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# TAMIL UNIVERSITY

## Thanjavur, Tamil Nadu – 613 010

**(Reaccredited with 'B$^{+}$' grade by NAAC)**

## DEPARTMENT OF ENVIRONMENT AND HERBAL SCIENCE

# M.Sc. - ENVIRONMENTAL SCIENCE

## (Choice Based Credit System)

## Duration of the Course: 2 Years

## OBE Model Syllabus

***(Effective from the academic year 2020-21 and thereafter)***

**M. Sc. ENVIRONMENTAL SCIENCE**

**OBE REGULATIONS AND SYLLABUS**

(With effect from the academic year 2020-2021 onwards)

## 1. Preamble

Growing populations and high standards of living put increasing pressure on our environment. Since the beginning of industrialization and urbanization, we have been facing with an increasing number of environmental challenges such as air, water and soil contamination, energy crisis, land degradation, deforestation, loss of biodiversity, global warming and climate change, etc., Considering the above issues, addressing environmental problems from a scientific perspective is utmost important for today's world. So, there is a need to develop the next generation as skilled professionals in a multidisciplinary Environmental Science programme to solve the environmental issues.

## 2. General Graduate Attributes

### *2.1. Environmental Knowledge*

Apply the basic knowledge of environmental components and its interactions and to conceptualize the domains towards environmental protection and to visualize the environmental management perspectives.

### *2.2. Critical Thinking Skills*

To analyze and evaluate critically, the issues related to the environment, and biosphere and pollution related issues and delineating the possible factors for environmental sustainability.

### *2.3. Research Skills*

Improve the research-oriented skills by involving into the specific need-based research works and thereby enhancing the research-oriented work environment.

### *2.4. Problem Solving Skills*

Identify, analyze and assess the complex environmental issues and to apply the knowledge to solve the issues.

### *2.5. Environment Management*

To improve oneself to undertake and manage environment related works and to develop a leadership quality and capacity to manage a team for carrying out assigned or specific tasks.

### *2.6. Technical Skills*

To acquire and equip oneself with technical knowledge on critical environmental problems and to devise technical strategies for the betterment of the environment.

### *2.7. Use of Modern Tools*

To acquire the knowledge and working experience on modern tools in terms of instrumentation, softwares and research methods which can be used to assess the environmental quality.

### *2.8. Project Management*

To manage and coordinate specific environmental work, tasks or projects and to apply specific principles and methodologies to carry out environmental project works.

### *2.9. Societal and Environmental Concern*

To have appealing concern over the environment and its well-being, and to apply the acquired knowledge and skills for the societal upliftment and for sustainable environment.

### *2.10. Individual and Team Work*

To develop the skill of working individually and to be a part of a team as an effective team member or a leader of the team in order to manage projects related to environment.

### *2.11. Innovation and Entrepreneurship*

To develop skills of innovation and entrepreneurship in the field of environmental technology to initiate small scale start-ups and upscale the process towards entrepreneurship**.**

## 3. Programme Specific Qualification Attributes

### *3.1 Knowledge and understanding level (L1 and L2)*

Students can understand the fundamentals of ecology, environment, biodiversity and natural resources their process for sustainable development. The students can understand the basics of pollutant and their toxic effects.

### *3.2 Application level (L3)*

Students will be capable of applying microbes for potential environmental cleanup and green energy production, and to generate value-added products through waste recycling.

### *3.3 Analytical level (L4)*

Students can analyze the environmental parameters of each and every aspects of and biochemical reaction in animals including human being.

### *3.4 Evaluation capability level (L5)*

Students can acquire the capability of evaluating the responsible factors for any kind of environmental related issues and can be able to apply the acquired knowledge in providing solutions to the environmental problems.

### *3.5 Scientific or synthesis level (L6)*

Students will be able to synthesize or develop new processes or products or to formulate new scientific tools related to environment.

## 4. Vision

• Creating and Maintaining Excellence in Environmental Science and contributing our knowledge and effort in bringing up rich posterity.

## 5. Programme Objectives and Outcomes

### 5.1 Programme Educational Objectives (PEOs)

Post graduate of M.Sc. Environmental Science program will be

| | |
|---|---|
| PEO1 | Utilizing domain knowledge to understand the environment and to provide solutions for the development of society. |
| PEO2 | Applying research and acquired skills with a rich set of communication and leadership skills to sustain in the environment. |
| PEO3 | Expressing constant development in their specialized career through life-long learning, appreciating human values and ethics. |

### 5.2 Programme Outcomes (PO)

After successful completion of the two years M.Sc. Environmental Science Programme, the students are expected to have

| | |
|---|---|
| PO1 | Deep knowledge in natural resources, ecosystem and their biogeochemical processes, biodiversity, GIS and their importance, various elements of climate change and environmental clearance procedures. |
| PO2 | Good understating in properties of environmental pollutants and their impact on environment, occupational diseases, nanomaterials and their toxicity. |
| PO3 | Capability in applying microbes for potential environmental cleanup and energy production, and to generate value added products through waste recycling and other sustainable environmental management practices. |
| PO4 | Acquire more knowledge and skills in methods used for EIA studies, auditing, remote sensing and Geographic Information Systems to monitor the pollution, environmental issues and critically analyzing the global climate change issues. |
| PO5 | Expertise to become as environmental consultants / managers at local, regional and national levels industries / institutions /organizations. |
| PO6 | Capability to become an entrepreneur in the field of EIA, waste management and waste recycling, natural product, environmental safety trainer. |
| PO7 | Qualification to be employed as a researcher / scientist / faculty in colleges / universities / Research organizations. |

**6. Candidate's eligibility for admission**

Candidate who has passed the B.Sc. degree in any Life Sciences including Environmental Science/ Environmental Management/ Microbiology/ Applied Microbiology/ Industrial Microbiology/ Botany/ Plant Sciences and Plant Biotechnology/ Zoology/ Animal Science/ Applied Animal Science and Animal Biotechnology/ Biochemistry/ Bioinformatics/ Biology/ Life Sciences/ Home Science/ Food Science & Nutrition/ BSMS/BAMS/BUMS/ Chemistry with Botany/ Zoology as Allied Subjects of any University accepted by the Syndicate as equivalent there to shall be eligible for admission to M.Sc. Degree Course in Environmental Sciences.

**7. Duration and pattern**

Two Years and Semester Pattern

| | |
|---|---|
| Semester I | July – November |
| Semester II | January – May |
| Semester III | July – November |
| Semester IV | January – May |

**8. CBCS- Structure of the Programme**

The programme structure comprises of two parts.

| **Course Component** | **No. of Courses** | **Hours of Learning** | **Marks** | **Credits** |
|---|---|---|---|---|
| **Part A (Credit Courses)** | | | | |
| Core Courses | 11 | | 1100 | 50 |
| Elective Courses | 3 | | 300 | 12 |
| Supportive Courses | 3 | | 300 | 9 |
| Lab Course | 3 | | 300 | 15 |
| Research Project | 1 | | 150 | 6 |
| Field visit | 1 | - | 50 | 2 |
| Total | 22 | | 2200 | 94 |
| **Part B (Self-Learning Credit Courses)** | | | | |
| Industry oriented course | 1 | 18 hrs | 100 | 2 |
| **Total** | **23** | | **2300** | **96** |

**9. Examinations**

Examinations are conducted in semester pattern. The examination for the Semester I & III will be held in November/ December and that for the Semester II and IV will be in the month of April/ May. Candidates failing in any subject (both theory, practical skill) will be permitted to appear for such failed subjects in the same syllabus structure at subsequent examinations within next 5 years. Failing which, the candidate has to complete the course in the present existing syllabus structure.

**10. Scheme for Evaluation and Attainment Rubrics**

Evaluation will be done on a continuous basis and will be evaluated three times during the course work. The first evaluation will be in the 8th week, the second in the 16th week and the end – semester examination in the 19th week. Evaluation may be by objective type questions, short answers, essays or a combination of these, but the end semester examination is a University theory examination with prescribed question paper pattern.

***10.1 Attainment Rubrics for Theory Courses***

Internal (Max. Marks - 25)

| Attendance | Seminar | Assignment | Cycle Test | Total |
|---|---|---|---|---|
| 5 | 5 | 5 | 10 | 25 |

External (Max. Marks - 75)

| Question Paper Pattern (Theory) Section | Approaches | Mark Pattern | L Level |
|---|---|---|---|
| A | One/ two lines or one line (Answer all questions) | 20 x 1 = 20 (Multiple Choice Questions) | L1, L2 |
| B | 150 to 200 words (Answer all questions - either or) | 5 x 5 = 25 (Essay type questions) | L3, L4 |
| C | 400 to 500 (Answer any three out of five questions) | 3 x 10 = 30 (Essay type questions) | L5, L6 |

**Attainment Rubrics for Lab Courses**

***Internal*** *(Max. Marks - 40)*

| Attendance | Practical Test | Observation Note | Periodical Performance | Total Marks |
|---|---|---|---|---|
| 5 | 20 | 5 | 10 | 40 |

***External** (Max. Marks - 60)*

| Major Experiment | Minor Experiment | Spotters | Record | Viva-Voce | Total Marks |
|---|---|---|---|---|---|
| 20 | 15 | 15 | 5 | 5 | 60 |

***Attainment Rubrics for Research***

| | |
|---|---|
| *Internal (Max. Marks - 50)* Periodical Review and Results Presentation | 50 Marks |
| *External (Max. Marks - 100)* Vivo-Voce Presentation | 25 Marks |
| Dissertation | 75 Marks |

**Passing Minimum**

- For **internal assessment**, passing minimum shall be of **50%** (Fifty Percentage) of the maximum marks prescribed for the respective paper.
- For **external examination**, passing minimum shall be of **50%** of the maximum marks prescribed for the paper.
- In the aggregate (External + Internal) **the passing minimum shall be of 50%** (50 out of 100 marks) for each paper/ practical/ project and viva-voce.
- Grading shall be based on overall marks obtained (internal + external).

