।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपुरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ,नांदेड.
25 1994 - 2019 SILVER JUBILEE YEAR
Phone : (02462) 229542 ACADEMIC (1-BOARD OF STUDIES) SECTION Website: srtmun.ac.in
Fax : (02462) 229574 E-mail: bos.srtmun@gmail.com

**प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्याबाबत.**

# प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक ०८ जून २०१९ रोजी संपन्न झालेल्या ४४ व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/४४–२०१९ च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे खालील विषयांचे C.B.C.S. (Choise Based Credit System) Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्यात येत आहेत.

1. Botany
2. Certificate Course in Industrial Safety, Health and Environmental Management (SHM)
3. Chemistry
4. Computer Application
5. Computer Network
6. Computer Science
7. Geophysics
8. Mathematics
9. M.C. A.
10. Microbiology
11. Physics
12. Zoology
13. Geology
14. Environmental Science

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या www.srtmun.ac.in या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड –४३१ ६०६
**जा.क्र.:**शैक्षणिक–१/परिपत्रक/संकुले/पदव्युत्तर–सीबीसीएस अभ्यासक्रम/२०१९–२०/**४६५**

**दिनांक :** ११.०७.२०१९

स्वाक्षरित
**उपकुलसचिव**
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. संचालक, सर्व संबधित संकुले, विद्यापीठ परिसर, प्रस्तुत विद्यापीठ.
४) साहायक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ

# Swami Ramanand Teerth Marathwada University

# M.Sc. Environmental Science
# 2 Years (4 Semester Program)
# Syllabus
## *With effective from 2019 – 2020*

## Department of Environmental Science
## School of Earth Sciences
## SRTM University
## NANDED

# M.Sc. Environmental Science
# 2 Years (4 Semester Program)

## PROGRAM EDUCATIONAL OBJECTIVES (PEO):

**PEO1:** To create and disseminate knowledge to the students about environmental problems at local, regional and global scale.

**PEO2:** To provide practical training on modern instrumentation and analytical techniques for environmental analyses.

**PEO3:** To sensitize students towards environmental concerns, issues, and impacts of climate change and related mitigation strategies.

**PEO4:** To make the students to apply their knowledge for efficient environmental decision-making, management and sustainable development.

**PEO5:** To prepare students for successful career in environmental departments, research institutes, industries, consultancy and NGOs, etc.

## PROGRAMME OUTCOMES (PO):

After completion of the program, the students have:

**PO1:** Acquired fundamental knowledge of different aspects of environment and local, regional and global environmental problems.

**PO2:** Developed environmental monitoring skills, including conduct of experiments and data analysis.

**PO3:** Obtained exposure to the environmental pollution control technologies.

**PO4:** Acquired the knowledge and skills needed for the environmental design and management.

**PO5:** Acquired skills in the preparation, planning and implementation of environmental projects.

**PO6:** The students passing M.Sc. Degree in the subject Environmental Science and other relevant subjects have the opportunity of job and services in the field of Teaching,

Researches, Projects, Effluent Treatment Plants of various Industries/Companies/Factories, Municipal Councils/Corporations, Central Pollution Control Board, State Pollution Control Boards, National Research Institutes/Organizations/Laboratories, NEERI, EIA, GIS, Environmental Monitoring Projects, Environmental Consultants, Different Laboratories, NGO's, Forest department, Water Purification and Treatment Plants and Various Sectors related to the field of Environment.

## PROGRAM SPECIFIC OUTCOMES (PSO):

**PSO1:** Understand the basic concepts of Environments and its components along with their interactions through study of Ecology, Biodiversity, Environmental Chemistry, and Environmental Microbiology

**PSO2:** Understand the different kinds of Pollutions and their sources through study of Climate and Air Pollution Studies, Hazardous Waste & Environmental Toxicology and Soil Pollution and different laws about pollution

**PSO3:** Analyse and determine pollution using Environmental Analytical Techniques, Biostatistics and Computational Techniques.

**PSO4:** Understand different technologies like biotechnology, water and Wastewater treatment technology to find the solutions and their applications in abatement of Pollution and other environmental problems.

**PSO5:** Use of different tools for the management of Environment, Energy resources, solid wastes, Biodiversity conservation like Remote Sensing & Geographical Information Systems and different methodologies.

**PSO6:** Understand the disaster management and industrial safety.

**PSO7:** Determine the environmental impact due to different developmental projects and find solution to eliminate these impacts.

**PSO8:** Through Dissertation, student can identify a particular environmental problem, review the literature for finding the gaps, develop research methodology, collect data and carry out data analysis and interpretation for finding a suitable solution and acquire the ability to write the research findings in the form of structured thesis and communicate the research results through oral or poster presentations.

# M.Sc. Environmental Science
# Syllabus Pattern

Syllabus of M.Sc. Environmental Science program offered by the School of Earth Sciences has been prepared considering the syllabi for the UPSC, CSIR-NET, UGC-NET and UGC-SET examinations and the requirements of the industry. The M.Sc. program in Environmental Science is imparted to the students for two academic years consisting of four semesters. Candidates will be examined and evaluated on grade basis at the end of each semester in different theory and practical papers as per the credits offered by each course.

The M.Sc. Environmental Science program consists of (i) Core Subjects (ii) Subject Electives and (iii) Open Elective Courses. The Core Subjects shall be **75%** of the program (***with a total of 100 credits***), which are mandatory for all the students. Students can choose one Subject Elective per semester from the list of Subject Electives provided. A student has to take 8 credits of Open Elective courses within the 2 year term of the program. The Open Electives can be selected from the Open Elective courses offered by the School of Earth Sciences *OR* offered by other Schools from the University Campus. Students are also encouraged to select Open Elective courses from National Educational Platforms such as MOOCS/NPTL/SWAYAM. If a student wishes, he/she can take a few extra courses, which will be considered as add-on credits.

In addition to class-room teaching and laboratory, the M.Sc. Environmental Science program offers intensive training/internships to the students in the nationally reputed institutes. The semester breaks can also be utilized for the training and internships.

Students will be assessed through Mid-Term and End-Term examinations. Mode of assessment in the Mid-Term examinations consists of Tutorials, Home Assignments, Seminars, Field studies, Quizzes and Oral presentations. The End-Term examinations will be based on paper-pen pattern and laboratory experiments/calculations.

Every M.Sc. Environmental Science student has to mandatorily submit dissertation thesis. The dissertation work is based on either new data generated for the proposed scientific problem *OR* based on available large global data sets using innovative ideas. The thesis should be based on sound methodology and well defined objectives. Through dissertation work the student should be well-versed with the literature on the chosen topic, independently define a scientific problem, carry out focused study on a research topic, analyze and interpret large data sets, independently write thesis / project proposal and present and defend the dissertation work. The Dissertation must be submitted by the end of fourth Semester with a Seminar presentation in the presence of faculty members, students and external examiners for the purpose of evaluation. The School of Earth Sciences strongly encourages the M.Sc. Environmental Science students to publish their dissertation work in SCI journals.

# M.Sc. Environmental Science
# I Year - I Semester
# Syllabus

| M.Sc. Environmental Science, I Year, I Semester (Total Credits 25) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sr.No.** | **Subject** | **Code** | **Theory Paper** | **Credits** | | **Sr.No.** | **Code** | **Practical based on** | **Credits** |
| **1** | **Core** | ENS-C101 | Ecology and Biodiversity | 4 | | **1** | ENS-C105 | Ecology and Biodiversity | 2 |
| **2** | **Core** | ENS-C102 | Environmental Microbiology | 4 | | **2** | ENS-C106 | Environmental Microbiology | 2 |
| **3** | **Core** | ENS-C103 | Environmental Chemistry | 2 | | **3** | ENS-C107 | Environmental Chemistry | 1 |
| **4** | **Core** | ENS-C104 | Environmental Analytical techniques | 2 | | **4** | ENS-C108 | Environmental Analytical techniques | 1 |
| **5** | **Subject Elective (Choose any One)** | ENS- E101 | Environmental Geosciences | 3 | | **4** | ENS-E106 | Environmental Geosciences | 1 |
| | | ENS- E102 | Indian Environment | | | | ENS-E107 | Indian Environment | |
| | | ENS- E103 | Environmental Impact Assessment | | | | ENS-E108 | Environmental Impact Assessment | |
| | | ENS- E104 | Current Environmental Issues I | | | | ENS-E109 | Current Environmental Issues | |
| | | ENS- E105 | Wetland Ecology | | | | ENS-E110 | Wetland Ecology | |
| **6** | **Open Elective (for students from all the Schools including School of Earth Sciences)** | ENS-OE101 | Water Pollution | 2 | | **5** | ENS-C109 | Seminar | 1 |
| | | ENS-OE102 | Applied Microbiology | | | | | | |
| | | ENS-OE103 | Global Climate change | | | | | | |
| | | ENS-OE104 | Fundamentals of Environmental Chemistry | | | | | | |
| | | ENS-OE105 | Soil science | | | | | | |
| | | | **Total** | **17** | | | | **Total** | **8** |

# Department of Environmental Science
# School of Earth Sciences
# SRTM University
# NANDED

# ENS-C101: ECOLOGY AND BIODIVERSITY
# (Theory: 4 credits & Practical: 2 credits)

**Salient features of this Course:** Scope of Ecology, Population dynamics, Ecosystem functions, Community Structure, Adaptations to the climatic & other conditions, Successions, biodiversity importance and conservation

**Prerequisite:** Basic knowledge about living and non living components of environment and their interactions, climatic conditions and flora and fauna of particular place.

**Course Objectives:** This course aims to enable the students to gain knowledge about how the living and non living components are related to each other and their relationship decides their behavioural and special pattern.

