attributes of Governance</li> <li>2. Elements of governance: Institutional and structural, rules and regulation</li> <li>3. Environmental governance in India-Issues and challenges</li> </ol>                                                                                                                                                                                                                               | 05              |
| 2        | <b>ISO 14000 standards</b> <ol style="list-style-type: none"> <li>1. Overview of ISO 14000-Management system benefits and scopes Implementation and certification ISO/207 TC function, Environmental management and sustainability aspects</li> </ol> <b>Basic of EMS and EMP</b> <ol style="list-style-type: none"> <li>1. Elements of EMS and EMP, Planning and selection of appropriate resources management</li> <li>2. Benefits of EMS and EMP system</li> </ol>                                                                           | 10              |
| 3        | <b>EIA and Audits</b> <ol style="list-style-type: none"> <li>1. Introduction, Needs and Goals, Advantages and Disadvantages of EIA process</li> <li>2. Life cycle assessment , Societal response &amp; Responsibilities (Public participation),EIA Notification, 2006</li> <li>3. Methods of data collection: Network, Checklist, Matrix, Overlay &amp; GIS , Cost –benefit analysis</li> <li>4. Concept of Audit: Definition and Types, Benefits, and objectives of environmental audit, on-site, offsite audit, report preparation</li> </ol> | 10              |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 4 | <p><b>Case Studies</b></p> <ol style="list-style-type: none"> <li>1. With respect to mining, construction, industries, developmental projects</li> <li>2. Sustainability reporting for industries, Case studies related to EIA, Environmental Audits</li> </ol>                                                                                                                                                                                                                                                                                                                                                                         | 05 |
|   | <p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1.EIA notification published by Ministry of Environment, Forests and Climate Change,<br/>Government of India</li> <li>2.Environmental Impact Assessment, Canter R.L., McGraw Hill International Edition</li> <li>3.Environmental Impact Assessment: Practical Guide for Professional Practices by Rathi<br/>AKA, Publisher: Gujarat Akar Unlimited, 2016</li> <li>4.Preventive Environmental Management: An Indian Perspective by Dr. Shyam R. Asolekar &amp; Dr. R. Gopichandran</li> <li>5.Environmental Impact Assessment -T.V. Ramachandra ,2019</li> </ol> |    |



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|-----------------------------|-------------------------------|
| <b>Course / Paper Title</b> | Sustainable Development       |
| <b>Course Code</b>          | 23SBEV62MM                    |
| <b>Semester</b>             | VI                            |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes) |

| <b>Course Objectives</b> |                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.                       | To nurture values of social responsibility, professionalism in the delivery of services and capacities in integrating knowledge, attitude and practice.                                                                                                                                                                                                                    |
| 2.                       | To develop required competency and skills for managing the development programmes and projects                                                                                                                                                                                                                                                                             |
| 3.                       | To acquire the ability to work effectively with others in a multi-cultural environment.                                                                                                                                                                                                                                                                                    |
| 4.                       | To prepare the students for demonstrating innovative practices in the development sector.                                                                                                                                                                                                                                                                                  |
| 5.                       | To provide a platform that enhances the creative, entrepreneurial and critical mind of the professionals.                                                                                                                                                                                                                                                                  |
| 6.                       | To inculcate the knowledge base on sustainable development with a view to balance our economic, environmental and social needs, allowing prosperity for now and future generations. To train students to undertake major initiatives in the efficient management of natural resources and the prevention of environmental pollution with focus on Sustainable Development. |

| <b>Course Outcome</b> |                                                                                         |
|-----------------------|-----------------------------------------------------------------------------------------|
| 1.                    | The students demonstrate a comprehensive understanding of the dimensions of development |

|    |                                                                                                                                                                                                   |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2. | Transform into original researchers and undertake cutting-edge research and teaching for an in-depth understanding of complex environmental issues                                                |
| 3. | Predict the environmental change and provide scientifically sound and socially acceptable solutions                                                                                               |
| 4. | Develop as sustainability managers to guide manufacturing industries, nongovernment organizations (national and international), and policy-making bodies.                                         |
| 5. | Act as a catalyst to bridge the gap between science and society in achieving ecosystem restoration, conservation and management of biodiversity including the well-being of the society at large. |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                          | No. of lectures |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction to Sustainability</b><br>Sustainability Concept, Meaning, and Definitions – Importance of sustainability goals – History of sustainability – Three Pillars of Sustainability – Theories of Sustainability: Systems Theory, Popular sustainability, and Ideal scientific model - Issues and Challenges relating to sustainability.                                                                            | 05              |
| 2        | <b>Sustainable Development</b><br>Concept, meanings, scope, and definitions of sustainable development – Principle of Sustainable Development – The pillars of sustainable development – Approaches to Sustainable Development: Status Quo Approach, Community Capacity Building Approach, Industrial Sector Approach, Integrated Systems Approach, Human Development Approach, and Green Account Approach.                  | 05              |
| 3        | <b>Goals of Sustainable Development</b><br>Nature of Sustainable Development Goals – 2030 Global Agenda for Sustainable Development – Government Policies and their implications for sustainable development in India – Contribution of International Organizations and NGOs – Government Initiatives for Sustainable Development.                                                                                           | 05              |
| 4        | <b>Measurement and Indicators of Sustainable Development</b><br>Measurement Tool for Sustainable Development: Gross National Happiness (GNH) – Human Development Index (HDI) – Ecological Footprint (EF) – and The Happy Planet Index (HPI); Indicators of Sustainable Development: Indicators for Education – Indicators for Health – Indicators for Economy – Indicators for Gender Equality – Indicators for Zero Hunger. | 05              |