**11. Grading System**

Evaluation of performance of students is based on ten-point scale grading system as given below.

| **Ten Point Scale** | | | |
|---|---|---|---|
| **Grade of Marks** | **Grade points** | **Letter Grade** | **Description** |
| 90-100 | 9.0-10.0 | O | Outstanding |
| 80-89 | 8.0-8.9 | D+ | Excellent |
| 75-79 | 7.5-7.9 | D | Distinction |
| 70-74 | 7.0-7.4 | A+ | Very Good |
| 60-69 | 6.0-6.9 | A | Good |
| 50-59 | 5.0-5.9 | B | Average |
| 00-49 | 0.0 | U | Re-appear |
| ABSENT | 0.0 | AAA | ABSENT |

## Table of Courses

| பருவம் Semester | பா.கு.எண் Course Code | பாடத்தலைப்பு Course Title | கற்பித்தல் அளவன் Credits | கற்பித்தல் நேரம் Teaching Hours | மதிப்பெண் Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | அக மதிப்பெண் Internal Mark | புற மதிப்பெண் External Mark | மொத்த மதிப்பெண் Total Marks |
| பருவம் 1 Semester 1 | MES4111 | Core – 1 **Fundamentals of Environmental Sciences** அடிப்படைச்சூற்றுச்சூழல் அறிவியல் | 5 | 5 | 25 | 75 | 100 |
| | MES4112 | Core – 2 **Environmental Microbiology Biotechnology and Toxicology** சுற்றுச்சூழல் நுண்ணுயிரியல், உயிர் தொழிற்நுட்பவியல் மற்றும் நச்சியியல் | 5 | 5 | 25 | 75 | 100 |
| | MES4113 | Core – 3 **PRACTICAL – 1** செய்முறை பயிற்சி – I | 5 | 5 | 40 | 60 | 100 |
| | MES4114 | Core – 4 **Environmental Chemistry** சுற்றுச்சூழல் வேதியியல் | 4 | 4 | 25 | 75 | 100 |
| | EES4131 | Elective –1 **Bio-Statistics and Computer Application** உயிர் புள்ளியியல் மற்றும் கணினி பயன்பாடு | 4 | 3 | 25 | 75 | 100 |
| | SES4121 | Supportive – 1 | 3 | 3 | 25 | 75 | 100 |
| | | **Sub-Total** | 26 | 25 | | | 600 |
| பருவம் 2 Semester 2 | MES4211 | Core – 5 **Energy Resources and its Sustainability** ஆற்றல் வளங்கள் மற்றும் நிலைத்தன்மை | 5 | 5 | 25 | 75 | 100 |
| | MES4212 | Core – 6 **Environmental Pollution** சுற்றுச்சூழல் மாசுபாடு | 5 | 5 | 25 | 75 | 100 |
| | MES4213 | Core – 7 **PRACTICAL - 2** செய்முறை பயிற்சி -II | 5 | 5 | 40 | 60 | 100 |
| | MES4214 | Core – 8 **Environmental Impact Assessment** சுற்றுச்சூழல் தாக்க மதிப்பீடு | 4 | 4 | 25 | 75 | 100 |
| | EES4231 | Elective – 2 | 4 | 3 | 25 | 75 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Remote Sensing and Geographical Information System**<br>தொலை உணர்வு **மற்றும் புவி தகவலமைப்பு** | | | | | |
| | SES4221 | Supportive - 2 | 3 | 3 | 25 | 75 | 100 |
| | | **Sub-Total** | 26 | 25 | | | 600 |
| **பருவம் 3 Semester 3** | MES4311 | Core –9<br>**Environmental Engineering**<br>**சுற்றுச்சூழல் பொறியியல்** | 5 | 5 | 25 | 75 | 100 |
| | MES4312 | Core – 10<br>**Research Design and Instrumental Methods**<br>**ஆய்வு வடிவம் மற்றும் ஆய்வு உபகரணங்களின் பயன்பாடு** | 5 | 5 | 25 | 75 | 100 |
| | MES4313 | Core –11<br>**PRACTICAL - 3**<br>செய்முறை பயிற்சி –III | 5 | 5 | 40 | 60 | 100 |
| | MES4314 | Core –12<br>**Waste Management**<br>**கழிவு மேலாண்மை** | 4 | 4 | 25 | 75 | 100 |
| | EES4331 | Elective –3<br>**Disaster Management**<br>**பேரிடர் மேலாண்மை** | 4 | 3 | 25 | 75 | 100 |
| | SES4321 | Supportive - 3 | 3 | 3 | 25 | 75 | 100 |
| | | **Sub-Total** | 26 | 25 | | | 600 |
| **பருவம் 4 Semester 4** | MES4411 | Core - 13<br>**Environmental laws and policies**<br>**சுற்றுச்சூழல் சட்டங்கள் மற்றும் கொள்கைகள்** | 4 | 4 | 25 | 75 | 100 |
| | MES4412 | Core – 14<br>**Environmental Management and Sustainable Development**<br>**சுற்றுச்சூழல் மேலாண்மை, நிலைத்த நீடித்த வளர்ச்சி** | 4 | 4 | 25 | 75 | 100 |
| | MES4441 | **Internship Work**<br>**களப்பணி** | 2 | - | - | 50 | 50 |
| | MES4451 | **Project work**<br>**ஆய்வுத் திட்டப்பணி** | 6 | 15 | 50 | 100 | 150 |
| | | **Sub-Total** | 16 | 23 | 50 | 100 | 400 |
| | MES4442 | **Industry Oriented course** | 2 | - | - | 100 | 100 |
| | TOTAL | | **96** | **98** | | | **2300** |

## SEMESTER – I

## Core - 1: Ecology and Biodiversity Conservation

### 1.1 Course Objectives

The purpose of this course is to gain an understanding of the value of Scope and Importance of Environmental Science. Biodiversity and drivers of its loss; current efforts to conserve biodiversity on global, national and local scales; practical issues with local conservation and organizations, policies and programmes for sustainable management of bioresources.

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Course Outcomes | Unit |
|---|---|---|
| **CO1** | Understand the definition, concepts of Environmental Science and Components of the environment | I |
| **CO2** | Know about ecology and ecosystem of the environment and Biodiversity and its types | II |
| **CO3** | Understand the biodiversity conservation and its types | III |
| **CO4** | Applications of Conservation Genomics and technology | III |
| **CO5** | Study about structure and management of bioresources | IV |
| **CO6** | Know more knowledge about sampling and assessment of flora and fauna | V |

### 1.3 Mapping Scheme

The mapping of course outcomes with programme outcomes is tabulated as follows

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | H | L | L | L | H | M | H |
| CO2 | H | L | - | - | H | L | H |
| CO3 | H | L | L | L | H | M | H |
| CO4 | M | - | - | - | M | - | L |
| CO5 | H | - | - | - | M | L | M |
| CO6 | M | - | - | - | L | L | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Ecology and Biodiversity Conservation)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Components of the environment | Environmental Science - Definition, Scope and Importance. Components: Atmosphere, Hydrosphere, Lithosphere and Biosphere – Structure and composition. | 8 |
| II | Ecosystem and Biodiversity | Ecology: Types of ecosystem – Terrestrial and Aquatic ecosystems - Ecological pyramids - Food Chain - Food Web - Energy flow – Biodiversity - Types of Biodiversity: Species, Genetic and Ecosystem diversity – Alpha, beta, and gamma diversity | 8 |
| III | Conservation Strategies of Biodiversity | *In-situ* conservation: Afforestation, Social Forestry, Agro-forestry, Zoos, Biosphere Reserves, National Parks, Sanctuaries, Protected Area Network, Sacred Groves and Sthalavrikshas – *Ex-situ* conservation: Botanical gardens, Cryopreservation, Gene Bank, Seed Bank, Pollen Bank, Sperm Bank, cDNA Bank - Conservation Genomics: Environmental DNA (eDNA) for wildlife biology and biodiversity monitoring, Next Generation Sequencing (NGS) Techniques, DNA barcodes, Transcriptome and Epigenome tools, CRISPR based gene drives | 12 |
| IV | Sustainable Management of Bioresources | Physical Structure: - structure, stratification; Biological structure: Species richness, Species diversity, Abundance, Dominance, Frequency, Importance value, Keystone species; Community characteristics: guild, ecotone, edge effect, ecological niche, ecological equivalents, and ecological succession. | 12 |
| V | Plant & animal populations | Qualitative assessment – Floristic composition, stratification; Quantitative assessment Frequency, density, abundance, cover and basal area; Sampling phytoplankton and periphyton; Sampling animal populations. | |

## 1.5 REFERENCE

### 1.5aText books


1. Agarwal KC (2002). Global Biodiversity. Nidhi Publishers, Bikaner. 686 pages.
2. Clarke GL (2003) Elements of Ecology. John Wiley, London.560 pages.
3. Odum Eugene P (1971).Fundamentals of Ecology. W.B. Saunders Co.Philadelphia and London. 574 pages.
4. Sharma PD (2003).Ecology and Environment. Rastogi Publication, Meerut.
5. Mishra PC and Trivedy RK (1994).Ecology and Pollution of Indian Lakes and rivers. Enviromedia, Karad.


### 1.5b Reference books


1. Singh JS, Singh SP and Gupta SR, Ecology, Environment and Resource Conservation (2006). Anamaya Publisher, New Delhi.
2. Verma PS and Agarwal VK, Environmental Biology: Principles of Ecology (2015). S Chand & Company Pvt Ltd.
3. Chapman JL and Reiss MJ, Ecology-Principles and applications (1995). Cambridge University Press.