**Course Outcomes:** On successful completion of the module, students should be capable of:

1. Identifying various ecosystems and their characteristics, functions and interactions.
2. Identifying various aspects of population ecology, community ecology, Concept of biodiversity, its Importance measurement methods and its status in India

## Course contents:

**Unit I: Introduction to Ecology**

Definition, Introduction of ecological status in India, Scope, Branches of ecology: Applied ecology, ecological importance, Environmental Factors and their impact on living organisms, Structure and function of an ecosystem, Food chain, Food web, Energy flow in an ecosystem, Types of ecosystem, Concept and types of productivity, Measuring primary productivity: Factors affecting primary production.

**Unit II: Population ecology**

Basic concepts of population ecology, Population dynamics, Characteristics: Natality, Mortality, Fecundity, Density, Age distribution, Biotic potential, Pray predator relationship, Concept of carrying capacity and distribution of population, Dispersion and migration of population, Factors influencing dispersion and migration.

**Unit III: Community ecology**

Definition and characteristics, Stratifications, Periodicity, Fluctuations, Eco-tone and edge effect, Ecological niche, Eco-types, Classification of Communities, Structure and features, Stability, Evolution of Community, Role of plants, animals and microorganisms and their inter-relationships, Ecological succession, Ecological Adaptations.

**Unit IV: Biodiversity** 15 Lectures

Concept of biodiversity and Importance, biodiversity status in India, Levels of biodiversity, Major hotspots of biodiversity in India, Types of biodiversity: Ecosystem, Species, Genetic, Measurement of biodiversity, Reasons of depletion of biodiversity, Biodiversity conservation

**ENS-C105: Practical based on ENS-C101 (2 Credits)**

## Prescribed and Reference Books


**01. Fundamentals of Ecology:** Eugene P. Odum, (Natraj Publishers, Dehradun)
**02. Principles of Ecology:** P. S. Verma, V. K. Agarwal (S. Chand and Co. New Delhi)
**03. Environmental Biology:** P. D. Sharma (Rastogi Publications, Meerut)
**04. Ecology and Environment:** P. D. Sharma (Rastogi Publications, Meerut)
**05. Principles of Environmental Biology:** P. K. G. Nair (Himalaya Pub. House, New Delhi)
**06. Environmental Biology:** M. P. Arora (Himalaya Publishing House, New Delhi)
**07. Environmental Science:** Enger Smith, Smith, W. M. C. Brown (Company Publishing)
**08. Principles of Soil Science:** Watt K. E. F. (1973), (McGraw Hill Book Comp, New Delhi)
**09. Introduction to Environmental Studies:** Turk & Turk
**10. Ecology and Field Biology:** Robert Leo Smith (Harper Collins college publication)
**11. General Ecology:** H. D. Kumar (Vikas Publishing house, New Delhi)
**12. Elements of Ecology:** Brijgopal, N. Bharadwaj (Vikas Publishing house, New Delhi)
**13. Fundamentals of Environmental Science:** G. S. Dahliwal, G. S. Sangha, P. K. Ralhan, Kalyani Publishers, New Delhi
**14. Environmental Ecology:** Bill Freedman (Academic Press, New York)
**15. Concepts of Ecology:** N. Arumugam (Saras Publication, Kottar, Dist. Kanyakumari)
**16. Plant Ecology:** P. L. Kochhar


# ENS-C102: ENVIRONMENTAL MICROBIOLOGY
# (Theory: 4 credits & Practical: 2 credits)

### Course Objectives:

Students are expected to have the advanced learning of Environmental microbiology. Course also discusses applications of microbial environment, eutrophication and its management, microorganism in extreme environments, microbial treatment, bioremediation and biodegradation of xenobiotics.

### Course Outcomes:

After learning the course the students should be able to:

1. Use the working knowledge of microbiology to appreciate the role of microbes in environmental pollution problem survey.
2. Perform basic experiments related to microbiological examination of water/soil/ food.
3. Relate the role of microorganisms in spread of human diseases and control.
4. Select the type of physical and chemical agents for microbial control for further studies.
5. Justify the role of microbes in bioremediation and industrial use for healthy ecosystem.

# Course Content

**UNIT I:**

History, Diversity and Scope of Microbiology: Importance of microbiology, Morphological Features and Significance: Viruses, Bacteria Algae, Fungi and Protozoa branches of microbiology: Microbes and food, Dairy Microbiology, Industrial Microbiology, Soil microbes isolation and significance, Cell elements its composition, Prokaryotic and Eukaryotic cell Phototrophy, Chemolithotrophy, Anaerobic respiration.

**UNIT II:**

Growth and reproduction of bacteria: Concept of Growth and reproduction, mechanism of binary fission, Growth, growth curve of bacterial population and its practical applications, generation time, Quantitative measurement of bacterial growth, Microbial metabolism and functional diversity of bacteria Prokaryotic diversity. Microbial ecosystems, Population and community environment, microenvironment, Microbial growth on surfaces environment, effects on microbial growth, environmental and microbial ecology.

**UNIT III:**

Microscopy and staining: Microscope, Types, Magnification, Resolution, Use of oil immersion objective, Compound microscope: Principle, Working and significance, Concept and types of stains, Smear Preparation, Simple and Differential staining Grams and Acid fast staining. Classification of bacteria based on: Nutrition, Physical factors: pH, Temperature, Water activity, Aeration, Chemical factors: Media, types of media, media ingredients. Methods in Microbial culture: Pure culture technique, Streak plate, Pour plate, spread plate. Sterilization methods: Sterilization by Physical agents, Dry heat and moist heat, Radiation etc. Chemical Sterilization: Ethylene oxide, Formaldehyde, Sterilization by filtration membrane filter, Control of microbes, Pasteurization, Ultraviolet light, Bacteriological examination of potable water MPN (Presumptive, Confirmative and Completed tests), Soil micro-flora, Rhizosphere. Role of microbes in carbon, nitrogen, sulphur cycle.

**UNIT IV:**

Application of microbes in environmental conservation, Investigations in environmental microbiology: sampling, detection, isolation, Bioremediation and wastewater microbiology, Acid mine drainage, Enhanced metal recovery. Drinking water microbiology, treatment, Water borne microbial diseases. Epidemiology, endemic, pandemic and biosensors, Public health and microbes, microbial awareness and sanitation education.

## ENS-C106: Practical based on ENS-C102 (2 Credits)

# Prescribed and Reference Books


1. Environmental Microbiology : Ralph Mitchell
2. Engineering- Treatment and Reuse :Metcalf and Eddy, Inc., Revised by Tchobanoglous, Burton and Stensel
3. Introduction to Microbiology: A.S. Rao
4. Environmental Microbiology: Manish L. Shrivastva
5. Handbook of Bioremediation Edited : Norris et al, Robert S. Kerr; Environmental Research Laboratory
6. Bioremediation Principles: Ewies, Ergas, Chang and Schroeder
7. General microbiology Volume I & II: C. B. Powar & H. F. Daginawala (Himalaya publishing House, Mumbai), 2002
8. Fundamental principles of Bacteriology: A. J. Salle, (Tata McGraw-Hill Publishing Company, New Delhi), 1974
9. Microbiology: P. D. Sharma (Rastogi publication Meerut)
10. Microbiology: Pelczer, Reid & Chan (Tata McGraw-Hill Publishing Company Limited, New Delhi)
11. Hand book of Microbiology: Yu. S. Krivashein (Mir Publishers Moscow)
12. Microbiology for Environmental Engineering: M. C. Kinnery (Tata McGraw-Hill Publishing Company New Delhi)
13. Introduction to Virology: S. B. Biswas
14. General microbiology: Stainier
15. Applied Microbiology: Kale & Kishore Bhusari (Himalaya Publishing House, Mumbai)
16. Medical Microbiology: Day & Day and Anantnarayan

# ENS-C103: ENVIRONMENTAL CHEMISTRY
# (Theory: 2 credits & Practical: 1 credit)

## Salient features of this Course:

Environmental chemistry is the study to study the fate of pollutants in environment. It deals with the distribution and relations between environment and chemicals. The contemporary environmental issues will be discussed with basic chemistry to identify possible solutions to recent environmental problems in front of the world. The students will be able to understand the chemistry of air, water, soil and how the anthropogenic activities are responsible for present situation. The students will examine the sources, reactions, transport mechanism, effects and control measures of chemicals present into the surrounding atmosphere.

## Pre-requisites:

This course may be taken up by students from any discipline to understand the basics of environmental chemistry and fate of chemicals. Students will learn about the basic environmental issues caused by innumerous chemicals spread by anthropogenic activities and their impact as well as they will understand preventive and corrective measures to deal with these chemicals.

## Course Objectives:

1. To enhance the knowledge about fundamental chemical processes and their impact on the surroundings.
2. To develop new methodologies to tackle environmental pollutions.
3. To encourage students to develop and promote awareness among the society regarding pollution and its prevention.
4. To undertake the role of individual/volunteer in pollution prevention.
5. To understand chemical laboratory safety guidelines.

## Course Outcomes:

At the completion of the course the students will be able to

1. Understand about basics of Environmental Chemistry and chemicals associated risk to the surround environment.
2. It will help students to understand burning current environmental issues like Air pollution, Green house effect, global warming, ozone depletion etc.
3. It may recognize potential environmental impacts of substances.
4. They will understand chemical laboratory safety guidelines.
5. It will add to their knowledge about quantitative concepts, like normality, molarity, concentration, exposure levels and limits, as it is necessary for the evaluation of the impact of a substance.
6. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

# Course Content

**Unit I:**

Environmental Chemistry: Introduction, Concept and scope, Importance, Basic water chemistry, Solubility and Impurities, Gases solubility in water, Alkalinity or Acidity of water, Concentration, Normality, Molarity, Concept of dilution, Single step dilution, Serial dilution, Multiple step dilution, Sample collection guidelines, Sample preservation, Sampling order, Sample labeling, Data collection and record keeping, Laboratory safety procedures. Accuracy and Precision, Use of chemicals in potable water treatment, Potable water quality standards, Pesticides in water, Hydrocarbons, saturated and unsaturated hydrocarbons, Solutions and colloids, Types of solutions, Buffer solutions and their role, Soaps, Detergent wastes and its effects, Paints.