|    |                                                                                                                                                                                                                                                                                                                                                                        |    |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 5. | <b>Challenges in Sustainable Development and Social Exclusion</b><br>Concept and implications, human development of the sociocultural and other ethnic groups of the society; Contemporary Issues of Development – Bottom of the pyramid approach; Understanding the importance of social capital, social mobilization, social security, and population stabilization. | 10 |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <b>Suggested Readings</b> <ol style="list-style-type: none"> <li>1. Agrawal, A N (1995). Indian Economy: Problems of development and planning. pune: Vishwa Prakashan</li> <li>2. Baldev Raj Nayar, Globalization and Nationalism: The Changing Balance of India's Economic Policy, 1950–2000 (New Delhi: Sage, 2001)</li> <li>3. Bidyut Mohanty (1993) Urbanization in Developing Countries Basic Services and community Participation, Institute of Social Science, Concept Publishing House.</li> <li>4. Friedman, J. and W. Alonso (Eds.) (1975), Regional Policy, Readings in Theory and Application, MIT Press, Cambridge, Mass.</li> <li>5. Glasson, J. (1975), An Introduction to Regional Planning: Concepts, Theory and Practice, Hutchison, London.</li> <li>6. Kumar, V. (2009). Encyclopedia of Child Welfare and Protection. Anmol Publications Pvt. Ltd. New Delhi.</li> <li>7. Mukherji, Rahul (Eds.). (2007), India's Economic Transition: The Politics of Reforms, Oxford University Press.</li> <li>8. Ray, D., Development Economics, 1998, Chapters 2, 9, 10, 12, and 16.</li> <li>9. Seth, V.K. (1987), Industrialization in India: A Spatial Perspective, Commonwealth Publishers, New Delhi</li> <li>10. <a href="https://www.bdu.ac.in/schools/social-sciences/social-work/docs/syllabi/PG-Diploma-Sustainable-Development-Syllabus-2022-2023.pdf">https://www.bdu.ac.in/schools/social-sciences/social-work/docs/syllabi/PG-Diploma-Sustainable-Development-Syllabus-2022-2023.pdf</a></li> </ol> |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



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|-----------------------------|-------------------------------|
| <b>Course / Paper Title</b> | Wildlife Management           |
| <b>Course Code</b>          | 23SBEV63MM                    |
| <b>Semester</b>             | VI                            |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes) |

| <b>Course Objectives</b> |                                                                                            |
|--------------------------|--------------------------------------------------------------------------------------------|
| <b>1.</b>                | To understand about Wildlife and its significance                                          |
| <b>2.</b>                | To understand the various threats associated with Wildlife                                 |
| <b>3.</b>                | To understand various Wildlife conservation techniques and Management, Legislations        |
| <b>4.</b>                | To provide an insight about Role of Government, NGO, Local people in Wildlife conservation |

| <b>Course Outcome</b> |                                                                                                   |
|-----------------------|---------------------------------------------------------------------------------------------------|
| <b>1.</b>             | Students will learn effective Wildlife Management Techniques                                      |
| <b>2.</b>             | Students will understand the importance of Wildlife of India and its conservation                 |
| <b>3.</b>             | Students will understand laws, various Government bodies, NGO working towards Wildlife Protection |
| <b>4.</b>             | Encouragement of students for research , create career in Wildlife and its Management             |



## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | No. of lectures |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction to Wildlife</b><br><br>1. Definition of Wildlife, Significance of Wildlife<br>2. Global distribution of Wildlife<br>3. Need for Wildlife Protection and Conservation<br>4. Hotspots of Biodiversity in World and India<br>5. Protected Wildlife species in World and India<br>6. India as a mega bio diversity country                                                                                                                                                                                           | 03              |
| 2        | <b>Threats to wildlife</b><br><br>1. Habitat Destruction<br>2. Developmental projects---Urbanization, Agriculture expansion, Poaching, industrial expansion, Human- Wildlife conflict, Deforestation, Pollution<br>3. Exploitation of animals and plants                                                                                                                                                                                                                                                                         | 03              |
| 3        | <b>Wildlife Census Technique</b><br><br>1. Planning census – Total counts - Sample counts – Basic concepts and applications<br>2. Direct count (block count, transect methods, Point counts, visual encounter survey, waterhole survey)<br>3. Indirect count (Call count, track and signs, pellet count, pugmark, camera trap)<br>4. Identifying animals based on indirect signs; Capture recapture techniques<br>5. Field techniques for identification of Plants, Mammals, Birds, Herpetofauna, indigenous fishes, Butterflies | 05              |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 4 | <b>Human Wildlife Conflicts</b> <ol style="list-style-type: none"> <li>1. Basic concepts, reasons for conflicts and Control measures</li> <li>2. Case studies – Elephant, Gaur, Wild boar, Monkey, Tiger and Leopard</li> <li>3. Translocation of Wild animals – Principles, Methods and Applications</li> <li>4. Wildlife Crime with case studies</li> </ol>                                                                                                                                                                                                                                                                                      | 05 |
| 5 | <b>Conservation and Management of Wildlife</b> <ol style="list-style-type: none"> <li>1. In-situ conservation: Wildlife Sanctuaries, National Parks, Tiger Reserves and Biosphere reserves, Conservation reserves, Sacred Habitats</li> <li>2. Ex-situ conservation: Botanical Gardens, Zoos, Seed and Seedling Banks, Pollen culture, Tissue and DNA bank, Butterfly gardens</li> <li>3. Traditional knowledge in Wildlife conservation</li> <li>4. Wildlife Projects: Tiger, Elephant, Lion, Vulture and Hangul</li> <li>5. Role of Remote sensing and GIS in Wildlife conservation</li> <li>6. Eco-tourism and Wildlife Conservation</li> </ol> | 07 |
| 6 | <b>Wildlife Legislations, Role of Government, NGO, and Local people in Conservation of Wildlife</b> <ol style="list-style-type: none"> <li>1. Role of Government Institutions in Conservation- Wildlife Board, Zoological Survey of India, Botanical Survey of India, Forest Research Institute, Survey of India, Central Marine Fisheries Research Institute</li> <li>2. Role of NGO – WWF, ATREE, BNHS, WTI, Kalpavriksha</li> <li>3. International agencies- UNEP, GEF, WCS, Bird Life International</li> <li>4. Role of Tribals in Conservation- Bedas, Kadu</li> </ol>                                                                        | 07 |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  | <p>kurubas etc</p> <p>5. Biodiversity Act, Wildlife protection Act, Wildlife trade and regulations, CITES, International agreements and treaties</p>                                                                                                                                                                                                                                                                                                                                                                     |  |
|  | <p><b>Suggested readings</b></p> <p>1.Principles of Environmental science - Cunningham and Cunningham</p> <p>2.Ecology, Environment and Resource Conservation (2006): Singh JS, Singh SP and Gupta SR; Anamaya Publ, New Delhi</p> <p>3.Fundamental of Ecology (1971): EP Odum; WB Saunders Company.</p> <p>4.Plant Diversity Hotspots in India (1997): PK Hajra and V. Mudgal; Botanical Survey of India</p> <p>5.Environmental Management (2005): Bala Krishnamoorthy; Prentice-Hall of India Pvt. Ltd., New Delhi</p> |  |