### 1.5c Web sources

1. https://libguides.brighton.ac.uk/ecology/webresearch
2. https://projects.ncsu.edu/cals/course/fw353/Estimate.htm#:~:text=In%20practice%2C%20population%20estimates%20are,%2C%20and%20mark%2Drecapture%20methods
3. https://www.questia.com/library/science-andtechnology/environmental-and-earth-sciences/ecology

## Core- 2: ENVIRONMENTAL MICROBIOLOGY, BIOTECHNOLOGY AND TOXICOLOGY

### 1.1 Course Objectives

- To learn the basic knowledge about Microbiology
- To know the role of microbes and microbial interactions in soil and air
- To understand the bioremediation and application to Environmental pollution
- To learn the basic knowledge about toxicology
- Apply the Biotechnology tools for clean environment to clean the environment

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Course Outcomes | Unit |
|---|---|---|
| **CO1** | Able to understand about microbes and culture preparation | I |
| **CO2** | Understand the role of microbes in pollution and treatment of wastes | II |
| **CO3** | Apply the Biotechnology tools for clean environment and hazardous wastes using bioremediation | III |
| **CO4** | Know about origin, classification of Toxicology, Toxicants in the environment, levels of toxicity | IV |
| **CO5** | Study on major toxicants, Bioaccumulation, biomagnification and Biotransformation | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | L | M | L | L | H | L | M |
| CO2 | H | M | - | - | M | - | L |
| CO3 | L | L | M | M | H | M | H |
| CO4 | M | H | L | - | - | - | L |
| CO5 | L | - | L | L | H | L | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental Microbiology, Biotechnology and Toxicology)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Introduction to Microbiology | Ultra structure of Prokaryotic and Eukaryotic cell – Sterilization techniques used in microbiology - Preparation of media for isolation and culture of microorganisms - Microbial growth and multiplication of bacteria, virus and fungi – Nature of virulence, toxins, extra cellular enzymes of pathogenic bacteria. | 7 |
| II | Applied Microbiology | Microbial air pollutants – Bioaerosols, Aero allergen, Water pollution: Sources and nature of pollutants in water. Assessment of microbiological quality of water - MPN technique. Domestic solid (compost) and liquid waste treatment – Eutrophication. Microbial conversion of solid waste to food (Mushroom, SCP), fuels (Biogas, Ethanol). | 7 |
| III | Environmental remediation Bioremediation | Bioremediation- Biotechnology for clean environment- Bioindicators and biosensors for detection of pollution- Biotechnology for hazardous waste management, Persistent organic pollutants, Xenobiotics, Biological Detoxification of PAH, Biotechniques for Air pollution control- Indian GMOs. | 10 |
| IV | Toxicology | Toxicology – Definitions, Classification, Origin and General Nature of Toxicants in Environment, Basic Probit analysis, concepts – Toxicants – Toxicity - Acute, sub acute, chronic, dose effect, LD50, LC50 and response safe limits, Dose response relationship - graphs, concentration response relationship, Safe Limits. | 10 |
| V | Mechanism and Toxicology | Bioaccumulation and Biomagnifications of toxic materials in food chain, Types, mechanism and Toxicology of major pollutants, Biotransformation, biomonitoring, concept of bioindicator groups and examples. | 10 |

## 1.5 References

### 1.5a Text Books


1. Dubey and Maheshwari, (1999), A text book of Microbiology, 1/e, Chand publications, New Delhi.
2. Mohapatra P K (2008). Text Book of Environmental Microbiology, I K International Publishing House Limited.
3. Michael J. Pelczar, Microbiology (2010). Tata McGraw-Hill.
4. Casida LE, Industrial Microbiology (2015). New Age International, PJ Limited, Publisher.
5. Singh DP and Dwivedi SK, Environmental Microbiology and Biotechnology 1st Ed. (2004). New Age International (P) Ltd., Publishers, New Delhi.
6. Klassen CD and Watkins JBIII, Casarett and Doull's, The Basic Science of Poisons Companion Handbook, Toxicology 6th Ed (2001). McGraw-Hill, New York.


### 1.5b Reference Books


1. Brock TD, Madigan MT, Martinko JM and Parker J (1994) Biology of Microorganisms, VII Ed., Prentice-Hall, New Jersy, USA.
2. Ronald M. Atlas and Richard Bartha, (1997). Microbial Ecology, 4/e, Benjamin Cummings Publishing company, USA.
3. Crawford RL and Crawford DL, Bioremediation–Principles and applications (1996) Cambridge University Press.
4. Tortora GJ, Funke BR, Case CL, Microbiology (2014). Pearson Publishers.
5. Glazer AN and Nikaido H, Microbial Biotechnology (1995), WH Freeman and Company, New York, USA.
6. Glick BR and Pastemak JJ, Molecular Biotechnology: Principles and Applications of Recombinant DNA (1994). ASM Press. Washington, DC USA.
7. Rajendran P and Gunasekaran P, Microbial Bioremediation (2006), MJP Publishers, Chennai.


### 1.5c Web sources


1. https://micro.magnet.fsu.edu/cells/bacteriacell.html
2. https://www.grains.kstate.edu/spirel/docs/research/heatipm/presentations/Thermal%20death%20kinetics.pdf
3. https://www.bgr.bund.de/EN/Themen/Min_rohstoffe/Biomining/biomining_node_en.html
4. https://acsess.onlinelibrary.wiley.com/doi/full/10.2134/csa2017.62.1202
5. https://www.ncbi.nlm.nih.gov/books/NBK554776/

## Core- 4: ENVIRONMENTAL CHEMISTRY

### 1.1 Objectives

• To impart the basic and fundamental knowledge of chemical principles governing the reactions of the environment (in various spheres).

• To make the students understand the chemical reactions taking place in natural environment and their interrelationships.

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Course Outcomes | Unit |
|---|---|---|
| **CO1** | Apply the basic concepts to prepare solutions in different concentration units used in chemical analysis. | I |
| **CO2** | Categorize the importance of atmospheric gases and Compare thermochemical and photochemical reactions in the atmosphere | II |
| **CO3** | Determine the properties and chemical reactions of water and water quality | III |
| **CO4** | Estimate properties of soil and evaluate the soil quality. | IV |
| **CO5** | Explain various biochemical reactions involved in living organisms. | V |

### 1.3 Mapping Scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | - | L | - | - | M | - | H |
| CO2 | M | H | - | M | M | - | M |
| CO3 | L | H | L | M | L | L | H |
| CO4 | - | L | - | M | L | L | H |
| CO5 | L | - | - | - | M | - | M |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental Chemistry)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Fundamentals of Environmental Chemistry | Environmental Chemistry: Definition and explanation of various terms Scope – Molarity, molality, normality and percent solutions, stock and standard solution preparation. Stoichiometry, Gibb's Energy, chemical potential, chemical equlibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, radionuclide's | 10 |
| II | Atmospheric Chemistry | Atmospheric layers - Classification of elements, chemical speciation, particles, ions and radicals in the atmosphere - Chemical processes for formation of inorganic and organic particulate matter. Thermo chemical and photochemical reactions in the atmosphere - Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog. | 12 |
| III | Water Chemistry | Formation of water, unusual physical properties, hydrogen bonding in biological system, unusual solvent properties, changes in water properties by addition of solute - Chemical reactions in aquatic environment; Concept of oxygen demand - DO, BOD, COD; TDS, pH, conductivity – Colloids – Salinity - Chemical speciations in aquatic environment - Role of water in the environment – Hydrological cycle . | 12 |
| IV | Soil Chemistry | Chemical composition of earth, metals, minerals, fossil fuels and soils Physico-chemical characteristics of soil, soil air, soil clays, organic carbon, soil humus and mineralization, cation exchange capacity, soil water solution, Nitrogen pathways, C/N ratio, soil acidity and salinity | 12 |

| | | | |
|---|---|---|---|
| V | Biochemistry | Classification and functions of carbohydrates, proteins and lipids. Metabolism - Glycolysis, Citric acid cycle, Electron transport, Oxidative phosphorylation and regulation of ATP production. Photosynthetic pathway. | 12 |

## 1.5 References

### 1.5a Text Books


1. De, A.K. (2007) Environmental Chemistry, Seventh Edition, New Age International Publishers.
2. Sharma, B.K and H. Kaur, (1994) Environmental Chemistry, Goel Publishing House Ltd., Meerut, UP.
3. Banerji SK, Environmental chemistry (2002). Prentice-Hall of India Private Limited, New Delhi.


### 1.5b Reference Books


1. Balram Pani, (2007) Text Book of Environmental Chemistry, I.K. International Publishing House PVT. Ltd.
2. Manahan, S.E. (2010), Environmental Chemistry, Ninth Edition, CRC Press.
3. Dara, S.S and D.D. Mishra (2009) A Text Book of Environmental Chemistry and Pollution Control, 10th edition, S. Chand & Company.
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5. Cunningham P, Cooper H, Eville G and Hepworth MT, Environmental Encyclopaedia (1999). Jaico Publishing House, Mumbai.
6. Don S, Essentials of Physical Chemistry (2011). CRC Press. ISBN: 9781439896938.
7. Johnson DO, Netteville JT, Wood JC and James M, Chemistry and the Environment (1973). W.B. Saunders Co., Philadelphia.


### 1.5c Web Sources

1. https://learn.careers360.com/chemistry/some-basic-concepts-in-chemistrychapter/
2. http://www.uigi.com/air.html
3. http://www.chem1.com/acad/pdf/c3redox.pdf
4. https://byjus.com/physics/air-composition-properties/
5. https://onlinelibrary.wiley.com/doi/full/10.1002/9781119300762.wsts0025
6. https://www.acs.org/content/acs/en/greenchemistry/what-is-greenchemistry.html

# Elective-1: Biostatistics and Computer Applications

## 1.1 Course Objectives

• To teach the basic concepts of statistics and its role as an important tool in arriving at conclusions in biology and environment.

• To introduce the students, the basic methods of using computer and applying them in computing / analyzing the environmental data and solving the environmental issues.

## 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Course outcomes | Unit |
|---|---|---|
| CO1 | Easy understanding on basic computer and its functions | I |
| CO2 | Get knowledge on statistics, data collection, data processing and tabulation, graphical representation of data | II |
| CO3 | Acquire the knowledge on descriptive statistics and apply to the large data | III |
| CO4 | Have an idea to apply the statistical tool like correlation and ANOVA | IV |
| CO5 | To get clear knowledge in types of computer applications to use in biological data and testing hypothesis | V |

## 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | L | - | - | L | L | H | M |
| CO2 | M | - | - | M | M | H | H |
| CO3 | - | M | - | - | M | H | H |
| CO4 | - | | - | - | | M | M |
| CO5 | L | M | - | L | M | M | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Biostatistics and Computer Applications)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Introduction to computer | History of Computer; character and organization – types and generation of computer. Hard ware and Software: Types of memory; primary (RAM, ROM, PROM, EPROM, EEPROM) and secondary (Floppy, hard disc, eband DVD), video terminal, OMR, OCR, Printers and scanners Operating system | 8 |
| II | Introduction to Statistics | Scope, limitations of statistics, statistical method and experimental method. Collection of data, sampling, classification and tabulation of data. Diagrammatic & graphic presentation of data. Information technology: Information Types, needs, data processing. Computer application in Environmental Studies. | 10 |
| III | Descriptive statistics | Introduction, measure of central location, mean, median, mode, measure of shapes. Properties of mean, measure of spread, variance and standard deviation, co-efficient of variation. Sampling theories and Hypothesis testing, techniques and experimental designs. Testing hypothesis: Significance level and $X^2$ test, t and F test. | 10 |
| IV | Correlation and ANOVA | Data sheet and data management. Analysis of variance: One way and two way ANOVA, Regressions: Defining the fit, Correlation, Calculation of correlation and regression. | 10 |
| V | Computer applications and biostatistics | Tabulation of data. Graphical presentation of data; line graph, bar chart, cumulative bar chart, percentage bar, chart, pie chart and three dimensional graphs. Frequency analysis; Univariate and bivariate frequency tables. | 10 |

| | | | |
|---|---|---|---|
| | | Calculation of mean, median and mode. Calculation of modal frequency; grouping table and analysis table. Testing and hypothesis; application of 't' test. | |

## 1.5 REFERENCES

### 1.5a Text Books


1. Bryan FJ, Manly, (2008). Statistics for Environmental Science and Management, Second Edition, ISBN 9781420061475.
2. Ford ED, (2000). Scientific methods for Ecological Research. Cambridge University Press, Cambridge


### 1.5b Reference Books


3. John Schuenemeyer, Larry Drew, (2011). Statistics for Earth and Environmental Scientists.
4. Rosner B, (1986), Fundamentals of Biostatistics, Duxbury Press, Boston
5. Snedecor W and G Cochran, (1967). Statistical Methods. Oxford and IBH Publishing Co. Calcutta.