**Unit II:**

Industrial activity and environment, Chemistry of Air pollutants from industries, particulate matter, Photochemical Smog formation, Chemistry of acid rain, Formation of acid rain, Effects of acid rain, Efforts to control acid rain, legal aspects to control air pollution, Nuclear accidents and related case studies. Global warming, Measurement, Effects, Control of global warming, Bhopal gas tragedy, Carcinogens, Carbon sequestration, Ozone depletion, Trace metal characteristics in relation to toxicity, Biochemical effects of trace elements.

## ENS-C107: Practical based on ENS-C103 (1 Credit)

# Prescribed and Reference Books


1. Environmental Chemistry: B.K. Sharma, and H. Kaur, Goel Publishing House.
2. Environmental Chemistry by A. K De, New Age International Publishers
3. Elements of Environmental Chemistry : H.V. Jadhav.
4. Environmental Chemistry : Samir K. Banerjee, Prentice Hall of India Pvt. Ltd. New Delhi.
5. Environmental Chemistry : J. W. Moore and E. A. Moore
6. Environmental Pollution, N. Manivasakam
7. A Test Book of Environmental Chemistry & Pollution Control by S. S. Dara, S. Chand and Co.
8. Fundamentals of Environmental Chemistry by Manahan, Stanley E.
9. Chemistry of the Environment by Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. Strong, Elsevier Science & Technology Books
10. Applications of Environmental Chemistry by Eugene R. Weiner, CRC Press, LLC
11. Environmental Pollution Analysis : Khopkar
12. Environmental and Man : The Chemical Environmental : J. Lenihan and W.W. Fletcher

# ENS-C104: ANALYTICAL TECHNIQUES
# (Theory: 2 credits & Practical: 1 credit)

## Salient features of this Course:

The course content is very important to students to know the various analytical techniques for air soil, water analysis techniques. The environmental pollution are directly linked to development and economic growth of the nation.

## Pre-requisites:

This course may opt by any students from science discipline to understand the air and water pollution and its control measures for protection of natural resources.

## Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of analysis of environmental contaminants.
2. To study and analyse the impacts of air, soil and water contaminants (energy, resources/waste) within the built, urban, agricultural and natural environments.

## Course Outcomes:

At the completion of the course the students will be able to

1. Analyze and interpret the air, water, soil etc pollution problems.
2. Students can be able to handle the various instrument and their applications in analysis of soil, water and air contaminants.
3. Students are able to think critically and contribute to research in solving contemporary air and water pollution problems with professional and ethical accountability.

## Course contents:

**Unit I:**

Significance and the role of Instruments in various analysis, Factors affecting measurement, Classification of Instrumental methods, Types of errors: Determine errors, Indeterminate errors, principals of colorimetry, theory, working and applications. Fluoride meter principle, working, Salient features of this Course, High Volume Air Sampler, Respirable Dust Sampler uses, CO detector and its applications, Digital pH meter, Conductivity meter and its working, Nephlometry and Turbidity meter **a**pplications in Environmental studies, potentiometry method, types of electrodes,

**Unit II:**

Principle and working of ICPAES, Principle and working of Spectrophotometer, Ultra Violet (UV), Spectrophotometer working and applications, Infra Red (IR) Spectrophotometer: working and applications, working and applications; Atomic Absorption Spectrophotometer (AAS): working, applications and its importance, Flame Photometer: working and applications in environmental Analysis, Uses and working of BOD cooling incubator, Laminar air flow applications and working, Colony counter its working and applications in microbial study, COD digester working and uses for analysis of various effluents and samples, Gas analyser applications and working, Industrial stack analysers, Chlorine testing kit applications, Soil testing kit and its importance in nutrient study.

## ENS-C108: Practical based on ENS-C104 (1 Credit)

# Prescribed and Reference Books


1. **Instrumental Methods of Chemical Analysis :** Gurdeep Chatwal (Himalaya Publishing House, New Delhi), 2000
2. **Instrumental Methods of Analysis :** Willard Merit and Dean (CBS Publication, New Delhi)
3. **Instrumental Methods of Environmental Analysis :** Karan Sareen, ( Sarup ans Sons Publishers, New Delhi ), 2001
4. **Instrumental Methods of Chemical Analysis :** B. K. Sharma, Goel Publishing House, Meerut (1996).
5. **Standard Methods for the Examination of Water and Waste Water :** ( APHA, AWWA & WPCF ), 1985
6. **Instrumental Methods and chemical Analysis:** H. Kaur, Pragati Prakashan, Merrut (2009).
7. **Instrumental Analysis :** Shoog Holler (Harcourt Asia Publishers Ltd., New Delhi), 1952
8. **Instrumental Methods of chemical Analysis:** Chatwal and Anand (Himalaya Publishing House, New Delhi), 1994
9. **Instrumental Methods :** V. B. Borade (Nirali Prakashan, Mumbai)
10. **Instrumental Analysis for science and technology:** W. Ferren (Agrobios India, Jodhpur)

# ENS-E101: ENVIRONMENTAL GEOSCIENCES (Theory: 3 credits & Practical: 1 credit)

**Pre-requisite(s):** Any B. Sc., B. Sc. Agri./Forestry, B.E. Civil

**Course Objectives:** This course aims to:

1. To develop the basic observational skills needed to function as geoscientists.
2. To make quantitative measurements of various physical and chemical properties of the Earth system.
3. To develop mapping skills and use such (topographic and geologic) maps to estimate distances, visualize landforms, and locate / identify geologic features.
4. To identify the common forms of igneous, metamorphic, and sedimentary rock in hand samples and in field exposures using observations of mineral composition and texture.
5. To teach them the Climates of India, weathering process and formation of Soil.

**Course Outcomes:** On completion of this course, students should be able to:

1. Demonstrate knowledge of: physical and chemical properties of the lithosphere and hydrosphere (minerals, rocks, soils, and water); geologic time and earth history; and crustal materials.
2. Demonstrate competence in fundamental geological skills including: mineral, rock and soil identification; interpretation of topographic maps, geologic maps, and collection of organized field and laboratory data.
3. Apply the Geoscience knowledge in solving various environmental problems and issues
4. Gain an understanding of the societal relevance of earth systems.

## Course contents:

**Unit I**

Origin of Earth. Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere. Concept of minerals and rocks. Formation of igneous, sedimentary and metamorphic rocks. Controls on formation of landforms - tectonic including plate tectonic and climatic.

**Unit II**

Energy budget of the Earth. Earth's thermal environment and seasons. Climates of India, western disturbances, Indian monsoon, droughts, El Nino, La Nina. Concept of residence time and rates of natural cycles. Paleoclimates.

**Unit III**

Weathering- Physical and Chemical Weathering processes. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls. Geochemical classification of elements, abundance of elements in bulk earth; crust, hydrosphere and biosphere. Partitioning of elements during surficial geologic processes; Geochemical recycling of elements.

## ENS-E106: Practical based on ENS-E101 (1 Credit)

# Prescribed and Reference Books

**Text Books:-**

1. Textbook of Geology Paperback – G.B. Mahapatra

2. Principles of Geology—Charless Lyell

3. Fundamentals of Soil Science—Henry D. Foth

4. An Introduction to Geology: With Multiple Choice Questions Paperback – V. S. Joji

5. Weathering Hardcover – Lucy Wood

**Reference Books:-**

1. Essentials of Geology-- Frederick K. Lutgens, Dennis G. Tasa

2. Essentials of Geology Loose Leaf – Stephen Marshak

# ENS-E102: INDIAN ENVIRONMENT
# (Theory: 3 credits & Practical: 1 credit)

**Salient features of this course:** Indian environment is diverse ecological system, comprising of Glaciers, Marine, Riverine, Forest, Grassland, Terrestrial, Mountains, Desert, Brackish as well as Wetland respectively. Indian environment study deals with the status of abiotic and biotic factors and its interactions so our emphasis of this course is to propagate this huge biodiversity system. It included diversity of organisms in an environment, interactions among individuals within a population, and interactions among species.

## Pre-requisites:

The aim of this module is to provide an understanding of

(i) Indian environment and the various factors influencing the biodiversity and all.
(ii) Impacts of several climate change factors will help for the planning and conservation methods.

## Course Objectives:

1. To understand the fundamental concepts of environment in concern with Indian climate and the widely distributed abiotic and biotic resources.
2. Demonstrate an understanding of the application of environmental resources includes air, water, soil, vegetation, agriculture etc.
3. To study meticulously from minor to major resources with the information about species ecosystem and its environment, with an emphasis on Its need in maintaining environmental balance.

## Course Outcomes:

1. Appreciation of the need for both a multi-disciplinary and an interdisciplinary approach in advancing knowledge and understanding of Environment, Ecology, Aquatic species and the climate.
2. Knowing of the processes which shape the natural healthy ecosystem at different temporal and spatial levels, provides the information about diverse resources.
3. Understanding of the contribution of individual biotic species and its scope for the society in keeping local and global environment balance for better human life with deep study of global climate change impact and preparedness.