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|                             |                                     |
|-----------------------------|-------------------------------------|
| <b>Course / Paper Title</b> | Environmental Monitoring (Elective) |
| <b>Course Code</b>          | 23SBEV61MEA                         |
| <b>Semester</b>             | VI                                  |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)       |

| <b>Course Objectives</b> |                                                                                                                 |
|--------------------------|-----------------------------------------------------------------------------------------------------------------|
| 1.                       | To aware students regarding sampling and analytical techniques in environmental monitoring.                     |
| 2.                       | To give basic knowledge about procedures of environmental monitoring                                            |
| 3.                       | To correlate environmental factors and there interdependence on each other                                      |
| 4.                       | To give scientifically accurate ways of environmental interpretations with respect to environmental monitoring. |

| <b>Course Outcomes</b> |                                                                                                                 |
|------------------------|-----------------------------------------------------------------------------------------------------------------|
| 1.                     | To aware students regarding sampling and analytical techniques in environmental monitoring.                     |
| 2.                     | To give basic knowledge about procedures of environmental monitoring                                            |
| 3.                     | To correlate environmental factors and there interdependence on each other.                                     |
| 4.                     | To give scientifically accurate ways of environmental interpretations with respect to environmental monitoring. |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | No. of lectures |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Statistics in Environmental Monitoring</b> <ul style="list-style-type: none"> <li>• Samples &amp; Population</li> <li>• Concept of sample, types of sampling, Sample support, Sample size &amp; Confidence interval</li> <li>• Frequency Distribution</li> <li>• Density Function: Mean, Mode, Median, Variance, Standard Deviation</li> <li>• Introduction to environmental transport – BOX Models and the application to multimedia transport of pollutants</li> </ul>                                                                                                                                                                                                                | 05              |
| 2        | <b>Weather and Air Monitoring</b> <ul style="list-style-type: none"> <li>• <b>Weather</b>-- Introduction to weather system and parameters: Light, Rainfall, Wind direction, Wind velocity, (Movement of pollutants), Temperature, Pressure, Humidity Monitoring tools / instruments and their working principle</li> <li>• <b>Air</b> -National standards for ambient air quality, Site and parameter selection, Monitoring of particulate matter and gases, Ambient air and work zone monitoring techniques ,Monitoring tools/instruments used for the same and its work principle, Atmospheric Dispersion – Gaussian Dispersion model. Pollen grains monitoring, Case studies</li> </ul> | 05              |
| 3        | <b>Noise and Radiation Monitoring</b> <ul style="list-style-type: none"> <li>• <b>Noise</b> --Introduction of noise &amp; vibration; measuring techniques, National standard for noise, Noise monitoring methods, A-weighted Sound Level: The Basic Noise Unit, Maximum Sound Level (Lmax) During a Single Noise Event Sound Exposure Level (SEL): Equivalent Sound Level [Leq(h)]</li> <li>• <b>Radioactivity</b>-- Radiation types and measurement, Detection of nuclear radiations, G. M counter, scintillation counter, semi-conductor detector. personal dosimeter, Units of</li> </ul>                                                                                               | 05              |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|   | measurements, Half-life period, radiation dose measurement, Case studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |
| 4 | <b>Water and Soil Monitoring</b> <ul style="list-style-type: none"> <li>• <b>Water</b> --Purpose / objectives of monitoring, Sampling techniques, Collection of sample, sample preservation, Physical, chemical, biological parameters of water &amp; its monitoring, Standardization &amp; calibration of monitoring instruments, General effluent standards, stream standards, Drinking water standard (IS10500 and WHO Standards),</li> <li>• <b>Soil Sampling Methodology</b>--Objectives of soil monitoring / testing, Sampling and sample units, sample number, Site selection, In-field sampling technique, Instruments / equipment's used, Important soil quality indicators, Case studies</li> </ul> | 05 |
| 5 | <b>Biodiversity Monitoring</b> --Vegetation Monitoring, Measurement of height, girth and biomass, Measurement of frequency, density and diversity, Vertebrate Monitoring, Transect method: Line and belt transect, point count, pug mark, pellet / dung count, call count, scat / pellet analysis and camera trapping etc., Invertebrate Monitoring, Net swipe, light trap, shredder count, pit traps. Biological monitoring, Case studies                                                                                                                                                                                                                                                                    | 05 |
| 6 | <b>Instruments in Environmental Monitoring</b> -- pH meter , Conductivity meter, Colorimeter, Hot air oven, autoclave, laminar flow, UV Spectrophotometer, Nitrogen (TKN), HVS, RSPM 2.5, Atomic absorption spectrophotometer ,Gas chromatography, Mass spectroscopy, Scanning electron microscopy, Utilisation of Artificial Intelligence in Environmental Monitoring.                                                                                                                                                                                                                                                                                                                                       | 05 |