### 1.5c Web sources

1. https://peda.net/kenya/ass/subjects2/computer-studies/form-1/itc2
2. https://www.learncomputerscienceonline.com/introduction-to-computer-system/
3. http://oms.bdu.ac.in/ec/admin/contents/160_16SNMECA2-16SNMECS2-16SNMEIT1_2020052705350867.pdf
4. https://www.britannica.com/science/statistics
5. https://www.scribbr.com/category/statistics/
6. https://www.analyticssteps.com/blogs/7-types-statistical-analysis-definition-explanation
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037948/
8. https://sccn.ucsd.edu/~arno/mypapers/statistics.pdf

# SEMESTER – II

## Core - 5: ENERGY RESOURCES AND ITS SUSTAINABILITY

### 1.1 Course Objectives

• To impart the basic knowledge of energy sources (both renewable and nonrenewable).

• To instruct the students the importance of conservation of energy and developing green energy technologies.

• To facilitate students to analyze and act locally and legally by developing their skills for critical investigation, bringing together multiple disciplinary perspectives, working with various stakeholders through deep change and become a driving force for sustainability.

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Course outcomes | Unit |
|---|---|---|
| **CO1** | Understand the basic knowledge of natural energy resources | I |
| **CO2** | Knowledge of non-renewable energy resources and its utilization | II |
| **CO3** | Clarity to renewable energy sources and its current scenario | III |
| **CO4** | Production of nuclear energy and bioenergy conversion methods | IV |
| **CO5** | Understanding of sustainable energy usages and green technologies for sustainable development | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | H | - | - | - | M | M | H |
| CO2 | M | - | - | - | H | M | M |
| CO3 | M | - | - | - | H | M | M |
| CO4 | M | - | - | - | H | L | M |
| CO5 | M | - | - | - | H | H | L |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Energy Resources and Sustainability)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Energy sources | Introduction to nexus between Energy, Environment and Sustainable Development; Energy transformation from source to services; Energy sources, sun as source of energy; classification of energy sources, quality and concentration of energy sources; fossil fuel reserves estimates, duration; theory of renewability, renewable resources; overview of global and India's energy scenario | 10 |
| II | Non-renewable Energy Sources | Global Energy crisis - Non-renewable energy sources: Fossil fuels – Composition, Classification, energy content of coal, crude oil and natural gas – Consumption and demands of coal, crude oil and natural gas – Environmental impacts of fossil fuel consumption | 10 |
| III | Renewable Energy Sources | Solar energy, geothermal energy, tidal energy, wind energy - Principals of generation of hydro-electric power - Ocean thermal energy conversion - Energy use pattern in different parts of the world - Management of renewable energy - Present scenario of renewable energy sources in India | 12 |
| IV | Nuclear energy and bioenergy | Nuclear energy - Introduction, nuclear energy sources, fission and fusion, nuclear fuels, Nuclear reactor – principles and types - Impacts of large-scale exploitation of nuclear energy sources. Bioenergy: Methods to produce energy from biomass. Biomass conversion technologies – Biogas generation-classification and types of biogas plants. | 10 |
| V | Green Innovation & Sustainability | Criteria for choosing appropriate green energy technologies, the emerging trends – process/ product innovation technology; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity (WEHAB) – design for sustainability. Future energy Systems - clean/ green energy technologies; International agreements/ conventions on energy and sustainability | 12 |

**1.5 References**

**1.5a. Text Books:**

1. Rai GD, Non-conventional energy sources (2001). Khanna publishers, New Delhi.
2. Murray RL, Nuclear Energy–An Introduction to Concepts (2009). Systems and Applications of Nuclear Processes, 6th ed. Elsevier.
3. Sukhatme SP, Solar Energy (1996). Tata McGraw Hill publishing company Ltd., New Delhi.

**1.5b. Reference books:**

1. Maheswari A and Parmar G, A Text book of Energy, Ecology, Environment and Society, Anmol Publications, New Delhi, 2002.
2. Dunn PD, Appropriate Technology. Macmillan Education limited, 1979.
3. Johnson Gary L, Wind Energy System Prentice - Hall Inc., New Delhi,1985.
4. Trivedi PR and Sudarshan KN, Environment and natural resources conservation, Common Wealth Publishers, New Delhi,1994.

**1.5c. Web Links**

1. https://mnre.gov.in/
2. https://www.ibef.org/industry/renewable-energy.aspx
3. https://www.iea.org/reports/india-energy-outlook-2021
4. http://www.mospi.nic.in/sites/default/files/reports_and_publication/ES/Energy%20Statistics%20India%202021.pdf

## Core - 6: ENVIRONMENTAL POLLUTION

### 1.1 Course Objectives

The purpose of this course is to gain awareness of environmental pollution and an overview of causes and consequences to natural, economic and social systems, to understand the fundamental principles governing the interactions between transports of pollutants in the environment.

### 1.2 Course Outcomes

| CO | Course outcome | Unit |
|---|---|---|
| CO1 | Learn about the various forms of air pollutants, sources and its effects | I |
| CO2 | Have clear understanding on the water pollution | II |
| CO3 | Get knowledge on marine pollution and its impacts | III |
| CO4 | Get exposed to knowledge on soil/ land pollution of the environment | III |
| CO5 | Understand problems of radioactive and noise pollution | IV |
| CO6 | Understand the ill effects of pollution and Create awareness to public on Environmental pollution and its control | |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | L | H | L | M | H | - | L |
| CO2 | L | H | - | M | H | - | M |
| CO3 | L | H | - | M | H | - | M |
| CO4 | L | H | - | M | H | - | M |
| CO5 | L | H | - | M | H | - | M |
| CO6 | - | L | L | L | L | M | |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental pollution)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Air pollution | Types of air pollutants, primary and secondary – particulate and gaseous contaminants - their sources. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model-Introduction. Gaseous pollution control measures. Automobile pollution in India; Particulate matter pollution – $PM_{10}$ and $PM_{2.5}$. Impact of air pollution - vegetation, animals, human beings and materials, Acid rain formation its effects on environment, Greenhouse Effect-Global Warming Stratospheric ozone depletion. Air quality standards. Case study - Photochemical smog in London and Los Angeles; Bhopal gas disaster. | 12 |
| II | Water Pollution | Sources of water pollution, Classification of water pollutants - Oxygen demanding wastes, pathogens, plant nutrients, synthetic organic compounds, inorganic chemicals and mineral substances. Groundwater pollution - Sources and sinks, Purification of water by adsorption, flocculation, ion exchange and reverse osmosis methods. Alternatives of end of pipe treatments, online monitoring of industrial effluents. Water quality standards. Case Study- Minnamata Disaster, Love Canal Disaster. Thermal pollution: Sources and effects. | 12 |
| III | Marine Pollution | Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system, Impact of marine pollution, Oil pollution - sources and effects, Control measures - coastal management. Episode - Torrey Canyon, British Petroleum - Gulf of Mexico oil spill. | 10 |
| IV | Soil Pollution | Properties of soil - Physico-chemical and biological (texture, structure, inorganic and organic components). Movement and sorption mechanisms of organic and inorganic contaminants and their impacts. Sediment Pollution – Black carbon. Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers. | 10 |
| V | Radioactive and Noise Pollution | Radiation - types and units-sources natural and man-made, Effect of radioactive pollution and nuclear explosions. Episode - Chernobyl and Fukusima | 12 |

| | | | |
|---|---|---|---|
| | | Daiichi Nuclear Disaster. Noise pollution: Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, TNI). Noise dose and Noise level standards and impacts of noise pollution. | |

## 1.5 References

### *1.5a Text Books*


1. De, A.K. (2007) Environmental Chemistry, Seventh Edition, New Age International Publishers.
2. Kannan K, Fundamentals of Environmental Pollution (1991). S. Chand and Co., Delhi.
3. Rao MN and Rao HVN, Air Pollution (1989). Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Sharma BK and Kaur H, Soil and Noise Pollution, Water Pollution (1994). Goel Publishing House, Meerut.
5. Malhotra R, Climatology (2010). Global Vision Publishing House, New Delhi.


### *1.5b Reference Books*


1. Manahan, S.E. (2010), Environmental Chemistry, Ninth Edition, CRC Press.
2. Dara, S.S and D.D. Mishra (2009) A Text Book of Environmental Chemistry and Pollution Control, 10th edition, S. Chand & Company.
3. Abbasi SA, Environmental pollution and its control (1998). Cogent international, Pondicherry.
4. Kudesia VP, Air pollution (1997). Pragati publications, Meerut.
5. Das AK, Environmental Chemistry with Green Chemistry (2010). Books and Allied (P) Ltd. Kolkata.
6. Bhatia HS, Environmental pollution and its control (1998). Galgotia Publications (P) Limited, Delhi.


### *1.5c Web Links*

1. https://www.unep.org/beatpollution/global-response-pollution
2. https://www.unep.org/beatpollution/
3. https://in.one.un.org/blogs/five-indian-innovations-to-beat-air-pollution/
4. https://www.ccacoalition.org/sites/default/files/resources/2016_Breathing-Cleaner-Air-Ten-Scalable-Solutions-for-Indian-Cities.pdf
5. https://www.weforum.org/agenda/2019/09/how-technology-can-help-indiabreathe-more-easily/

## Core - 8: ENVIRONMENTAL IMPACT ASSESSMENT

### 1.1 Course Objectives

The purpose of this course is to introduce the methodology of environmental impact assessment (EIA) as a vital tool for sound environmental management and decision-making and to provide an overview of the concepts, methods, issues and various forms and stages of the EIA process.