## Course contents:

**UNIT-I**

Climate of India, precipitation, monsoon, influence of climate factors on ecological systems, impact study on aquatic flora and fauna, Indian vegetation, forest, agriculture system, role of rivers in overall development of Indian sectors, global warming, climate change role and mitigation, wild life species conservation, environmental laws implementation of air, water, national forest policy, biodiversity act., wild-life protection act. importance of social forestry, industrial forestry, medicinal forestry, aforestation, causes of deforestation, flood control methods, water recharge techniques, national environmental policies, environmental researches, use of RS and GIS in environmental resources study.

**UNIT-II**

Atmosphere, water cycle, lithosphere, hydrosphere, perennial and non-perennial rivers in India, role of major projects/dams in development of electricity, industries and agriculture, biotic communities, water conservation, rainwater harvesting methods and its implementation, ground water storage, wide awareness programs/projects, role of Governmental and NGO's agencies in maintenance of environmental resources, Chipko movement and other, peoples participations in protecting vegetation/forest, climate change impact on water bodies and wetland ecosystems, eco-friendly works/projects, sustainable development.

**UNIT-III**

Ecology and ecological characteristics, perspectives, freshwater and marine ecosystems and its resources, impact of air, water pollutants on surrounding environment, mitigation of various pollution sources in relation to local environment, environmental related projects on biodiversity, biodiversity conservation, Global agreements and national concerns, Swachh Bharat Abhiyan, Clean India Green India project, energy and environmental strategies in India, non-conventional energy resources utilization project implementation, biomass, biogas energy generation project and distribution system, composting and waste recycling techniques, national river purification projects.

## ENS-E107: Practical based on ENS-C102 (1 Credit)

# Prescribed and Reference Books


1. Mills, D.H. (1972) An introduction to freshwater Ecology. Liver & Boyd, Edinburg
2. Das, S.M. (1989) Hand book on Limnology & Water Pollution. South Asian Publishers, New Delhi.
3. Verma & Agarwal (1995) Environmental Biology (Principles of Ecology) Chand & Co, New Delhi.
4. S C Santra, Environmental Science.
5. Chokkan, K.B., Pandya, H. and Raghunathan, H. (Eds). 2004. Understanding Environment. Sagar publication India Pvt. Ltd., New Delhi

6. Harper, C., Harper, C.L. and Snowden, M. 2017. Environment And Society: Human Perspectives On Environmental Issues.

7. Hukkinen, J.I. 2012. Social networks and natural resource management: uncovering the social fabric of environmental governance.

8. Kumar, M. 2014. Adaptations to Climatic Variability: Irrigation, and Settlements patterns in Early Medieval Rajasthan,

9. Rangarajan, M. and Sivaramakrishnan, K.2012. India's Environmental History (2 Vols.).

# ENS-E103: ENVIRONMENTAL IMPACT ASSESSMENT
# (Theory: 3 credits & Practical: 1 credit)

## Salient features of this Course:

The course content is very important to students of any discipline to know the environment related problems. It is essential to understand the role of international and national organizations in environmental protection and conservation. The environmental management is directly linked to development and economic growth of nay nation. So the management of our own natural environment has become an important segment in achieving sustainable development

## Pre-requisites:

This course may opt by any students from any discipline to understand the environmental impact assessment study for developmental projects for protection of natural resources.

## Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of sustainable environmental management in any organizations. Moreover to address the issues like environmental conservation and natural resource management in sustainable manner.
2. To understand the EIA process and their role in developmental projects and conservation.

3. To study and analyse the impacts of flows (energy, water, resources/waste) within the built, urban, agricultural and natural environments.

## Course Outcomes:

At the completion of the course the students will be able to

01. Analyze and interpret the environmental problems at national and international level.

02. It is important to predict the environmental impacts of developmental projects and engineered solutions in global and socio-economic context.

03. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability.

04. It is useful for politicians, decision makers, local bodies, Bureaucrats etc for effective management.

# Course contents:

**Unit I:**

Environmental Impact Assessment (EIA), Aims and objectives of EIA, EIA Methods: Environmental impact statement (EIS), Conceptual approach for EIA studies its scope & objectives. Procedure for reviewing EIA of developmental projects,

**Unit II:**

Life-cycle analysis, cost-benefit analysis, Guidelines for Environmental Audit. Collection of base line data, Selection of data source, EIA Check lists, Matrix & Network methods for EIA. Prediction of short & long term impacts on environment (physical, biological & socio culture).

**Unit III:**

Public Participation, Methodology and approach for public participation, Regulatory requirements, Advantages and disadvantages of Public participation, EIA Notification 1994, 2006 and amendments. Accreditation of EIA consultants by Quality Control of India – requirements and guidelines Case studies related EIA.

## ENS-E108: Practical based on ENS-E103 (1 Credit)

# Prescribed and Reference Books

01. Environmental Law & Policy in India: Divan S & Rosencraz A,Oxford Uni Press, New Delhi, 2001

02. Conservation & Environmentalism-An Encyclopedia: Paehlka R. Garland Pub Inc.New York, 1995

04. Environmental Awareness & Education: V. P. Kudesia, Educational Publishers,Meerut U.P.

05. Biodiversity: V. P. Kudesia, Educational Publishers, Meerut, U.P.

06. Our Environment and Green Revolution : M. P. Mishra, S.Chand & Co.Ltd.New Delhi, 2000

07. Environmental Concerns & Strategies : T. N. Khoshoo.

08. Environmental Management in India : R. K. Sapru.

09. Forests in India : V. P. Agrawal, Oxford & IBH Publishing Co. Pvt.Ltd. New Delhi, 1968

10. Environmental Impact Assessment: R.R. Barthwal

11. An Introduction to Environmental Management : Dr. Anand S. Bal, Himalaya Pub House, 2005.

12. Environmental Management ; N. K. Uberoi, Excel publication new Delhi. 2ndedition.

13. Introduction To Environmental Impact Assessment: John Glasson, Riki Therivel

14. Environmental Impact Assessment: Larry W. Canter McGraw-Hill, 1996 -Technology & Engineering

15. Shukla, S.K. and Srivastava, P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.

16. Ministry of Environment & Forests, Govt. of India 2006 EIA Notification

# ENS-E104: Current Environmental Issues- I
# (Theory: 3 credits & Practical: 1 credit)

## Salient features of this Course:

This interdisciplinary course aims to increase the basic understanding of current environmental problems and their probable solutions. Our environment is changing constantly due to the natural and anthropogenic activities. The students should be aware about these changes, their consequences and solutions to cope up with the situation. These events required urgent attention as they are making us more vulnerable to disasters. Environmental issues are a warning of the future disaster and if they are not controlled, soon earth may become lifeless.

## Pre-requisites:

This course may be taken up by students from any discipline to understand the fundamental concepts related to the environmental issues and the science behind them.

## Course Objectives:

1. To make students aware with present issues obstructing the sustainable environmental development.
2. To enhance the knowledge about environmental concerns.
3. To develop new methodologies to tackle environmental problems.
4. To encourage students to develop and promote awareness among the society regarding current environmental issues and related information with development of common solutions to the environmental issues.
5. To undertake the role of individual/volunteer in managing these issues and to develop an awareness about environmental issues.

## Course Outcomes:

At the completion of the course the students will be able to

1. It will help students to understand burning current environmental problems like epidemic issues, problems associated with various pollutions like Green house effect, global warming, ozone depletion, solid waste and its management etc.
2. Students will learn about the basic environmental issues caused by anthropogenic and natural activities and their impact as well as they will understand preventive and corrective measures to deal with.
3. It may recognize potential environmental impacts of associated problems.
4. Students can think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

## Course contents:

The Syllabus includes recent developments in relation to the environmental sciences including Global Environmental problems like global warming, climate change, pollution and pollution mitigation studies, energy resources, green energy, Environmental Education and Awareness, and other aspects in the field of environmental sciences. It will also cover happenings at national and international level, environmental amendments etc.

**ENS-E109: Practical based on ENS-E104 (1 Credit)**

# ENS-E105: WETLAND ECOLOGY
# (Theory: 3 credits & Practical: 1 credit)

**Salient features of this Course:** Introduction to wetlands, Wetland Hydrology, Biochemistry of Wetlands, Wetland classification, Wetland management

**Pre-requisite:** There are no specific prerequisites for this class, but it is expected that students are familiar with basic principles of chemistry, physics, and biology.

**Course Objectives:** This course will introduce and discuss the definition of a wetland; characteristics of wetland systems; the principles of wetland ecology; the functions of wetlands; and regulations and permitting process regarding development near and within wetlands. This course is designed to introduce you to the major conceptual and factual bases for understanding, studying, managing and utilizing wetlands.

**Course Outcomes:** At the completion of the course the students will be able to

1. Conduct wetland delineations or wetland functional assessments,
2. Pursue career planning's in natural resource management while working in consulting, industry, government, or a non-profit organization.

## Course contents:

**Unit I:**

Introduction to wetlands, Biological adaptations, Ecosystem Development, World wetlands, Indian wetlands, Wetland Hydrology, Biochemistry of Wetlands

**Unit II:**

Wetland classification, Wetland values, Human impacts, Wetland conservation

**Unit III:**

Wetland management, Ramsar Convention, Wetland Regulations, Wetland Mapping, Treatment, Wetland Creation and restoration

## ENS-E110: Practical based on ENS-E105 (1 Credit)

## Prescribed and Reference Books


1. Mitsch, W.J. and J.G. Gosselink. 2015. Wetlands, 5th edition. John
    a. Wiley and Sons, NY, NY. 736 pp. Available digitally.
2. Wright, W. and J. Gosselink 2007. *Wetlands*, Fourth Edition. 2007. John Wiley & Sons, Inc. 582 pp.
3. Wetlands, 2000, 3rd edition, Wiley (www.wiley.com, ISBN 047129232X) *or*
4. Rivers under Siege, UT Press (http://utpress.org/, ISBN 1572334908) Jim W. Johnson


# ENS-OE101: WATER POLLUTION
# (Theory: 2 credits)

### Salient features of this Course:

The course content is very important to students to know the water pollution related problems. The environmental pollution are directly linked to development and economic growth of the nation.