**Suggested Readings:**

1. Waste Water Engineering , Met Calf and Eddy, INC, Tata McGraw Hills
2. Indian Standard for Drinking Water, BSI, New Delhi. Environmental Pollution Control, C. S. Rao, Wiley Eastern Ltd.,1993
3. Air Pollution Control and Engineering, De Nevers, McGraw Hills, 1993, 10.
4. Fundamentals of Air Pollution, Samuel, J. W., 1971, Addison Wesley Publishing
5. Fundamentals of Environmental Pollution, Krishnan Khannan, S. Chand and Company Ltd., 1994.
6. Noise Pollution, Vandana Pandey, Meerut Publishers, 1995.
7. Environmental Pollution Control, C. S. Rao, Wiley Eastern Ltd., 1993.
8. Air Pollution Control and Engineering, De Nevers, McGraw Hills, 1993.
9. Fundamentals of Environmental Pollution, Krishnan Khannan, S. Chand and Company Ltd., 1994.
10. Environmental Chemistry, A. K. De., New Age Intl. Pub Co, New Delhi, 1990.
11. Environmental Pollution Analysis - S. M. Khopkar.



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|-----------------------------|-------------------------------------|
| <b>Course / Paper Title</b> | Environmental Toxicology (Elective) |
| <b>Course Code</b>          | 23SBEV61MEB                         |
| <b>Semester</b>             | VI                                  |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)       |

| <b>Course Objectives</b> |                                                                                                                                                                                                                                 |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.                       | To Provide a wide knowledge on environmental toxicants and its impact on health                                                                                                                                                 |
| 2.                       | To provide a scope for students to understand the toxicants disposition and metabolism, fate of toxicants in the environment, diseases caused by various pollutants, heavy metals and POP's and occupational health and safety. |

| <b>Course Outcome</b> |                                                                                                           |
|-----------------------|-----------------------------------------------------------------------------------------------------------|
| 1.                    | To analyse the different types of toxicants, sources and its effects                                      |
| 2.                    | To distinguish the toxic and non-toxic ingredients in by products                                         |
| 3.                    | To explain the fate of pollutants in the environment                                                      |
| 4.                    | To explain the effect of various types toxicants on human and environmental health                        |
| 5.                    | apply the safety and precautionary measures related to environmental toxicants and occupational exposures |



## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                             | No. of lectures |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Environmental Toxicology</b><br>1. Definitions, Classical toxicology, ecotoxicology and environmental toxicology.<br>2. Classification of toxicants.<br>3. Toxic agents: Pesticides, metals, solvents radiation, carcinogens, poisons, bio-toxins, petrochemicals. LD50, OECD guidelines, doses, types of toxicity, Occupational Health and toxicity                                                         | 05              |
| 2        | <b>Toxicant uptake</b><br>1. Route of toxicant uptake/Absorption of toxicant at tissue and cellular level<br>2. Distribution and storage of toxicant.<br>3. Biotransformation and elimination of toxicant.<br>4. Xenobiotics: Definition, types and significance Target organ toxicity: Hepatotoxicity, Hepatotoxicity, Nephrotoxicity, Neurotoxicity                                                           | 05              |
| 3        | <b>Environmental Toxicology</b><br>1. Food additives, air, water and soil pollutants and Bio-indicators. Effect of pollutant on ecosystem with case study of important Organo-phosphorous and Organo-chlorine pesticides and Nitrates<br>2. Solid waste management: Primary waste products-Solid waste, toxic biological and hospital landfills, incineration, source reduction and recycling.                  | 10              |
| 4        | <b>Bioremediation, its role and significance.</b><br>1. Toxicological risk assessment and management with reference to relevant case study.<br>2. Principles and significance of systematic toxicology.<br>3. Genotoxicology: Definition, Effects, molecular mechanisms and prevention.<br>4. Applications of toxicology anthropogenic activities and environment.<br>5. Human toxicology and medicinal ethics. | 10              |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>Suggested Readings</b></p> <ol style="list-style-type: none"><li>1. B.M. Francis. (1994.), Toxic Substances in the Environment. New York, John Wiley &amp; Sons.</li><li>2. Bryan Ballantyne, Timothy C. Marrs, Tore Syversen. (2009), General Applied Toxicology. 6 Volume Set, Third Edition. Queensland, John Wiley &amp; Sons. • Cockerham L.G., Shane B.S. (1993), Basic Environmental Toxicology. USA, CRC Press.</li><li>3. Edward A. (2013), Laws. Environmental Toxicology: Selected entries from the encyclopedia of sustainability science and technology. New York, Springer-Verlag. • Hayes, A. W. (2008), Principles and Methods of Toxicology, 5th Edition, Boca Raton, FL, Taylor and Francis.</li><li>4. I.C. Shaw and J. Chedwick. (2004), Principles of Environmental Toxicology, Boca Raton, FL, Taylor and Francis.</li><li>5. Levy B.S., Wegman D.H. (1995), Occupational Health recognizing and preventing work related disease. Boston, MA: Little Brown &amp; Co.</li><li>6. Walker C.H., Sibly R.M., Hopkin S.P., Peakall D.B. (2012), Principles of Ecotoxicology. Fourth Edition. USA, CRC Press.</li><li>7. Zakrzewski S.F (2002), Environmental Toxicology. 3rd Edition. New York, Oxford Univeristy Press.</li><li>8. Landis W, Sofield R, Yu M.H., (2017),Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes, Fifth Edition. Canada, CRC Press.</li></ol> |
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|                             |                               |
|-----------------------------|-------------------------------|
| <b>Course / Paper Title</b> | GIS & Remote Sensing          |
| <b>Course Code</b>          | 23SBEV62MEA (Elective)        |
| <b>Semester</b>             | VI                            |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes) |