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Explain the major principles and components of EIA processes | I |
| CO2 | List and comply with the environmental clearance procedures in India | II |
| CO3 | Understand about the methods used for EIA studies | III |
| CO4 | Discuss the implications of current jurisdictional and institutional arrangements in relation to EIA | IV |
| CO5 | Access different case studies/ examples of EIA in practice | IV |
| CO6 | Summarize the EIA report with suitable environmental management plan | V |

### 1.3 Mappings scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | - | L | - | M | H | - | M |
| CO2 | M | M | - | L | M | L | H |
| CO3 | L | - | - | M | L | L | M |
| CO4 | L | - | L | H | M | - | H |
| CO5 | - | - | - | H | M | L | M |
| CO6 | L | L | M | M | H | - | M |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental Impact Assessment)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Introduction to EIA | History and perspectives. EIA – Definition and Terminologies. Types of EIA - Projects subject to EIA. Regulatory framework in India, EIA guidelines, Govt. of India EIA Notifications 1994. 2006 and amendments up to 2020. | 12 |
| II | EIA Methodologies | Adhoc, Overlays, Matrix, Checklist and Network approach. Battle Columbus Technique and modeling. EIA Process, EIS and EMP. Public Consultation, list of industries attracting EIA, Environmental Clearance. Composition of expert committee, Terms of Reference, EIA Report Preparation. | 12 |
| III | Public Participation, Preparation and Review of EIA Report | Objectives of People's Participation - Advantages and Disadvantages - People's Participation Techniques: Public Hearing - Preparation and Review of EIA Report: EIA Reports Content - Basis and Criteria for Evaluation of EIA Reports and EIA | 8 |
| IV | EIA case studies | Air, Noise, Water, Land, flora and fauna, Socio – economic and biotic environment. Environmental setting, Identification, evaluation and prediction of environmental impacts. Case studies of EIA of developmental projects – Hydel project, Oil Pipeline project, East Coast Road, Mining project. | 8 |
| V | Environmental Audit | Guidelines, planning for Environmental Audit. Life cycle analysis, Cost Benefit Analysis. Industrial safety and OHSA systems and ISO 27001. 45001 & OHSAS 18001, Environmental Management Systems. Cleaner production technologies, Eco-mark and Eco labeling schemes. | 10 |

**1.5 References**

**1.5a Text Books**

1. Canter LW (1996) Environmental Impact Assessment. McGraw Hill, New York.

2. EIA Manual (2001) Ministry of Environment, Forest and Climate Change, New Delhi.

3.Munn RE, Environmental Impact Assessment (1982). McGraw Hill Book Co., New York.

**1.5b Reference books**

1. Anjaneyulu Y and Valli Manickam (2007) Environmental Impact Assessment Methodologies, 2nd Edition, B.S. Publications (ISBN: 978-81-7800-144-9).

2. Cutter L, Environment risks and hazards (1999). Prentice Hall of India Private Limited, New Delhi..

3. Eccleston CH (2000) Environmental Impact Assessment - A Comprehensive Guide to Project and Strategic Planning, John Wiley and Sons, NY.

4. Peter Wathern (2015) Environmental Impact Assessment: Theory and Practice, Taylor & Francis, London

5. Singleton R, Castle, P and Sort, D (1999) Environmental Assessment, Thomas Telford Publishing, London.

6. Whitelaw K and Butterworth (1997) ISO 14001: Environmental System Handbook.

## Elective paper - 2: Remote Sensing and Geographical Information System

### 1.1 Course Objectives

• To teach the basic knowledge about the remote sensing and geographical information systems.

• To introduce the principles and applications of remote sensing and GIS technologies in mapping and assessing the environmental resources / environmental pollution.

### 1.2 Course Outcomes

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Building a foundation for understanding Remote Sensing and Geographic Information System as a powerful tool for geospatial analysis. | I |
| CO2 | Build the foundation of understating of cartography, digital image, spatial and non-spatial data and geospatial terminology. | II |
| CO3 | Learn about data and sources (RS based and other sources, field data collection) and integrate those into GIS environment for analysis. | III |
| CO4 | Appreciate the application of RS-GIS techniques to the matrices of environment and resource management. | IV |
| CO5 | Obtain basic competence in assessing the environmental pollution and natural disasters. | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | M | - | - | M | L | L | L |
| CO2 | M | - | - | H | M | | M |
| CO3 | M | - | - | H | M | | M |
| CO4 | M | - | - | H | H | | M |
| CO5 | H | L | L | H | H | M | L |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Remote Sensing and Geographical Information System)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Fundamentals of remote sensing | Background of remote sensing, Electromagnetic radiation, Interactions between matter and Electromagnetic radiation. Reflectance, Spectral reflectance and their characteristic sensor: Type of sensor, Characteristics of optical detectors, Types of scanners, Atmospheric sensors, Microwave sensors produces used in remote sensing. Applications of remote sensing for Environmental studies | 10 |
| II | Principles of Geographic Information System (GIS) | Concepts and Components of GIS – Hardware, software and organizational Context- Data, Maps, Projection, Data input, Data output, Data interaction and Analysis using raster and vector data. | 10 |
| III | Applications of Remote Sensing and GIS | Land use/land cover Mapping; Basic concept and classification and Land use change detection mapping – Mapping of soil erosion prone areas – Mapping of Forest degradation and Biodiversity conservation –Mapping of wetlands; Mapping of Site selection for waste disposal. | 10 |
| IV | Remote Sensing and GIS applications for pollution | Impact assessment of degradation and contamination of surface water and groundwater quality. Watershed Management-Eutrophication and its impacts–Coastal and marine pollution–Coastal dynamics. Mapping of Air pollutants due to Industrial activities. | 8 |
| V | Natural Disaster Assessment | Floods–Droughts–Landslides–Earthquakes–Volcanic eruptions–Desertification. | 8 |

**1.5 References**

**1.5a Text Books**


1. Lillesand, T.M. And P.W.Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York. Third Edition, 2007.
2. Chang KT, Introduction to Geographic Information System (2002). McGraw Hill, Boston.
3. Kang - Tsung Chang, Introduction to Geographic Information System, MC Graw Hill, Boston. 2002.
4. Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems. 2nd Edition, Oxford University Press, 2006.

**1.5b Reference book**

1. Reddy MA. Text book of Remote Sensing and GIS (2003). BS Publications Hyderabad.
2. Panda BC. Remote Sensing Principles and Application (2005). Viva Books Private Limited, New Delhi.
3. Singh S, Geomorphology and Remote Sensing in Environmental Management (1992). Scientific Publishers, Jodhpur.
4. Pirazizy AA, Environmental Geography and Natural Hazards (1992). Concept Publishing Company, New Delhi.
5. Sabins FF, Remote Sensing Principles and Interpretation (1978). Freeman, San Francisco.

# SEMESTER – III

## Core - 9: ENVIRONMENTAL ENGINEERING

### 1.1 Course Objectives

The purpose of this course is to teach the students about the background of engineering principles, designs and methods to solve the environmental problems like wastewater treatment, sludge stabilization and biogas production, and to monitor environmental pollutants.

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Understand the complex environmental issues use of various engineering strategies to apply to solve environmental issues | I |
| CO2 | Understand the basic principles and methods of environmental engineering | I |
| CO3 | Identify the suitable treatment methods for wastewater treatment and sludge stabilization | II |
| CO4 | Understand the process of biogas production from sludge. | III |
| CO5 | Use their acquired knowledge to design the reactors for sewage and sludge treatment. | IV |
| CO6 | Monitor the environmental pollutants and control the treatment process | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes are tabulated as follows.

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | M | L | H | M | M | H | M |
| CO2 | L | L | H | L | H | M | M |
| CO3 | L | - | H | L | H | M | M |
| CO4 | L | - | H | - | M | M | M |
| CO5 | - | - | M | L | H | M | H |
| CO6 | - | L | H | - | H | M | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental Engineering)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | An Overview of Wastewater Treatment and Disposal | Environmental sanitation, wastewater - wastewater quantity and quality - characteristics - treatment required - preliminary, primary, secondary, and tertiary treatments - sedimentation - effluent disposal - chlorination - sludge stabilization - biosolids. Sewer system - design of sewers, estimation of sewage flow, sewage collection, and odour control. | 10 |
| II | Pre and Primary Wastewater Treatment Plant | Principle and design of screening, equalization tank, grit chambers, rectangular and circular coagulation and flocculation tank, sedimentation tank. Chemically Enhanced Primary Treatment (CEPT) - Design for a Small Community level. | 8 |
| III | Aerobic Treatment of Wastewater | Principles and design of aerobic biological treatment of sewage - Activated sludge process, Oxidation Ditch, Aerobic lagoons, Trickling filters, Sequencing batch reactors, Fluidized-bed bioreactors - Nutrient removal and pathogen reduction. | 8 |
| IV | Anaerobic Treatment of Wastewater and Sludge | Design of facilities for anaerobic treatment of wastewater and sludge - Anaerobic digesters and septic tanks, Anaerobic filters, Upflow anaerobic sludge blanket reactor (UASB) - Sludge thickening and digestion - Biogas production - Sludge dewatering process, Biosolids - drying and disposal. | 10 |
| V | Air Pollution and Control Equipments | Principle and design of minimum stack height - Settling chamber - Cyclone collector - Fabric filter and Electrostatic Precipitators (ESP) - Bioscrubbers. | 8 |

## 1.5 References

### 1.5a Text Books

1. P. Venugopala Rao. (2002). Textbook of Environmental Engineering PHI Learning Pvt. Ltd.

2. N. N. Basak. (2017). Environmental Engineering Tata McGraw Hill Publishing Company.

### 1.5b Reference Books

1. Air Pollution Control Technology Manual (1998) Overseas Environmental Cooperation Center, Japan.

2. Anne Maczulak (2010) Environmental Engineering: Designing a Sustainable Future, Infobase Publishing, NY, USA.

3. Louis Theodore (2008) Air Pollution Control Equipment Calculations, John Wiley & Sons, NJ, USA.

4. Mihelcic JR, Fry LM, Myre EA, Phillips L and Barkdoll BD (2009) Field Guide to Environmental Engineering for Development Workers - Water, Sanitation, and Indoor Air, American Society of Civil Engineers, USA.