### Pre-requisites:

This course may opt by any students from science discipline to understand the water pollution and its control measures for protection of natural resources.

### Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of water pollution problems and there control measures.

2. To know the water pollution legislation and their operations at national level.

3. To study and analyse the impacts of water contaminants within the built, urban, agricultural and natural environments.

## Course Outcomes:

At the completion of the course the students will be able to

1. Analyze and interpret the water pollution problems.

2. Students can be able to understand the sources and impacts of water pollutants on living and nonliving things.

3. Students are able to think critically and contribute to research in solving contemporary water pollution problems with professional and ethical accountability.

4. It is useful for politicians, decision makers, local bodies, bureaucrats etc for effective management of pollution problems.

## Course contents:

**Unit I**

Definition, Hydrosphere, Types of water pollutants- physical, chemical, biological, Classification of pollutants- Inorganic pollutants, organic pollutants, Biological pollutants, sediments, Oxygen demanding waste, DO and BOD interrelationship, Disease causing agents, Radioactive pollutants

**Unit II**

Sources of water pollution- Point sources, Non point sources, Natural and Anthropogenic sources, Sewage and domestic waste, Industrial effluent (like Dairy, Sugar, Paper & Pulp, Distillery and food processing, etc.), Agricultural discharges (Fertilizers, Pesticides, Herbicides, etc.), Detergents, Toxic metals, Thermal pollution Types of pollution- Groundwater pollution (F, Fe, Mn As), Surface water pollution- Lake water pollution, River water pollution, Eutrophication, Marine pollution, Effect on life

## Prescribed and Reference Books

01. Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996.

02. Aquatic Pollution: An Introductory Text: By Edward A. Laws

03. Water Pollution: Causes, Effects and Control - P. K. Goel

# ENS-OE102: APPLIED MICROBIOLOGY
# (Theory: 2 credits)

## Course Objectives:

Students are expected to have the advanced learning of Environmental microbiology. Course also discusses applications of microbial environment, eutrophication and its management, microorganism in extreme environments, microbial treatment, bioremediation and biodegradation of xenobiotics.

## Course Outcomes:

After learning the course the students should be able to:

1. Use the working knowledge of microbiology to appreciate the role of microbes in environmental pollution problem survey.
2. Perform basic experiments related to microbiological examination of water/soil/ food.
3. Relate the role of microorganisms in spread of human diseases and control.
4. Select the type of physical and chemical agents for microbial control for further studies.
5. Justify the role of microbes in bioremediation and industrial use for healthy ecosystem.

## Course contents:

**UNIT I: History and scope of environmental microbiology**

Diversity and Scope of Microbes, microbial applications, viruses, bacteria, algae, fungi, protozoa branches of microbiology, soil microbes isolation and significance, micronutrients, macronutrients, prokaryotic and eukaryotic, concept of growth, growth curve of microbial population, quantitative measurement of bacterial growth, microscope, compound microscope, principle, working and significance. Staining methods, media, types of media, media ingredients. methods of microbial culture, pure, streak, pour and spread plate. Sterilization of microbial cultures, control of microbes, pasteurization, bacteriological examination of potable water,

**UNIT II: Microbial techniques**

Microbes and organic waste, biogas generation techniques, waste recycling characteristics of microbes, application of microbes in environmental conservation, bio-fertilizers and its wide applications in farming, investigations in environmental microbiology, sampling, detection, isolation, bioremediation and wastewater microbiology, drinking water microbiology, treatment, water borne microbial diseases. Symbiotic microbial culture, epidemiology of

microbes, microbes and human and plant health, general awareness of microbial diseases, social and preventive methods in microbial spread, microbial diversity.

## Prescribed and Reference Books


1. Environmental Microbiology : Ralph Mitchell
2. Introduction to Microbiology: A.S. Rao
3. Environmental Microbiology: Manish L. Shrivastva
4. Bioremediation Principles: Ewies, Ergas, Chang and Schroeder
5. General microbiology Volume I & II: C. B. Powar & H. F. Daginawala (Himalaya publishing House, Mumbai), 2002
6. Fundamental principles of Bacteriology: A. J. Salle, (Tata McGraw-Hill Publishing Company, New Delhi), 1974
7. Microbiology: P. D. Sharma (Rastogi publication Meerut)
8. Microbiology: Pelczer, Reid & Chan (Tata McGraw-Hill Publishing Company Limited, New Delhi)
9. General microbiology: Stainier
10. Medical Microbiology: Day & Day and Anantnarayan.


# ENS-OE103: GLOBAL CLIMATE CHANGE (Theory: 2 credits)

### Salient features of this Course:

The course content is very important to students of any discipline to know the global environment related problems. It is essential to understand the role of international and national organizations in environmental protection and conservation. The environmental management is directly linked to development and economic growth of nay nation. So the management of our own natural environment has become an important segment in achieving sustainable development

### Pre-requisites:

This course may opt by any students from any discipline to understand the global environmental problems for protection of natural resources and sustainable development.

### Course Objectives:

This introductory course will give students an integrated overview of the science of climate

change and an analysis of the implications of this change for patterns of daily life in their

own circumstance and around the world. Identify the anthropogenic drivers of climate change. Explain observed and projected trends and impacts in the climate. Analyse different climate change scenarios and their implications.

## Course Outcomes:

At the completion of the course the students will be able to

1. Analyze and interpret the environmental problems at national and international level.

2. It is important to predict the environmental impacts of developmental projects and engineered solutions in global and socio-economic context.

3. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability.

4. It is useful for politicians, decision makers, local bodies, Bureaucrats etc for effective management.

5. After completing the course, students will be able to:

- Present the international climate change legal and policy framework and explain key issues under negotiation.
- Describe the expected consequences of climate change and the role of adaptation.
- Provide a rationale for climate change mitigation and propose actions in key sectors.

# Course contents:

### Unit 1: Introduction to Global Climate Change Science

Introduction to Global Climate Change Science, basics of climate change science. key concepts such as climate, weather and the greenhouse gas effect. Human contribution to climate change and provides an overview of important greenhouse gases and their main sources. Impact of industrial revolution on climate change, surface temperature, precipitation, ocean pH, sea-level and Arctic sea-ice extent, Ozone depletion etc. Global Environmental Issues – Biodiversity loss, Climate change, International efforts for environmental protection.

### Unit 2: Introduction to the International Legal and Policy Framework

Overview of how the international legal and policy framework to address climate change developed over time and points out some of the key issues under negotiation. A brief history of international climate change negotiations and introduces the 4 United Nations Framework Conventions on Climate Change (UNFCCC). Kyoto Protocol and its associated bodies. climate change adaptation, Climate Change Mitigation, roles of national international bodies in climate change planning. National Action Plan on Climate Change (Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, Green India', National Mission for Sustainable Agriculture Case studies of global climate changes.

## Prescribed and Reference Books


1. Cambridge University (2013). Climate Change: Action, Trends and Implications for Business.

2. Policymakers.

3. OECD (2009): Guidance on Integrating Climate Change Adaptation into Development Co-operation.

4. UNEP (2009). Climate Change Science Compendium UNEP (2009). Climate in Peril, a Popular Guide to the Latest IPCC Report.

5. UNFCCC. CGE Climate Change Training Materials.

6. UNFCCC (2008). Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change.

7. World Bank Report (2012). Turn Down the Heat. World Meteorological Organization (2012). Greenhouse Gas Bulletins.

8. Our Environment and Green Revolution : M. P. Mishra, S.Chand & Co.Ltd.New Delhi, 2000

9. Environmental Concerns & Strategies : T. N. Khoshoo.

# ENS-OE104: FUNDAMENTALS OF ENVIRONMENTAL CHEMISTRY (Theory: 2 credits)

## Salient features of this Course:

Environmental chemistry is the study to study the fate of pollutants in environment. It deals with the distribution and relations between environment and chemicals. The contemporary environmental issues will be discussed with basic chemistry to identify possible solutions to recent environmental problems in front of the world. The students will be able to understand the chemistry of air, water, soil and how the anthropogenic activities are responsible for present situation. The students will examine the sources, reactions, transport mechanism, effects and control measures of chemicals present into the surrounding atmosphere.

## Pre-requisites:

This course may be taken up by students from any discipline to understand the basics of environmental chemistry and fate of chemicals. Students will learn about the basic environmental issues caused by innumerous chemicals spread by anthropogenic activities and their impact as well as they will understand preventive and corrective measures to deal with these chemicals.

## Course Objectives:

1. To enhance the knowledge about fundamental chemical processes and their impact on the surroundings.
2. To develop new methodologies to tackle environmental pollutions.
3. To encourage students to develop and promote awareness among the society regarding pollution and its prevention.
4. To undertake the role of individual/volunteer in pollution prevention.
5. To understand chemical laboratory safety guidelines.

## Course Outcomes:

At the completion of the course the students will be able to

1. Understand about basics of Environmental Chemistry and chemicals associated risk to the surround environment.
2. It will help students to understand burning current environmental issues like Air pollution, Green house effect, global warming, ozone depletion etc.
3. It may recognize potential environmental impacts of substances.
4. They will understand chemical laboratory safety guidelines.
5. It will add to their knowledge about quantitative concepts, like normality, molarity, concentration, exposure levels and limits, as it is necessary for the evaluation of the impact of a substance.

6. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

## Course contents:

**Unit I:**

Environmental Chemistry: Introduction, Concept and scope, Importance, Basic water chemistry, Alkalinity or Acidity of water, Concentration, Normality, Molarity, Concept of dilution, Single step dilution, Serial dilution, Multiple step dilution, Sample collection guidelines, Sample preservation, Sampling order, Sample labeling, Data collection and record keeping, Laboratory safety procedures. Accuracy and Precision, Use of chemicals in potable water treatment, Potable water quality standards, Pesticides in water, Hydrocarbons, saturated and unsaturated hydrocarbons, Buffer solutions and their role, Soaps, Detergent wastes and its effects, Paints.

**Unit II:**

Industrial activity and environment, Chemistry of Air pollutants from industries, particulate matter, Photochemical Smog formation, Chemistry of acid rain, Formation of acid rain, Effects of acid rain, Efforts to control acid rain, Nuclear accidents and related case studies. Global warming, Measurement, Effects, Control of global warming, Bhopal gas tragedy, Carcinogens Carbon sequestration, Ozone depletion.

## Prescribed and Reference Books


1. Environmental Chemistry: B.K. Sharma, and H. Kaur, Goel Publishing House.
2. Environmental Chemistry by A. K De, New Age International Publishers
3. Elements of Environmental Chemistry : H.V. Jadhav.
4. Environmental Chemistry : Samir K. Banerjee, Prentice Hall of India Pvt. Ltd. New Delhi.
5. Environmental Chemistry : J. W. Moore and E. A. Moore
6. Environmental Pollution, N. Manivasakam
7. A Test Book of Environmental Chemistry & Pollution Control by S. S. Dara, S. Chand and Co.
8. Fundamentals of Environmental Chemistry by Manahan, Stanley E.
9. Chemistry of the Environment by Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. Strong, Elsevier Science & Technology Books
10. Applications of Environmental Chemistry by Eugene R. Weiner, CRC Press, LLC
11. Environmental Pollution Analysis : Khopkar
12. Environmental and Man : The Chemical Environmental : J. Lenihan and W.W. Fletcher

# ENS-OE105: SOIL SCIENCE
# (Theory: 2 credits)

**Salient features of this Course:** Formation, physical and chemical composition of soil, erosion & ecology of soil

**Pre-requisite:** Basic knowledge about components of environment and their interactions

**Course Objectives:** This course aims to enable the students to gain knowledge about how the Soil, its formation and its importance for plants and their growth

**Course Outcomes:** On successful completion the module, students should be capable of

1. Identifying various physical and chemical properties of soil
2. Identifying soil properties and its effect on plants

## Course contents:

**Unit I:**
Factors of plant growth, Plant roots and soil relations, Soil physical properties, Soil water, Energy and pressure relationships, the soil water potential, Soil water movement, Plant and soil, water relations, Soil ecology, Soil organic matter, Weathering and soil mineralogical composition, Soil clay minerals, Chemical composition of soils, Effects of flooding on chemical properties

**Unit II:**
Plant-soil macronutrient relations, Deficiency symptoms, Soil fertility evaluation, Application and use of fertilizers, Animal manures, Land application of sewage sludge, Fertilizer use and environmental quality, Sustainable agriculture

## Prescribed and Reference Books


1. Introductory Soil science by Dilip Kumar Das
2. Fundamentals of Soil science by Henry D froth
3. Fundamentals of Soil science by Eetela Sathyanarayana
4. Textbook of Soil science by T Biswas
5. Soil science at a glance by A M Latare
6. Soil science by Dr. S V Prasad

# M.Sc. Environmental Science
# I Year - II Semester
# Syllabus

| M.Sc. Environmental Science, I Year, II Semester (Total Credits 25) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sr.No.** | **Subject** | **Code** | **Theory Paper** | **Credits** | | **Sr.No.** | **Code** | **Practicals based on** | **Credits** |
| **1** | **Core** | ENS-C201 | Air and Water Pollution | 4 | | **1** | ENS-C204 | Air and Water Pollution | 2 |
| **2** | **Core** | ENS-C202 | Energy Resource management | 4 | | **2** | ENS-C205 | Energy Resource management | 2 |
| **3** | **Core** | ENS-C203 | Environmental Biotechnology | 4 | | **3** | ENS-C206 | Environmental Biotechnology | 2 |
| **4** | **Open Elective (to be selected by the School Student within the subject)** | ENS- E201 | Noise Pollution | 3 | | **4** | ENS- E207 | Noise Pollution | 1 |
| | | ENS- E202 | Fresh water biology | | | | ENS- E208 | Fresh water biology | |
| | | ENS- E203 | E- Waste | | | | ENS- E209 | E- Waste | |
| | | ENS- E204 | Fundamentals of Computer Applications | | | | ENS- E210 | Fundamentals of Computer Applications | |
| | | ENS- E205 | Current Environmental Issues II | | | | ENS- E211 | Current Environmental Issues II | |
| | | ENS- E206 | Bioremediation | | | | ENS- E212 | Bioremediation | |
| | **Open Elective For Students from other schools in University** | ENS-OE201 | Basics of Remote Sensing | 2 | | **5** | ENS-C207 | Seminar | 1 |
| | | ENS-OE202 | Bioinstrumentation | | | | | | |
| | | ENS-OE203 | Basics of Noise Pollution | | | | | | |
| | | ENS-OE204 | Fundamentals of Computer Applications | | | | | | |
| | | ENS-OE205 | Bioremediation | | | | | | |
| | | | **Total** | **17** | | | | **Total** | **8** |

# Department of Environmental Science
# School of Earth Sciences
# SRTM University
# NANDED

# ENS-C201: AIR AND WATER POLLUTION
# (Theory: 4 credits & Practical: 2 credits)

## Salient features of this Course:

The course content is very important to students to know the air and water pollution related problems. The environmental pollution are directly linked to development and economic growth of the nation.

## Pre-requisites:

This course may opt by any students from science discipline to understand the air and water pollution and its control measures for protection of natural resources.

## Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of air and water pollution problems and there control measures.

2. To know the Air and water pollution legislation and their operations at national level.

3. To study and analyse the impacts of air and water contaminants (energy, resources/waste) within the built, urban, agricultural and natural environments.

## Course Outcomes:

At the completion of the course the students will be able to

1. Analyze and interpret the air and water pollution problems.

2. Students can be able to understand the sources and impacts of air and water pollutants on living and nonliving things.

3. Students are able to think critically and contribute to research in solving contemporary air and water pollution problems with professional and ethical accountability.

4. It is useful for politicians, decision makers, local bodies, Bureaucrats etc for effective management of pollution problems.

# Course contents:

**Unit I: Air Pollutants and effects:**

Introduction of Air pollutants, primary and secondary pollutants, Natural contaminants: Aerosols, Dust, Smoke, Mist, Fog, Fumes, Particulate matter (PM), Suspended particulate matter (SPM), Respirable suspended particulate matter (RSPM), Fly ash, Photochemical smog; Gaseous air pollutants: Sulphur dioxide, Carbon monoxide, Radioactive gases etc. Natural sources: Volcano, Accidental fires in forests, Dust storms, Combustion, Acid manufacturing, Mobile sources, Indoor air pollution, Vehicular emissions etc. Effects of air pollution on human health, Vegetation, Animals, Material and structure, Long term effects on the planet:, Greenhouse gases, Types of greenhouse gases, Effects, Sources and remedies, Technological options, Kyoto protocol, Ozone depletion, Air pollution standards and indices, Air pollution related case studies.

**Unit II: Ambient Air Sampling, Measurement:**

Air sampling, Particulate matter sampling and analysis: Dust fall measurement, High volume air sampler; Gaseous pollutants sampling and analysis: Carbon monoxide, Ozone, Hydrogen sulphide, etc. Air pollution control devices principle and working: Gravity settlers, Cyclone separators, Fabric filters, Electrostatic precipitators, Wet scrubbers; Air pollution model: Boxmodel, Gaussian dispersion model, area and line sources. Prediction of effective stack height, physics of plume rise, Atmospheric metrological factors: Wind profiles, turbulent diffusion, topographic effects, stability, inversions, adiabatic lapse rate, plume behavior etc.

**Unit III: Basics of Water pollution**

Definition, Hydrosphere, Types of water pollutants- physical, chemical, biological, Classification of pollutants- Inorganic pollutants, organic pollutants, Biological pollutants, sediments, Oxygen demanding waste, DO and BOD interrelationship, Disease causing agents, Radioactive pollutants

**Unit IV: Sources and Effects of Water pollution**

Sources of water pollution- Point sources, Non point sources, Natural and Anthropogenic sources, Sewage and domestic waste, Industrial effluent (like Dairy, Sugar, Paper & Pulp, Distillery and food processing, etc.), Agricultural discharges (Fertilizers, Pesticides, Herbicides, etc.), Detergents, Toxic metals, Thermal pollution, Types of pollutionGroundwater pollution (F, Fe, Mn As), Surface water pollution- Lake water pollution, River water pollution, Eutrophication, Marine pollution, Effect on life.

## ENS-C204: Practical based on ENS-C201 (2 Credits)

# Prescribed and Reference Books


01. Air Pollution and Its Control: Sumit malhotra, Pointer publishers, Jaipur

02. Air Pollution: M. N. Rao, Tata McGraw – Hill publishing company, New Delhi

03. Air Pollution: B. K. Sharma, H. Kaur, Krishna prakashan media, Meerut

04. Pollution of Our Atmosphere: B. Henderson, Sellers Adam Hilger Limited, Bristol

05. Fundamentals of Air Pollution: Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, & A. C. Stern, Academic Press, California

06. Air Pollution Control Engineering: Noel De Nevers, Mc-Graw–Hill Intl, New York

07. Air Pollution: S. K. Agarawal, A. P. H. Publishing corporation, New Delhi

08. Environmental Engineering – Arcadio P. Sincero and Gregoria A. Sincero, Prentice Hall of India, 1999.

09. Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996.