| <b>Course Objectives</b> |                                                                                                                                         |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1.                       | To understand the fundamental concepts of GIS and remote sensing including the electromagnetic Spectrum, and nature of geospatial data. |
| 2.                       | To make the student to understand the various applications of remote sensing and GIS                                                    |
| 3.                       | Sustainable planning and management of projects                                                                                         |

| <b>Course Outcome</b> |                                                                     |
|-----------------------|---------------------------------------------------------------------|
| 1.                    | To understand the importance of remote sensing and GIS application  |
| 2.                    | To study and identify of satellite imageries, GIS Maps              |
| 3.                    | To learn the soft skills by using GIS & Remote sensing technologies |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | No. of lectures |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction to Remote Sensing</b><br>Basic concepts and fundamentals of remote sensing – elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology and units, over view of Indian Remote sensing satellites and sensors                                                                                                                                                                                                                                                                                                                                    | 05              |
| 2        | <b>Remote Sensing and GIS</b><br>Energy resources, energy interactions with earth surface features and atmosphere, resolution, visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of water bodies<br>Geographic Information System: Introduction, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS                                                                                                                             | 05              |
| 3        | <b>Types of data representation</b><br>Data collection and input overview, data input and output. Keyboard entry and coordinate geometry procedure, manual digitizing and scanning, Raster GIS, Vector GIS - Advantages and disadvantages. File management, Spatial data – Layer based GIS, Feature based GIS mapping.<br><b>GIS Spatial Analysis</b><br>Computational Analysis Methods (CAM), Visual Analysis Methods (VAM), Data storage vector data storage, attribute data storage, overview of the data manipulation and analysis. Integrated analysis of the spatial and attribute data. | 10              |
| 4        | <b>Applications of GIS</b><br>Application areas and user segments; Guide lines for preparation of GIS; Applications of GIS for land use and housing management; Assessment of physical transformation in an urban area.<br>Water Resources Applications Land use/Land cover in water resources, Surface water mapping and inventory, Watershed management for sustainable development. Reservoir sedimentation,                                                                                                                                                                                | 10              |

|  |                                                                                        |  |
|--|----------------------------------------------------------------------------------------|--|
|  | Ground Water Targeting and Identification of sites for artificial Recharge structures. |  |
|--|----------------------------------------------------------------------------------------|--|

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1. Concepts &amp; Techniques of GIS by C.P.Lo Albert, K.W. Yeung, Prentice Hall, 2002.</li> <li>2. Text Book of Remote Sensing and Geographical Information systems by M.Anji Reddy , 4th Edition,B.S.Publications,2012.</li> <li>3. Geographic information Systems by Kang- tsung Chang, McGraw-Hill,2003.</li> <li>4. Basics of Remote sensing &amp; GIS by S.Kumar, USP,2005.</li> <li>5. Remote Sensing and its applications by LRA Narayana, University Press 1999</li> <li>6. Principals of Geo physical Information Systems – Peter A Burragh and Rachael A. Mc Donnell, Oxford Publishers 2004</li> <li>7. <a href="http://ce.rvrjcce.ac.in/syllabus/ce422.pdf">http://ce.rvrjcce.ac.in/syllabus/ce422.pdf</a></li> </ol> |
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|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Course / Paper Title</b> | Solid Waste Management(Elective) |
| <b>Course Code</b>          | 23SBEV62MEB                      |
| <b>Semester</b>             | VI                               |
| <b>No. of Credits</b>       | 2 (30 Lectures of 60 minutes)    |

| <b>Course Objectives</b> |                                                                                      |
|--------------------------|--------------------------------------------------------------------------------------|
| 1.                       | To understand the concept of waste management and its harmful impacts on environment |
| 2.                       | To study various waste management techniques for conservation of environment quality |
| 3.                       | To learn about Integrated waste management processes                                 |

| <b>Course Outcome</b> |                                                                                                                                                             |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.                    | Students will realise the real time problems by keeping in view of social, environmental and health issues related to solid waste by various new techniques |
| 2.                    | Students will understand the various monitoring methods for waste disposal                                                                                  |
| 3.                    | Students will be aware about the 4 R's principle to be followed in day today life.                                                                          |