5. Pawlowski A, Dudzinska MR and Pawlowski L (2013) Environmental Engineering, CRC Press, Boca Raton, FL, USA.

### 1.5c Web References

1. http://www.suez-environnement.com/design-construction-water-plants/

2. https://www.dsd.gov.hk/EN/Sewerage/Sewerage_Strategy/index.html

3. http://www.eolss.net/sample-chapters/c09/e4-11-05.pdf

4. http://onsite.tennessee.edu/Aerobic%20Treatment%20&%20ATUs.pdf

5. http://www.thomasnet.com/products/air-pollution-control-equipment-780809-1.html

6. https://www.env.go.jp/earth/coop/coop/document/01-apctme/contents.html

7. https://engineeringonline.ucr.edu/blog/what-are-advanced-water-treatment-processes/

8. http://gcus.jp/wp/wp-content/uploads/2014/06/ebd9e233be72625b03c96047573177f9.pdf

9. https://www.diva-portal.org/smash/get/diva2:808135/FULLTEXT02.pdf

10 https://www.host.nl/en/biogas-plants/sludge-treatment/

## Core - 10: RESEARCH DESIGN AND INSTRUMENTAL METHODS

### 1.1 Course Objectives

The purpose of this course is to acquaint students about various types of research methods, instruments and their working principles, data process, report generation and to train the students to handle various research instruments.

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Know the types of research and scientific databases, report writing. | I |
| CO2 | Chose the research that they want to carryout. | II |
| CO3 | Understand the manuscript preparation and publication process. | II |
| CO4 | Understand the principles of research methods and instruments required for their research experiments. | III |
| CO5 | Apply their knowledge on instrumentation for environmental analysis, and field works and data collection. | IV |
| CO6 | To know the working principles of instruments and their applications. | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | M | L | L | H | M | L | H |
| CO2 | M | L | - | H | M | - | H |
| CO3 | M | L | - | H | H | M | H |
| CO4 | M | L | - | H | - | - | M |
| CO5 | M | L | L | L | M | L | M |
| CO6 | M | L | L | M | M | M | M |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Research Design and Instrumental Methods)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Research Methods | Meaning and Objectives of Research; Significance of research; Research and scientific methods; Criteria of good and advanced research; Types of Research: (Survey, Observation, case study, experimental, historical and comparative methods) Stages in preparation; Research methods Vs methodology; Writing of Research Proposal, Report and Research paper Features of a good design; Different research designs; Sampling – Types of sampling design. Data collection – methods; Measurement and scaling – Quantitative and qualitative; Classification; goodness. | 8 |
| II | Manuscript preparation and publications | Screening of material for inclusion within the structure of the manuscript - Importance of authors and their sequence - Importance of clear title, Abstract, Introduction, Methods, Results, Discussion and conclusion - Numbers and Statistics, Tables and Figures - Reference protocols ; Copyright Act (in brief), Plagiarism, Statistical methods and Citation index (h index and i-10 index) and SCI Impact factor for journals. | |
| III | Basic Analytical Equipments | Principle, Working mechanism and environmental applications of pH Meter, Conductivity meter, Nephlometer. Basic principles and applications of light and electron microscopes. Types, function and applications of centrifuges. Principle, types and environmental application of elctrophoretic techniques and radio immune assay techniques. | 8 |
| IV | Spectroscopy | Various ranges of electromagnetic radiation - Interaction of electromagnetic radiation with matter, Spectrophotometry - Principles and working mechanism, types and applications of colorimeter, UV - Visible spectrophotometer, fluorimeter, flame photometer, AAS, AES, ICP-MS, IR, NMR spectrophotometer and XRD spectrometer. | 12 |
| V | Chromato graphy & Mass Spectrometry | Principle and concept of chromatography - stationary phase, mobile phase, partition and adsorption, coefficients. Working principle, instrumentation and environmental applications of Thin layer and Ion exchange chromatography, HPLC, HPTLC, LC-MS, and GC-MS. | 12 |

## 1.5 References

### 1.5a Text Books:

1. Rt Kumar, (2010.) Research Methodology: A Step-by-Step Guide for Beginners, SAGE Pub.

2. Gurumani, N. (2006).Research Methodology for Biological Science. MJP Publishers.

### 1.5b References Books

1. Christian GD (2001), Analytical Chemistry, 5th edition, John Wiley and Sons Inc., India

2. Khopkar SM (1993) Environmental Pollution analysis, Wiley Eastern Ltd.

3. Manahan SE (2007) Environmental Chemistry, 7th edition, Lewis Publications, Florida, USA.

4. Manly, Bryan FJ (2001) Statistics for Environmental Science and Management, Chapman and Hall / CRC Press, Boca Raton, FL, USA.

5. Skoog DA, Holler FJ and Nieman TA (1980) Principles of Instrumental Analysis – 5th edition, Thomson Asia Pvt., Singapore.

6. Vogel AI (1998) Quantitative Analysis, 6th edition, Prentice Hall Inc., Willard HH, Merrit LL and Dean JA (1976) Instrumental Methods of Analysis, 5th edition, Van Nostrand Reinhold.

### 1.5c Web References

1. https://www.bio.umass.edu/biology/forms/content/499e-research-methodology

2. www.computerhope.com/os.htm

3. http://www.fao.org/docrep/005/ac665e/ac665e05.htm#TopOfPage

4. http://www.rss.hku.hk/plagiarism/page2s.htm

5. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1258

6. www.fao.org/docrep/W7295E/w7295e08.htm

7. https://chemistrynotesblog.wordpress.com/seperation-techniques/introduction-to-separation-techniques-2/

8. https://www.epa.gov/sites/production/files/2015-05/documents/402-b-04-001b-14-final.pdf

9. https://en.wikibooks.org/wiki/Proteomics/Protein_Identification-Mass_Spectrometry/Types_Mass_Spectrometry

## Core - 12: WASTE MANAGEMENT

### 1.1 Course Objectives

The purpose of this course is to understand the problems of different kinds of wastes and understand the proper collection, segregation and reduction methods for municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc. To identify waste nature and proper disposal methods for each type of wastes and identify the energy producing wastes and recovery of the energy from the wastes using different techniques.

### 1.2 Course Outcomes

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Understand health and environmental issues related to solid waste management; Select the appropriate method for solid waste collection, transportation, redistribution and disposal | I |
| CO2 | Become aware of Environment and health impacts of solid waste mismanagement | II |
| CO3 | Understand engineering, financial and technical options for waste management and wealth from waste management techniques | III |
| CO4 | Understand industrial specific wastes and their efficient management | III |
| CO5 | Describe methods of disposal of hazardous solid waste | IV |
| CO6 | Understand the energy recovery and industrial specific treatment techniques | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | H | M | L | L | M | - | L |
| CO2 | H | M | L | - | - | L | M |
| CO3 | H | M | M | - | M | L | H |
| CO4 | H | M | M | - | M | M | H |
| CO5 | H | M | H | - | - | M | H |
| CO6 | H | M | H | - | M | M | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Waste Management)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Municipal Solid Waste | Wastes – Introduction, Definition, Sources and Classification; Municipal Solid Wastes – Source, Types, Per Capita Generation, Global Scenario Wastes; Collection and Transportation Methods, Waste Processing and Material Recovery (TMRF), Effects of Municipal Solid Wastes on Environment. Disposal Methods (Landfill, Composting, Burning, Incineration, Pyrolysis, Anaerobic Digestion). | 12 |
| II | Hazardous & Radioactive Waste | Hazardous waste – Introduction, Characteristics, Classification of Hazardous Waste (Industrial, Hospital and Domestic) – Labeling and Handling of Hazardous Solid Wastes (Segregation, Recovery of Hazardous Waste Substances) - Hazardous Waste Disposal Techniques. Radioactive Wastes - Sources, Types, Effects, Control and Disposal Methods. | 12 |
| III | Biomedical, Plastic & e-waste | Biomedical Wastes: Sources, Types of Biomedical Wastes, Impacts of Biomedical Wastes on Environment - Control Measures of Biomedical Wastes. Plastic Wastes: Sources, Types, Facts & Figures of Plastic Waste Scenarios in National & International, Effects of Plastic Wastes on Environment, Control Measures of Plastic Wastes. E-wastes: Sources, Types of e-wastes – Impacts of e-wastes on Environment - Control measures of e-wastes. | 12 |
| IV | Industrial Waste | Paper and Pulp, Tanneries, Textiles, Thermal Power Plants, Mining and Ore Processing, Refineries, Iron Casting, Cement and Asbestos. Waste Sludge Dewatering and its Disposal. | 12 |

| | | | |
|---|---|---|---|
| V | Energy Recovery | Vermicomposting, mushroom cultivation, fly ash bricks, biogas, and electricity; Bioelectro chemical systems – Microbial electrolysis cell – Microbial fuel cell - Production of methane, ethanol, electricity. | 10 |

**1.5 References**

**1.5a Text Books**


1. Kinnaman, T.C and Takeuchi, K. (2014). Handbook on Waste Management, Edward Elgar Publishing, UK.
2. Ramesha Chandrappa and Jeff Brown, (2012). Solid Waste Management: Principles and Practice, Springer Science and Business Media Publishers.


**1.5b Reference Books**


1. Basarkar Shishir, (2009) Hospital Waste Management: A Guide for Self-Assessment and Review, JAYPEEDIGITAL
2. Hieronymi, C.K, R. Kahhat, and Williams, E. (2012) E-waste Management: From waste to resource. Routledge Taylor Francis Group Publishers.
3. Bhide and Sundaresan (2000) Solid Waste Management in Developing Countries – Indian National Scientific Documentation Center, New Delhi.
6. John Pitchel (2005) Waste Management Practices, Municipal, Hazardous, and Industrial. Taylor & Francis Group, LLC.
7. Lagrega, M.D, Buckingham, P.L and Evans, J.V. (2001) Hazardous Waste Management, McGraw Hill Int. Ed. New York.
8. Lie, D.H.F and Liptak B.G (2000) Hazardous Wastes and Solid Wastes, Lewis publishers, New York.

## Elective paper- 3: Disaster Management

### 1.1 Course Objectives

- To impart the basic knowledge on the natural and manmade hazards
- To enable students to understand the global disasters and initiatives taken for management plans and awareness.