10. Air Pollution Control Equipment – H. Brauer and Y. B. G. Verma, Berlin Heidelberg, New York, latest edition

11. Aquatic Pollution: An Introductory Text: By Edward A. Laws

12. Water Pollution: Causes, Effects and Control - P. K. Goel

# ENS-C202: ENERGY RESOURCE MANAGEMENT
# (Theory: 4 credits & Practical: 2 credits)

## Salient features of this Course:

The course will help the students in preparing for the successful career in the energy sector. It will provides the detailed information about renewable and non renewable energy resources including fossil fuels, nuclear energy, Solar energy, wind energy, geothermal energy, tidal energy, hydroelectric, biomass energy etc. The emphasis is given to alternate energy sources, their technology and application. The students will be able to understand society's present requirements and future energy demands. They will also learn about the methods of energy conservation in detail.

## Pre-requisites:

Basic understanding and interest about conventional and non conventional energy resources.

## Course Objectives:

1. This course will be useful to enhance the knowledge about energy resources in present generation including fundamentals of technology, management, energy conservation and energy security and to make them capable in addressing the nearby energy related issues.
2. To determine the role of renewable and non renewable energy resources and learn different utilities of energy
3. To develop new methodologies to tackle problems associated with energy sector.
4. To encourage students to develop and promote awareness among the society regarding energy resources and their sustainable utilization.

## Course Outcomes:

After successful completion of this course, a student should know

1. The fundamental knowledge about different types of energy
2. Depict the challenges associated with the use of different energy sources and their potential solutions
3. To recognize and describe the present state of energy security and its significance.
4. They will be acquainted with ideas for reducing energy impacts on the surrounding environment.
5. Identify the current developments in sustainable and renewable energy

## Course contents:

**Unit I : Introduction to Energy :**

Different forms of energy; Sources and requirements of Energy: Non renewable energy, Renewable energy, energy and the environment

**Unit II : Non Renewable Energy Resources :**

Petroleum: Extraction of crude oil, Environmental effects; Coal: Origin of coal, Composition of coal, Types of coal, Uses of Coal, Coal and the Environment; Gas: Formation, Sources of natural gas, Natural gas and the Environment; Nuclear energy: Nuclear fission, Energy released in nuclear fission; Nuclear fuel Uranium, Nuclear power and the Environment.

**Unit III : Renewable Energy :**

Alternate sources of energy; Solar energy: Solar electricity generation, Solar heaters, Solar dryers, Solar cookers; Wind energy: Wind Power plants, Wind power potential in India; Geothermal energy: Sources of geothermal energy, power generation from geothermal energy, Advantages of geothermal energy; Hydroelectric energy: micro hydropower, Hydropower and the environment; Tidal and wave energy: Ocean Thermal Energy Conservation.

**Unit IV : Biological Energy :**

Bio Fuel: Classes of bio fuel, Sources of bio fuel, Production of bio fuel, Ethanol. Biodiesel: Introduction, Plant oils used for bio diesel; Production of bio diesel: Vegetable oils as diesel fuels, Manufacturing process for bio diesel, Industrial scale production of bio diesel, Biomass energy: Wood and wood waste, Municipal solid waste, Landfill gas, Biomass and the Environment.

## ENS-C205: Practical based on ENS-C202 (2 Credits)

## Prescribed and Reference Books


01. Ecoinformatics Volume 5 : S. K. Agarwal, A. P. H. Publishing Corporation, New Delhi, 2002.
02. Fuels and Bio-fuels : Vijayalaxmi, Meena Devi, Nagendra Prasad, Agrobios (India), Jodhpur, 2007.
03. Environmental resource Conservation : S. K. Shukla, P. R. Shrivastava, Commonwealth Publishers, New Delhi, 1992.
04. Environmental Science : S. C. Santra, New Central Book Agency, Kolkata, 2005

05. Environmental Problems & Solutions : D. K. Asthana & Meera Asthana, S. Chand & Co. New Delhi, 1998
06. Environmental Science : Eldon D. Enger, J. Richard Kormelink, B. F. smith, R. J. Smith, WMC Brown Co. Dubuguelowa, 1984
07. Environmental Science : Bernard J. Neble, Richard T. Wright, Prentice Hall, New Jersey, USA, 1981
08. Non Conventional Energy Sources : S. N. Kaul, A. R. Bhalerao, R. K. Trivedy, Current Publications, Agra, 2007.
09. Fundamentals of Environmental Science : G. S. Dahliwal, G. S. Sangha, P. K. ralhan, Kalyani Publishers, New DelhI.
10. Environmental Science : Enger Smith, Smith, W. M. C. Brown ( Company Publishing )
11. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
12. S. P. Sukhatme and J K Nayak, **Solar Energy - Principles of thermal collection and storage**, 3rd Ed Tata McGraw-Hill, New Delhi.
13. D. Y. Goswami, F. Kreith and J. F. Kreider, **Principles of Solar Engineering**, Taylor and Francis, Philadelphia, 2000.
14. Sunggyu Lee, **Alternative Fuels**, Applied Energy Technology Series, CRC Press
15. Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka, **Handbook of Alternative Fuel Technologies**, CRC Press
16. G.N. Tiwari, M.K. Ghosal, **Fundamentals of Renewable Energy Sources**, Alpha Science
Intnl. Ltd., 2007
17. H S Mukunda, **Understanding Clean Energy and Fuels from Biomass**, Wiley India
18. Sobh Nath Singh, **Non-Conventional Energy Resources**, Pearson Education
19. Nijaguna, B.T., **Biogas Technology**, New Age International publishers (P) Ltd.
20. J W Twidell & A D Weir, *Renewable Energy Resources*, ELBS, 2006
21. Tiwari GN. Ghoshal MK. *Fundamental of Renewable Energy Sources*, Narosa, 2007.

# ENS-C203: ENVIRONMENTAL BIOTECHNOLOGY
# (Theory: 4 credits & Practical: 2 credits)

**Salient features of this Course:** Definition and scope of biotechnology, Biological treatment, Biotechnological approach of environmental pollution abatement using Biotools, Environmental and biotechnological management with biosensors

**Pre-requisite:** Knowledge about different kinds of pollution and their sources, different types of microbes, composition and decomposition of wastes.

**Course Objectives:** This course aims to enable the students to gain in depth knowledge about the basics and uses of biotechnology in environmental science.

**Course Outcomes:** On successful completion of the module, students should be capable of

1. Identifying the environmental problem and use the appropriate biosensors to identify it.
2. Identifying suitable biotechnological solution to the environmental problem using a suitable biotool.
3. Using bioremediation techniques to abate environmental problems

## Course contents:

**Unit I: Environmental Biotechnology**

Introduction and scope of Environmental biotechnology, Biological treatment, Factors impacting Bio-treatment, importance of microorganism and their growth, Biotechnological approach of environmental pollution abatement, Biodegradation of pollutants

**Unit II: Bio tools and Applications**

Biotechnological approach of energy management, Biomass, Biogas generation and its significance in waste recycling, Factors affecting biogas yield, Advantages and disadvantages. Biofuels: Bio-ethanol, Bio-diesel, Bio-hydrogen, Bio-fertilizer: bacteria and fungi. Natural composting, Vermi-composting and Earthworm technology, Use of surface worms, Typical Vermiculture plant, Maintenance and limitations of vermi composting, Merits and demerits.

**Unit III: Biosensors and Uses**

Biosensors and environmental pollutants, Biochemical Oxygen Demand sensors, Ammonia sensors, Nitrate sensors, Sulphate ion sensors, its advantages and disadvantages. Bioreactors and its scope, Biological filters, Rotating biological contractors (RBC) merits and demerits, Fluidized bed reactors, Inverse fluidized bed bio-film reactor (IFBBR), Expanded bed reactor (EBR), Contact digester, Packed bed reactors (PCR), Up-flow anaerobic sludge blanket reactors (UASB), Periodic biological Sequencing batch reactor (SBR), Membrane bioreactor.

**Unit IV: Bioremediation and Reclaimation**

Bioremediation, Types of bioremediation, Bio-remedial applications, Toxic site reclamation, Removal of spilled oil and grease deposits, Reduction of herbicides, pesticides and fertilizers. Biodegradation of xenobiotics, Toxic organics, Phenols as pollutants

## ENS-C206: Practical based on ENS-C203 (2 Credits)

# Prescribed and Reference Books


**01. Environmental Biotechnology:** S. N. Jogdand, Himalaya Publishing House, Mumbai, 2006

**02. A Textbook of Biotechnology:** R. C. Dubey, S. Chand & Company, New Delhi, 2002

**03. A textbook of Environmental Chemistry & Pollution Control :** S S Dara, S. Chand & Company,
New Delhi, 2002

**09. A textbook of Environmental Studies:** G R Chatwal & Harish Sharma, Himalaya Publication House,
New Delhi, 2004

**10. Environment & Biotechnology:** B.P. Singh, H. N. Verma & K. M. Srivastava, Today & Tomorrows
& Publishers, New Delhi, 1988

**11. Industrial Biotechnology (Problems & remedies):** Indu shekhar Thakur, I. K. International Pvt. Ltd., New Delhi, 2006

**12. Introduction to Environmental Biotechnology:** A. K Chatterji, PHI learning Pvt.Lim., New Dehli, 2009

# ENS-E201: NOISE POLLUTION
# (Theory: 3 credits & Practical: 1 credit)

## Salient features of this Course:

The course content is very important to students to know the noise pollution related problems and its control measures.