## Syllabus

| Unit No. | Title with contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | No. of lectures |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1        | <b>Introduction to Solid Waste</b> <ol style="list-style-type: none"> <li>1. Sources and generation of solid waste</li> <li>2. Classification and chemical composition</li> <li>3. Characterization of Municipal solid waste</li> <li>4. Hazardous waste and Biomedical waste, E-waste management</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 05              |
| 2        | <b>Impact of Solid waste (NO NEED)</b> <ol style="list-style-type: none"> <li>1. On environment, human, animals, and plant health</li> <li>2. Effect of solid waste and industrial effluent discharge on water quality and aquatic life</li> <li>3. Mining waste and land degradation</li> <li>4. Effect of landfills leachate on soil characteristics and ground water pollution.</li> <li>5. Effects of industrial waste on air quality</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 05              |
| 3        | <b>Techniques for Solid Waste Management</b> <ol style="list-style-type: none"> <li>1. Collection, storage, transportation, and disposal of solid waste (municipal, hazardous, and biomedical waste); landfill (traditional and sanitary landfill design)</li> <li>2. Thermal treatment (pyrolysis and incineration) of waste material, Recent updates on waste management IOT based</li> <li>3. Biological processing - composting, vermicomposting, anaerobic digestion, aerobic treatment, biological treatment; green techniques for waste treatment</li> <li>4. Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification</li> <li>5. Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management.</li> <li>6. Drawbacks in Waste management techniques.</li> </ol> | 10              |
| 4        | <b>Laws and its Amendments --Legal aspects of Solid Waste Management</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 10              |

|  |                                                                                                                                                                                                                                                                                                                                                                                                 |  |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  | <ol style="list-style-type: none"> <li>1. Municipal Solid Waste Management Rule, 2016</li> <li>2. Biomedical Waste Management Rule</li> <li>3. E-Waste Management Rule</li> <li>4. Construction and Demolition Waste Management and Rule</li> <li>5. Hazardous Waste Management Rule</li> <li>6. Role of CPCB and MPCB in Management of Solid Waste</li> <li>7. Related Case studies</li> </ol> |  |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report 570</li> <li>2. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley &amp; Sons</li> <li>3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press</li> <li>4. McDougall, F. R., White, P. R., Franke, M., &amp; Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley &amp; Sons</li> <li>5. US EPA. 1999. Guide for Industrial Waste Management. Washington D.C.</li> <li>6. White, P.R., Franke, M. &amp;Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic &amp; Professionals</li> <li>7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. &amp; Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C.</li> </ol> |
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|                             |                 |
|-----------------------------|-----------------|
| <b>Course / Paper Title</b> | Practicals -III |
| <b>Course Code</b>          | 23SBEV64MM      |
| <b>Semester</b>             | VI              |
| <b>No. of Credits</b>       | 2               |

| <b>Course Objectives</b> |                                                                                                                                                                                                                    |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1.</b>                | To develop an understanding of weather maps and their components and Apply knowledge to predict local weather patterns based on wind direction and rainfall analysis                                               |
| <b>2.</b>                | Learn the importance of Sodium Adsorption Ratio (SAR) in water quality assessment. And to understand the significance of chromium in wastewater and its environmental impact.                                      |
| <b>3.</b>                | Understand the concept of Water Quality Index (WQI) and its importance in water quality assessment.                                                                                                                |
| <b>4.</b>                | Analyze the impact of air quality on human health and the environment using API data.                                                                                                                              |
| <b>5.</b>                | Understand the principles of GPS technology and its application in environmental studies and to gain proficiency in georeferencing techniques for aligning maps and satellite imagery with geographic coordinates. |
| <b>6.</b>                | Develop skills in creating spatial data for points, lines, and polygons using GIS software.                                                                                                                        |

| <b>Course Outcomes</b> |                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1.</b>              | Students will demonstrate the ability to predict local weather patterns and understand their implications for agriculture, urban planning, and disaster management.      |
| <b>2.</b>              | Students will use WQI as a decision-making tool for evaluating water suitability for various uses (e.g., drinking, recreation, agriculture).                             |
| <b>3.</b>              | Students will be able to use GPS data for environmental monitoring, mapping, and spatial analysis.                                                                       |
| <b>4.</b>              | Students will master the process of georeferencing maps, satellite images, and GPS data for accurate spatial analysis.                                                   |
| <b>5.</b>              | Students will develop the ability to visually interpret satellite imagery for environmental monitoring, including land use changes, vegetation health, and water bodies. |
| <b>6.</b>              | Students will learn to calculate and map the carbon footprint of various activities, organizations, and regions.                                                         |

**Syllabus:**

| <b>Sr. No</b> | <b>Name of Practical</b>                                                                                       | <b>No. of Practical</b> |
|---------------|----------------------------------------------------------------------------------------------------------------|-------------------------|
| 1             | Study of weather maps, interpretation for wind direction, rainfall                                             | 01                      |
| 2             | Estimation of water quality index                                                                              | 01                      |
| 3             | Estimation of air pollution index                                                                              | 01                      |
| 4             | GPS handling and acquisition of data                                                                           | 01                      |
| 5             | Georeferencing using toposheet / satellite image / GPS<br>Preparation of subset of satellite image / toposheet | 01                      |
| 6             | Visual analysis and interpretation of satellite data                                                           | 01                      |
| 7             | Study of interpolation technique for mapping of ground water quality                                           | 01                      |
| 8             | Study of Google Earth for environmental sciences                                                               | 01                      |
| 9             | Analysis of solid waste leachate for selected wastewater parameters                                            | 01                      |
| 10            | Estimation of oil and grease from given water sample                                                           | 01                      |
| 11            | Study on carbon foot print mapping                                                                             | 01                      |

|    |                                                                                                                 |             |
|----|-----------------------------------------------------------------------------------------------------------------|-------------|
| 12 | Assessment of global warming potential of greenhouse gases                                                      | 01          |
| 13 | Case studies based on sustainable management                                                                    | 01          |
| 14 | Estimation of carbon sequestration potential of selected area/ plant                                            | 01          |
| 15 | Innovative practices for sustainable management in organization                                                 | 01          |
| 16 | Demonstration of working of incineration / pyrolysis with video.                                                | 01          |
| 17 | Assessment of threats to wildlife and their habitat in Western Ghats (Field visit)                              | 01          |
| 18 | Environmental Impact Assessment process with case studies                                                       | 01          |
| 19 | Preparation of draft of EIA report on selected developmental project                                            | 01          |
| 20 | Visit to regional pollution control board                                                                       | Field visit |
| 21 | Preparation of report on major judgement by courts on selected law case study of Pune, Taj-Mathura oil refinery | 01          |
| 22 | Report preparation on understanding the process of filing environmental case                                    | 01          |
| 23 | Effect of toxicants and wastewater on seed germination                                                          | 01          |
| 24 | Study visits to Dumping site/ NGO e –waste site/Hospital waste management                                       | 01          |