### 1.2 Course Outcomes

On the successful completion of the course, students will be able to

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Understand the disaster and their types, impacts to the properties | I |
| CO2 | Get the knowledge about the manmade problems to the nature and living things | II |
| CO3 | Understand the reasons of forming natural and manmade hazards to the world. | III |
| CO4 | Apply the knowledge to solve the problems of disaster at particular region. Aware the local people to protect them in secure shelter before disaster of the place. | IV |
| CO5 | Students can aware of management plan and technologies are available for disaster management | V |
| CO6 | Get strong knowledge about disaster and its control strategies by the proper plan | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | M | M | - | L | L | - | L |
| CO2 | M | M | - | M | M | - | L |
| CO3 | H | M | - | L | M | - | |
| CO4 | L | - | L | M | H | L | M |
| CO5 | M | - | M | M | M | L | M |
| CO6 | - | L | M | M | H | M | M |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Disaster Management)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Understanding Disasters | Disaster - Meaning, nature, characteristics and types of Disasters, Causes and effects. Disaster: A Global View, Disaster Profile of India, The Disaster Management cycle. | 8 |
| II | Natural hazards | Catastrophic geological hazards: Earthquakes, Tsunami's, volcanic eruptions, Snow avalanches, Landslides, Cyclones, Floods, Desertification, and Forest fires. | 10 |
| III | Manmade hazards | Improper irrigation and deforestation – Industrial hazards: Fire, Explosion, Toxic release and dispersion - Effects, Predictions, Forecasting and Mitigation measures of environmental hazards. | 10 |
| IV | Disaster management Plans | Components of disaster management plan - on-site and off-site emergency plans - Pre disaster phase, Actual disaster phase and Post disaster phase - Disaster assistance: Technological assistance, Relief camp Organization, Camp layout, Food requirement, Water needs, Sanitation, Security, Information administration, Fire fighting camping and Tent pitching, Rope, Knots and their use - Emergency rescue. | 10 |
| V | Awareness and education | Disaster education: Alternatives and new directions - Conceptualizing disaster recovery, Mitigation and preparedness, Programme planning and management. | 8 |

**1.5 References:**


1. Harold D. Foster (1980) Disaster Planning. The Preservation of Life and Property, Springer-Verlag, New York.
2. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
3. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
5. Central Water Commission, 1989, Manual of Flood Forecasting, New Delhi.
6. Government of India, 1997, Vulnerability Atlas of India, New Delhi.
7. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.

# SEMESTER- IV

## Core - 13: ENVIRONMENTAL LAW AND POLICIES

### 1.1 Course Objectives

The purpose of this course is to introduce the students to the vast field of Laws and Policies both at the national and international level relating to environment.

### 1.2 Course Outcomes

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Understand environmental legislation and policies of national and international regime. | I |
| CO2 | Have an insight into major acts and rules applicable for pollution control and natural resource conservation. | II |
| CO3 | To develop the skills needed for interpreting laws, policies and judicial decisions about the environment. | III |
| CO4 | Apply the legislation concepts for solving the local environmental problems | II |
| CO5 | Be in a position to prepare compliance reports for getting environmental clearance | IV |
| CO6 | Prepare the environmental management system for an organization. | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | M | L | - | L | L | - | H |
| CO2 | M | - | - | M | M | L | M |
| CO3 | M | - | L | M | M | L | M |
| CO4 | M | L | - | L | M | L | M |
| CO5 | - | L | L | - | M | M | M |
| CO6 | - | - | L | - | L | M | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental Law and Policies)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Environmental Protection | Indian Constitution – Structure – Provisions for environmental protection – Indian environmental Law – Framework and Implementation - Role of International Environmental Agencies -UNEP, GEF, UNFCC and IPCC | 8 |
| II | Environmental Laws in India | Indian Wildlife (Protection) Act, 1972; Forest Conservation Act 1980; Indian Forests Act (Revised) 1982; Water (Prevention and Control of Pollution) Act, 1975; Air (Prevention and Control of Pollution) Act 1981, 1987 and Rule 1982; Environment (Protection) Act, 1986 and Rules 1986; ; National Environment Appellate Authority Act, 1997; Biodiversity Act 2002; National Green Tribunal Act 2010 | 10 |
| III | Guidelines and Rules in India | Bio-Medical Waste (Management & Handling) Rules,1998; Recycled Plastics Manufacture and Usage Rules, 1999; Noise Pollution (Regulation and Control) Rules, 2000; Municipal Solid Waste (Management and Handling Rules) 2000; The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules,2008; Wetland Rules 2009; Coastal Regulation Zones (CRZ) Rules 2011; E-waste Management and Handling Rules 2011; Plastics Manufacture, Sale and Usage Rules, 2011. | 10 |
| IV | International Environmental Treaties and Conventions | Stockholm Conference on Human Environment,1972; Ramsar Convention on Wetlands, 197; Montreal Protocol, 1987; Basel Convention (1989,1992); Earth Summit at Rio de Zaneiro,1992; Kyoto Protocol, 1997; Earth Summit at | 8 |

| | | | |
|---|---|---|---|
| | | Johannesburg, 2002; , Copenhagen Summit 2009 and 2019. Paris Agreement, 2016, SDG - 2030 | |
| V | Major Initiatives/ Policies from MoEF | National Policies for Environmental Protection in India: National River Conservation Plan (NRCP), National Ganga River Basin Authority (NGRBA), Ganga Action Plan Phase I and II, Green India Mission – Environmental Clearances: National Environmental Assessment and Monitoring Authority (NEAMA) | 8 |

**1.5 References**

**1.5a Text Books**

1. Environmental Law in India (2000) P. Leelakrishnan Butterworths India Publishers

2. Textbook on Environmental Law (2010) N. Maheshwara Swamy, Asia Law House Publishers

3. Gurudeep Singh (2005) Environmental Law in India, McMillan, New Delhi.

4. ShyamDiwan and Armin Rosencrany (2001) Environmental Law and Policy in India, Oxford University Press, New Delhi.

5. Singh G (1995) Environmental Law: International & National Perspectives.

6. Tamil Nadu Pollution Control Board (1999) Pollution Control Legislation Vol. I and II, Chennai.

## Core - 14: ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT

### 1.1 Course Objectives

- To impart the basic knowledge on the concepts of environmental management.
- To enable students to understand the global issues and initiatives taken for sustainable development.

### 1.2 Course Outcomes

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Understand the important of natural resources and utilisation | I |
| CO2 | Get knowledge to the management of available natural resources | II |
| CO3 | Recognize the concepts of environmental sustainability. | III |
| CO4 | Discuss the components of environmental sustainability from regional to global level. | III |
| CO5 | Analyze environmental problems and develops skills to resolve for sustainable development. | IV |
| CO6 | Report various trans-boundary environmental issues through reviewing and analyzing. | V |

### 1.3 Mapping scheme

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | H | H | L | L | L | - | M |
| CO2 | H | H | - | L | L | L | M |
| CO3 | H | H | M | M | M | - | H |
| CO4 | H | L | M | M | M | - | H |
| CO5 | M | L | M | - | H | L | H |
| CO6 | M | L | M | H | H | - | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental Management and Sustainable Development)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Water management | Water resource Management: Water resources and their significance; water balance, water utilization and related problems, Rain water harvesting; restoration of water bodies; Water sharing, water disputes; Wetland management; watershed management. | 8 |
| II | Land management | Land Resources Management: land use pattern, land degradation - causes and control measures; wasteland Management, land reclamation methods – physical, chemical and biological, soil enrichment; Deforestation and its impacts. Afforestation - social and agro forestry schemes. | 10 |
| III | Sustainable development | Concepts of Sustainable development; Components; Sustainable Development Goals (SDGs); integrated approach to environment, practices of sustainable in India, Global conventions; New National Environmental Policy (2006); Agenda 21, Agenda 2030 for Sustainable Development; Millennium Development Goals (MDGs) | 10 |
| IV | Societal and Economic Sustainability | Societal Sustainability - Sustainable Governance indicators; Social Development Indicators (SDIs); Human Development Index (HDI); Sustainable Society Index (SSI); Economic sustainability- GDP per capita; Gini coefficient; ISO 14007:2019. | 8 |
| V | Environmental Sustainability | Integrated Pests and Weed Management, Integrated Farming; Sustainable Forest Management (SFM); Ecological Indicators and footprint; COVID 19: Challenges and Importance of Environmental Sustainability; Environmental Management System and Strategy; Environmental Performance Index; Environmental Vulnerability Index. | 10 |

**1.5 References**

**1.5a Text Books**


1. Blewitt J, Understanding Sustainable Development (2008). Earthscan. ISBN: 9781844074556.
2. Brandon P, Lombardi P, Evaluating Sustainable Development (2005). Wiley Blackwell.
3. Rogers PP, Jalal KF and Boyd JA, An introduction to sustainable development (2007). Earthscan Publications Ltd.
4. Munn RE (1982). Environmental Impact Assessment. McGraw Hill book Co. NY.
5. Murty JVS (1994). Watershed Management in India. Wiley Eastern Ltd., New Delhi.

**1.5b Reference Books**


1. Canter LW, Environmental impact assessment, McGraw Hill Book co. NY, 1977.
2. Centre for Science and Environment, The State of India's Environment: The second
   Citizen's Report, CSE, New Delhi, 2008.
3. Deborah Reyes, Sustainable Development: Process, Challenges and Prospects, 2015.
   Nova Publisher. ISBN: 978-1-63482-506-1
4. Nandhithakrishna (1998). Environmental Laws of India – An Introduction. C.P.R. Environnemental Education Centre, Chennai.


**1.5c Web Links**

1. http://css.umich.edu/factsheets/social-development-indicators-factsheet
2. http://www.fao.org/forestry/sfm/en/
3. https://www.who.int/water_sanitation_health/resourcesquality/wpcchap6
   .pdf
4. https://iwlearn.net/manuals/tda-sap-methodology/development-of-thetda/identification-prioritisation-of-the-transboundary/what-is-transboundaryproblem#:~:text =A%20 transboundary%20problem%20is%20an,affecting%20(or%20impacting)%20another.
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7220565/

## INTERNSHIP AND FIELD WORK

Objectives:

• To involve the students to work with the employees of a selected industry in understanding and learning the environmental challenges (waste water / air pollution / noise / solid wastes) and their control measures.

• To expose the students to selected ecosystems / natural environment to learn the ecological principles.

• To visit certain industries to understand the environmental pollution and control practiced in various industries.

## Core - 15: PROJECT WORK

Objectives:

• To demonstrate the ability to carry out and write up an independent piece of work on a topic that is relevant to the course

• To demonstrate the ability to think critically and develop original ideas;

• To analyse data or literature and form conclusions based on this analysis

• To demonstrate independent research skills,

Supportive paper – 1: **ECO-TOURISM AND WILDLIFE MANAGEMENT**

**1.1 Course Objectives**

To know about the concept of ecotourism, development of ecotourism places. To know about the impacts and management issues of ecotourism.