**Note: Visits along with submission of visit report is compulsory.**

**References:**

1. Waste Water Engineering, Met Calf & Eddy; Inc, Tata McGraw Hill.
2. Waste Water Treatment for Pollution Control, Dr. Arceivala, Tata McGraw Hill.
3. Singh Anantpreet and Kaur Sukhjit, Biomedical Waste Disposal, Jaypee Brothers.
4. Ronald E. Hester and Roy M. Harrison, Electronic Waste Management, RSC Publishing.
5. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.
6. Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
7. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA
8. Surendra Malik and Sudeep Malik: Supreme Court on Environmental Law, Eastern Book Company, 2015.
9. Nawneet Vibhaw: Environmental Law - An Introduction, Lexisnexis, 2016.
10. Nancy K. Kubasek and Gary S. Silverman: Environmental Law, Pearson, 1999.
11. Guha R.: Environmentalism: A Global History, Allen Lane 2014.



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### **Syllabus for T.Y.B. Sc. Environmental Science**

**2023-24 (CBCS – Autonomy 21 Pattern)**

|                            |              |
|----------------------------|--------------|
| <b>Course/ Paper Title</b> | Project Work |
| <b>Course Code</b>         | 23SBEV65MM   |
| <b>Semester</b>            | VI           |
| <b>No. of Credits</b>      | 2            |

#### **Aims & Objectives of the Course**

| <b>Sr. No.</b> | <b>Objectives</b>                                                                                                                                                                           |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1              | To Plan, manage and execute a substantial project.                                                                                                                                          |
| 2              | To Explain the significance of the project in the context of the literature, the problem which the project solves, and the implications of what has been learned in conducting the project. |
| 3              | To Demonstrate mastery of the underlying theory of the project subject matter and analysis techniques.                                                                                      |
| 4              | Demonstrate mastery of a non-trivial technical skill in a scientific approach                                                                                                               |

#### **Expected Course Specific Learning Outcomes**

| <b>Sr. No.</b> | <b>Learning outcomes</b>                                                                                                   |
|----------------|----------------------------------------------------------------------------------------------------------------------------|
| 1              | Students understand the importance of field experience and implementation of various methods                               |
| 2              | Students will obtain quantitative information on the physical, chemical, and biological characteristics of various samples |

|   |                                                                                                                                                   |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | Students will be able to outline how sewage may be treated before discharge to the environment including the disinfection methods through project |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------|

### Syllabus

| Unit No. | Name of Unit | Content                                                                                                                                                                                                                                                                                                                    | Lectures |
|----------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1        | Project      | <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Hypothesis</li> <li>• Aim</li> <li>• Objectives</li> <li>• Materials and Methods</li> <li>• Results and Discussions</li> <li>• Summary &amp; Conclusion</li> <li>• Future prospects</li> <li>• References</li> <li>• Project Report Submission</li> </ul> | 36       |

### Policy procedure to be followed for T. Y. B. Sc. Project Work and Submission

Students have to complete six monthly project reports for successful completion of B. Sc. degree. Students can select topics related with various areas of Environmental science. Initially, students are asked to submit brief synopsis of the proposed work. Allotment of supervisor and final topics are selected based on facilities available in the department and based on possibilities of scientific work. Students are also free to have collaborative work and can choose a supervisor outside college. It is advised that students should have combination of external and internal supervisor after consultation with departmental staff member. Students can also start their project work at the start of year. An innovative topic, problem solving approach and originality in the work is expected. Students can select experienced teachers / experts / scientists of other reputed institutions. 'Acceptance Certificate' is required from external supervisor. Exposure and collaborative work is highly encouraged. Strict internal evaluation is carried out through six months while for final presentation and assessment of submitted reports, external supervisors are invited. The final report is prepared as per standard format which includes 'Completion Certificate' and 'Declaration' regarding originality of the content and work done by the student.



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### **Syllabus for T.Y.B. Sc. Environmental Science 2023-24 (CBCS –**

#### **Autonomy 21 Pattern)**

|                            |                         |
|----------------------------|-------------------------|
| <b>Course/ Paper Title</b> | On Job Training Program |
| <b>Course Code</b>         | 23SBEV6OJT              |
| <b>Semester</b>            | VI                      |
| <b>No. of Credits</b>      | 2                       |

### **Syllabus**

The Department of Environmental Science offers on-job training programs, particularly through collaboration with its Advanced Scientific Research Laboratory (ASR). These programs aim to equip students with practical skills and industry knowledge, enhancing their employability.

### **On-the-Job Training (OJT) Program in Environmental Science**

#### **Introduction**

The On-the-Job Training (OJT) program in Environmental Science is designed to provide practical, hands-on experience for students and professionals in the field of environmental science. This training program focuses on building essential skills and knowledge that bridge the gap between academic learning and the real-world application of environmental science principles. Participants will be involved in various tasks and projects that align with current environmental issues, regulations, and best practices in the industry.