**1.2 Course Outcomes**

On the successful completion of the course, students will be able to

| CO | Course Outcomes | Unit |
|---|---|---|
| CO1 | Know the principles, concept, types and benefits of ecotourism | I |
| CO2 | Know interesting places of ecotourism | II |
| CO3 | Evaluate the impacts of ecotourism on the environment | III |
| CO4 | Understand the need for wildlife conservation | IV |
| CO5 | Acquire the knowledge on management of Ecotourism | V |

**1.3 Mapping scheme**

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | L | - | - | L | L | L | M |
| CO2 | M | - | - | L | L | M | M |
| CO3 | M | M | L | L | H | M | H |
| CO4 | M | - | M | M | H | - | H |
| CO5 | M | - | - | M | H | M | M |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Eco-Tourism and Wildlife Management)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Introduction to Eco-Tourism | Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin of Ecotourism – Objectives of Ecotourism – Benefits of Ecotourism – Trends affecting Ecotourism. Concepts of Tourism - Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Consumptive and NonConsumptive Tourism | 7 |
| II | Interesting Eco-tourism | Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism – Ecotourism and Conservation – Study of different Ecosystem – Rain forest Ecotourism – Mountain Ecotourism – Polar, Islands and Coasts Ecotourism – Wilderness – Marine Ecosystem. | 10 |
| III | Impact of Eco-tourism | Impact of Ecotourism – Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research - Disasters and Ecotourism | 10 |
| IV | Wildlife Conservation | Wildlife conservation - Protected Areas Network in India - Goals of management, Strategies for planning. Factors influencing wildlife management such as habitats, population, behaviour, food habits, health, etc. - Tools for data collection and analysis. | 10 |
| V | Wildlife Management | Human land-use and wildlife management units - Important projects for the conservation of wildlife in India - Role of local communities in wildlife management – Wild life conservation laws - The Wildlife (Protection) Act, 1972 (2002 amendment). | 7 |

## 1.5References

### 1.5a Text Books


1. Dasman RF (1968) Environmental Conservation: John Wiley and Sons, New York.
2. Mukherjee N (2008) Ecotourism and sustainable Development. Cybetech Publications, New Delhi.


### 1.5b Reference Books


1. Prabhas Chandra (2003) Global Ecotourism, Kaniskha Publishers, New Delhi.
2. Sinha, P.C (2003) Encyclopedia of Ecotourism, Volume I, II and III, Anmol Publications Pvt. Ltd., New Delhi.
3. Weaver DB (2001) The Encyclopedia of Ecotourism, CABI Publishing, UK.

**1.5c Web sources**

1. www.incredibleindia.org/newsite/cms_page.asp?pageid=994
2. www.nativescience.org/html/eco-tourism.html
3. www.wcsindia.org/
4. envfor.nic.in/divisions/9-10.pdf
5. http://www.ceeraindia.org/documents/lib_tabofcon_160300.htm

Supportive - 2: **ENVIROMENTAL HEALTH AND SAFETY MANAGEMENT**

**1.1 Course Objectives**

- To understand the basic principles of environmental health and safety practices.
- To create awareness about public and occupational health and safety requirements associated with the environment.
- To understand the role of environmental health, protection, occupational health and safety, compliance and best practices.

**1.2 Course Outcomes**

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Concepts and scope, basic requirements for healthy environment, environmental quality, human exposure and health impact. | I |
| CO2 | Industrial pollution and chemical safety in public exposure from industrial sources, hazards by industry major chemical contaminants at workplace. | II |
| CO3 | Understand the environmental disease - Fluorosis and Allergies; epidemiological issues. | III |
| CO4 | Equip student with basic knowledge on safety issue related with explosion, pollutant release in water and air, and to implement measure during outbreak of flu epidemic at work place. | IV |
| CO5 | Understand of health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, health hazard in agriculture | V |

**1.3 Mapping scheme**

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | M | H | - | - | L | M | M |
| CO2 | M | H | - | - | M | H | H |
| CO3 | M | H | - | - | M | M | H |
| CO4 | L | M | L | M | M | M | M |
| CO5 | L | M | L | M | M | L | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Environmental Health and Safety Management)

| Unit | Unit Title | Learning Chapters (L1, L2,L3,L4,L5,L6) | Hours of Instruction |
|---|---|---|---|
| **I** | Environmental Health | Concept and scope; Global and regional perspectives; Basic requirements for healthy environment; Environmental quality, human exposure and health impact – impact of environmental factors on human health | 6 |
| **II** | Industrial Pollution and Safety management | Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents. Principles of functions and safety management. | 10 |
| **III** | Environmental Diseases | Asbestosis, Silicosis, Sycosis, Asthma, Fluorosis and Allergies; Epidemiological issues - Malaria and Kala –azar | 8 |
| **IV** | Occupational Safety and Health | Occupational hygiene/ safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Prevention and control of occupational diseases | 8 |
| **V** | Environmental Health Hazard and Risk Assessment | Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management | 6 |

## 1.5 References

### 1.5a Text Books


1. Shaw, J. Chadwick (1998) Principles of Environmental Toxicology, Taylor & Francis Ltd
2. AnnaleeYassi, Tord Kjellstr"om, Theo de Kok, Tee Guidotti (2001). Basic Environmental Health, Oxford University Press


### 1.5b Reference Books


1. Environmental Health- Monroe T. Morgan (2003).
2. Handbook of Environmental Health and Safety - Koren, H. (2002).
3. Risk Assessment - A Practical Guide, 1993. Institution of Occupational Safety and Health, UK.


### 1.5c Web References

1. www.ehs.ucsb.edu/
2. www.ifc.org/ehsguidelines
3. slintec.lk/wp-content/uploads/2011/08/HealthSafetyManual.pdf

Supportive – 3: **GLOBAL ENVIRONMENTAL ISSUES AND MANAGEMENT**

**1.1 Course Objectives**

To focus on major global environmental issues including population explosion, biodiversity loss, pollution, energy use, climate change and best environmental technologies for a sustainable development. To know how they are managed in various settings around the world.

**1.2 Course Outcome**

| CO | Outcomes | Unit |
|---|---|---|
| CO1 | Clearly identify important global, national, and local issues relating to population, food, and the environment | I |
| CO2 | Explain the causes and consequences of the global environmental issues | II |
| CO3 | Get more knowledge on loss of biological resources | III |
| CO4 | Understand the global disaster and hazards and their impacts | IV |
| CO5 | Preparing for plan of sustainable management to the current global issues | V |

**1.3 Mapping scheme**

The mapping of course outcomes with programme outcomes is tabulated as follows:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | M | H | L | M | H | - | L |
| CO2 | M | H | - | M | H | - | M |
| CO3 | L | M | - | L | M | L | M |
| CO4 | L | M | - | H | H | - | H |
| CO5 | L | M | M | H | H | L | H |

L: Low; M-Medium; H-High

**1.4 Syllabus** (Global Environmental Issues and Management)

| Unit | Unit Title | Learning Chapters | Hours of Instruction |
|---|---|---|---|
| I | Human Population and Environment | Basic demographic concepts: Growth, fertility, mortality and migration - Overview of population growth – Population distribution and Urbanization - Poverty, food security and environmental degradation – Development vs Environment. | 6 |
| II | Global Atmospheric Changes | Global Air Quality and $CO_2$ concentration scenario - Role of air pollutants in climate change – Sources of greenhouse gases - Ozone depleting substances – Facts and figures of current global warming scenarios in the world - El Niño and La Niña – Global consequences of El Niño | 8 |
| III | Overexploitation of Biological Resources | Overexploitation of natural resources: Ecological footprint – Earth Overshoot Day - Water resources: Status of groundwater quality in India – Desertification. Soil Resources: Global threats for soil quality - Loss of organic carbon. Biodiversity Resources: Biodiversity Hot spots in India – Bioprospecting – Factors influencing biodiversity loss. | 8 |
| IV | Global Disaster Episodes | Geological Disasters: Earthquake: Origin of Earthquake, its magnitude and intensity - Earthquake prone zones in India - Effects of earthquake. Volcanoes: Types of volcanic eruptions - Active volcanic belts in the world - Nature and magnitude of volcanic hazards. Hydrological hazards: Flash flood - Flood management strategies - Regions of flood prone zones in India – Flood forecasting and warning – Man -made disasters: Oil spills – Forest fire. | 10 |
| V | Sustainable Environmental Management | Utilization of renewable energy resources – Solar, Wind, Hydroelectric and Biomass energy resources – Sustainable agricultural practices (Biofertilizers and Biopesticides) – National Action Plan on Climate Change (Eight missions) – Recent initiatives related to climate change adaptation and mitigation in India - The Global 200: Priority Ecoregions for Global Conservation – UNDP Sustainable Development Goals 2030 Agenda. | 10 |

## 1.5 References

### 1.5a Text Books


1. Frances Harris (2012) Global Environmental Issues, 2nd edition, John Wiley & Sons Ltd., UK.
2. Stavros G. Poulopoulos and Vassilis J. Inglezakis (2016) Environment and Development: Basic Principles, Human Activities, and Environmental Implications. Elsevier, Netherlands.


### 1.5b Reference Books


1. Donald Hyndman and David (2005) Hyndman Natural Hazards & Disasters, Cengage Learning, USA.
2. John V. Walther (2014) Earth's Natural Resources, Jones & Bartlett Learning, USA.
3. Prasad Modak (2018) Environmental Management towards Sustainability, CRC Press, FL, USA.
4. PrasenjitMondal and Ajay K. Dalai (2017) Sustainable Utilization of Natural Resources, CRC Press, FL, USA.
5. Rajeev Pratap Singh, Anita Singh, VaibhavSrivastava (2017) Environmental Issues Surrounding Human Overpopulation, IGI Global, USA.
6. Raveendranathan D (2018) Development lead to Pollution and Depletion of Natural Resources, Notion Press, Chennai.
7. Serge Morand, Claire Lajaunie, RojchaiSatrawaha (2017) Biodiversity Conservation in Southeast Asia: Challenges in a Changing Environment, Earthscan from Routledge, UK.
8. Thangavel P and Sridevi G (2015) Environmental Sustainability: Role of Green Technologies, Springer, India.


### 1.5c Web Resources


1. https://www.stateofglobalair.org/sites/default/files/soga-2018-report.pdf
2. www.who.int/airpollution/
3. https://unfccc.int/
4. re.indiaenvironmentportal.org.in/files/part%20II%20groundwater%20CPCB.pdf
5. https://www.footprintnetwork.org/our-work/earth-overshoot-day
6. https://www.elsevier.com/ data/assets/pdf.../ElsevierDisasterScienceReport-PDF.pdf
7. siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf
8. https://link.springer.com/chapter/10.1007/978-981-10-1866-4_2
9. www.ipcc.ch/
10. https://climate.nasa.gov/