#### **Objective**

The primary objective of the OJT program is to equip participants with the ability to assess, analyze, and develop solutions for environmental challenges. The program emphasizes the integration of theoretical knowledge with practical work, helping trainees to develop a comprehensive understanding of environmental protection, sustainability, and conservation. It also aims to enhance skills related to environmental monitoring, data analysis, policy formulation, and environmental risk management.

#### **Key Components of the Program:**

##### **1. Site Assessment and Monitoring:**

Trainees will gain experience in conducting environmental site assessments, collecting samples, and performing

field studies. This includes water, soil, and air quality assessments. Participants will also learn how to use specialized equipment for data collection and analysis.

2. **Environmental Impact Assessments (EIA):**

A critical component of the program is learning how to conduct Environmental Impact Assessments. Trainees will understand the procedures for evaluating the potential impacts of industrial, commercial, or infrastructural projects on the environment. This includes the identification of potential risks and proposing mitigation strategies.

3. **Data Collection and Analysis:**

Data is the cornerstone of environmental science. During the OJT program, participants will work with various forms of environmental data, learning how to analyze and interpret findings to support decision-making processes in environmental management.

4. **Sustainable Practices and Conservation:**

The program also focuses on sustainable environmental practices, promoting conservation efforts and resource management. Trainees will get hands-on experience with projects related to waste management, energy conservation, water conservation, and sustainable agriculture.

5. **Policy and Regulatory Framework:**

Environmental policy and regulation play an essential role in addressing environmental issues. As part of the OJT, trainees will be exposed to the legal and regulatory frameworks that govern environmental practices, learning about laws such as the Clean Water Act, Clean Air Act, and various local regulations.

6. **Risk Management and Mitigation:**

Environmental risk management is a critical part of the program. Trainees will learn to identify environmental risks, assess their severity, and develop strategies to mitigate or prevent harm to ecosystems and human populations.

**Learning Outcomes:**

By the end of the OJT program in Environmental Science, participants should be able to:

- Demonstrate the ability to conduct environmental assessments and recommend appropriate actions.
- Use data collection tools and techniques to gather and analyze environmental data.
- Understand and apply environmental laws and policies to real-world scenarios.
- Contribute to sustainable environmental practices and solutions in various sectors.
- Communicate effectively with stakeholders and decision-makers regarding environmental issues.

**Duration and Structure:**

The OJT program typically lasts between 6 to 12 months, depending on the specific focus and the organization. The structure of the program is usually divided into both fieldwork and office-based tasks, allowing for a well-rounded experience. During the fieldwork phase, trainees will be involved in on-site environmental assessments, sample collection, and site visits. In the office-based phase, participants will analyze data, prepare reports, and contribute to project planning.

**Supervision and Mentorship:**

Throughout the program, trainees will be under the supervision of experienced environmental scientists and professionals. Mentors will provide guidance, feedback, and support to ensure the successful development of skills and competencies.

**Conclusion:**

The On-the-Job Training program in Environmental Science is an invaluable opportunity for individuals to gain practical experience and enhance their skills in a field that is crucial for the protection of the planet. Through exposure to real-world challenges and opportunities, participants will be well-prepared for careers in environmental science and contribute to the sustainability and well-being of the environment for future generations.



Design the solar power system • Decide the Photovoltaic system components to be installed • Finalise the plan and arrange for installation • Supervise the installation activity • Report and document completion of work • Ensure quality and safety procedures are followed

After completing this programme,

participants will be able to:

- Gain knowledge about Life Sciences Industry, Legal and Regulatory framework and Pharmacopeia to enable him/herself for establishing the Industry Standards in his/her performance
- Gain Scientific knowledge and skills about application of Basics of Chemistry, chromatography and separation science in instrumental analysis of Pharmaceutical Products as well as gain Procedural Knowledge and Quality skills for Sample Preparation and Sample Handling and Skills to perform Quality Check (Inspection and Analysis), to enable him/herself able to perform routine analysis in lab while ensuring compliance with GDP, GMP & GLP and organizational SOP
- Gain Knowledge of basic statistics and hands on Knowledge of various statistical tools and techniques to perform statistical analysis of QC results in lab while ensuring compliance with GDP, GMP & GLP and organizational SOP
- Operate analytical Equipment and Instruments like Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Fourier TransferInfrared (FT-IR), Inductively Coupled Plasma (ICP), Auto-Titration, UV-Visible mass spectrophotometer detection, stability chambers, BOD incubators, Photoflourometer
- Perform routine analysis in lab while ensuring compliance with GMP & GLP and carry out Quality Checks in the Quality Control process
- Follow the norms of Good Documentation Practice, online documentation system, various SOP's and reporting formats, GMP/ GLP guidelines relating to the required information capturing, reporting and documentation to meet the quality standards.
- Gain Knowledge of QMS for Quality Control, norms for global standards like cGMP, ISO, GLP, GDP. Skills to operate a Laboratory Management Information System
- Carryout reporting and documentation as per quality standards and SoPs

Participate in audits as a QC team member and generate the responses for audit queries. Ability to deal with potential risks and challenges for quality and data integrity.

- Maintain a healthy, safe and secure working environment at the pharmaceutical manufacturing shop floor, Laboratory and area around as per EHS requirement and Industrial practices. He/ she become capable of managing emergency procedures.
- Ensure routine maintenance and cleanliness at work area.
- Coordinate and support with Supervisor, cross functional teams and within the team for various functional activities
- Practice Professional Skills at work; like Decision Making, Planning & Organizing, Customer Centricity, Problem Solving (including trouble shooting), Analytical Thinking, Critical Thinking