## Pre-requisites:

This course may opt by any students from science discipline to understand the noise pollution and its control measures.

## Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of air pollution problems and there control measures.

2. To study the impacts of noise pollution and control measures

## Course Outcomes:

At the completion of the course the students will be able to

1. Analyze and interpret the noise pollution problems.

2. It is important to predict the noise pollution impacts due to developmental projects and engineered solutions in global and socio-economic context.

3. Students are able to think critically and contribute to research in solving contemporary noise pollution problems with professional accountability .

## Course contents:

**Unit I: Basics of Noise pollution**

Concept of Noise pollution, sources: point and line sources, multiple sources; outdoor and indoor noise propagation , weighting networks, Noise control and abatement measures: Active and Passive methods,

**Unit II: Impact of Noise pollution**

Impact of noise and vibrations on human health. Noise Menace– Prevention and Control of Noise Pollution, control of transmission, protection of exposed person, Absorbent

Annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom.

**Unit III: Noise measurement**

Noise measurement, noise standards and limit values; measurement of noise indices (Leq, L10, L90, L50, LDN, TNI). Noise measuring instruments and monitoring procedure, case studies

## ENS-E207: Practical based on ENS-E201 (1 Credit)

# Prescribed and Reference Books


1. Environmental Engineering – Arcadio P. Sincero and Gregoria A. Sincero, Prentice Hall of India, 1999.

2. Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996.

3. Environmental Noise Pollution – PE Cunniff, McGraw Hill, New York, 1987.

4. Handbook of Noise Measurement – APG Peterson & EE Gross PH, Englewood cliffs New Jersey, latest edition.

5. C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2000

# ENS-E202: FRESHWATER BIOLOGY
# (Theory: 3 credits & Practical: 1 credit)

**Salient features of this course:** The Ecology is fundamentally about studying interactions as an important emphasis of this course. These include interactions between organisms and their physical and chemical environment, interactions among individuals within a population, and interactions among species.

## Pre-requisites:

The aim of this module is to provide an understanding of

1. Freshwater ecosystems and the factors influencing their ecosystem function and
2. Interactions between humans and freshwater ecosystems.

## Course Objectives:

1. Gaining understanding of the fundamental concepts governing the ecology of inland aquatic systems.
2. Demonstrate an understanding of the application of limnology to society and everyday life, specifically the interaction between human populations and the health and management of freshwater ecosystem.
3. Critically analyze information about freshwater ecosystem, with an emphasis on primary scientific literature.

## Course Outcomes:

1. Full appreciation of the need for both a multi-disciplinary and an interdisciplinary approach in advancing knowledge and understanding of Earth systems, drawing, as appropriate, from the natural and the social sciences.
2. Deep understanding of the processes which shape the natural world at different temporal and spatial scales and their influence on and by human activities.
3. Strong familiarity with the terminology, nomenclature and classification systems used in environmental science.
4. Comprehensive understanding of the contribution of environmental science to knowledge.

## Course contents:

**UNIT-I**

Introduction to hydrosphere, water cycle, aquatic systems, sub-divisions, freshwater, wetlands, estuarine and marine ecosystems. Freshwater ecosystem, lentic, water bodies, pond, lake types based on thermal stratification, based on origin of lotic water bodies, major Indian rivers, status of physico-chemical parameters, biotic communities.

**UNIT-II**

Wetlands, fauna and flora and ecological characteristics, perspectives, brackish water and marine ecosystems, divisions, characteristics, abiotic parameters, distribution of biotic communities, major sources and types of pollutants, water pollutant analysis and its impact on wetland organisms, aquatic resource productivity and food chain of freshwater bodies, wetland conservation strategies in India, wetland projects for species conservation.

**UNIT-III**

Ecological adaptations of aquatic fauna and flora, kinds of adaptations primary and secondary aquatic adaptations, freshwater, estuarine, pelagic, inter-tidal land. Aquatic system study, measurement of water temperature, light transmission in the water column, water transparency, dissolved oxygen, collection and identification of plankton, hydrophytes, wetland plants, report writing.

## ENS-E208: Practical based on ENS-E202 (1 Credit)

## Prescribed and Reference Books

1. Mills, D.H. (1972) An introduction to freshwater Ecology. Liver & Boyd, Edinburg
2. Coker, R.E. (1954) Streams, Lakes & Ponds. University of North Carolina Press, chapel Hills, USA
3. Das, S.M. (1989) Hand book on Limnology & Water Pollution. South Asian Publishers, New Delhi.
4. Verma & Agarwal (1995) Environmental Biology (Principles of Ecology) Chand & Co, New Delhi.
5. S C Santra, Environmental Science.

# ENS-E203: E- WASTE
# (Theory: 3 credits & Practical: 1 credit)

## Salient features of this Course:

The course can learned by any students science discipline to understand the e-waste disposal and their associated environmental problems. Students from any science discipline can understand the pathway of pollutants in environment.

## Pre-requisites:

This course may opt by any students from any science discipline to understand the environmental pollutants and their pathways in soil. Students will learn how to mitigate the E-waste pollution by 4 R principle and product development from waste to wealth.

## Course Objectives:

1. The aim of this paper is to enhance the knowledge and skills related E-waste pollution, their sources and impacts.
2. To promote awareness among individual and societal level regarding hazardous waste.
3. To understand the role of individual/volunteer in mitigation & environmental pollution problems.
4. To understand the remedial measures/techniques for E-waste disposal and mitigation.

## Course Outcomes:

At the completion of the course the students will be able to

1. Analyze and interpret the E- waste pollution problems and associated risk to environment.
2. Students are able to design environmental engineering and eco-friendly systems to mitigate solid waste and soil pollution problems.
3. It may help to identify best waste management practices, modern tools and techniques.
4. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

## Course contents:

**Unit I: Introduction of E-Waste:**

Introduction of E-waste, classification, Sources and characteristics; Composition, collection of e-waste, toxicity due to hazardous substances in e-waste and their impacts, domestic ewaste disposal, e-waste management, occupational and environmental health perspectives of recycling e-waste in India.

**Unit II: E Waste Management and legislation**:

E-waste: methods of handling and disposal. Management of E-waste in Indian Context, technologies for recovery of resource from electronic waste, guidelines for environmentally sound management of e-waste, Recycling e-waste: practices & challenges Role of informal sector in e-Waste Management Procedures for setting up e-waste recycling facilities, Environmentally Sound Management of e-waste, Approach towards effective Management Systems for e-waste, Environmental problems originated from e-waste, Case studies of ewaste pollution. The e-waste (Management) Rules 2016

**ENS-E209: Practical based on ENS-E203 (1 Credit)**

## Prescribed and Reference Books


01. Solid waste pollution : Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008
02. Environmental Science : S. C. santra, New Central Book Agency, Kolkata, 2005
03. Environmental Engineering : Davis & Cornwell, McGraw – Hill Publications, New York, 1998
04. Environmental Science Principles and Practices : R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008
05. Tchobanoglous G., Theisen H., Viquel S.A., "Integrated Solid Waste Management: Engineering, Principles and Management issues", Tata McGraw Hill Publishing Company Ltd., New Delhi. [T2] CPHEEO Manual on Municipal Solid Waste Management.
06. Peavy H.S., Rowe D.R., Tchobanoglous G., "Environmental Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.
07. Cunningham W.P., Cunningham M.A., "Principles of Environmental Science", Tata McGraw Hill Publishing Company Ltd., New Delhi.
08. Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, New Delhi. [R4] Krishnamoorthy B., "Environmental Management, Text Book and Cases", PHI Learning (P) Ltd., New Delhi.

# ENS-E204: FUNDAMENTALS OF COMPUTER AND ITS APPLICATIONS
# (Theory: 3 credits & Practical: 1 credit)

## Salient features of this Course:

This course aims to empower students in learning fundamental knowledge about computers and their applications. It will help students to make the optimum utilization of computer resources in their daily activities.

## Pre-requisites:

Basic understanding and interest about Computer system, its applications and working.

## Course Objectives:

1. To discuss the fundamentals of Computer Organization and Architecture
2. To generate qualified manpower in the area of information and technology who can work anywhere seamlessly
3. Introduction to various aspects of computer applications and to equip students with emerging technologies in the computer field.

## Course Outcomes:

After successful completion of this course, a student should know

1. The fundamental knowledge about computers and computer applications.
2. Students will get the knowledge of computer organization and architecture and will know the actual working and organization of digital computer system.
3. They will be familiar with basics of computer applications and other important concepts like networking concepts.
4. They can easily use computers for day to day activities.

## Course contents:

**Unit I:**

Introduction to computer: Definition, Scope of Computers, Components of computer, Computer organizations, Basic block diagram of computer, storage devices, input/output devices, Binary number system, Input and output devices, Computer memory, Types of computers; Computer generations, Types of software, Applications of computer

**Unit II:**
Number systems: Binary, decimal and hexadecimal number system in computers, MS office, Data: Classification of Data; Collection of Data: Collection of primary data, Collection of Secondary data; DBMS, Diagrammatic presentation of Data: Simple bar diagram, Multiple bar diagram, Pie diagram; Graphical data presentation, Internet, Applications of Internet, E-mail

**Unit III:**
Concept of operating system, Computer graphics, Basic concepts of data communication and networking, Website, Internet browsing, basic concepts GIS, software's and its types, GIS-scope, Applications of Google Earth

## ENS-E210: Practical based on ENS-E204 (1 Credit)

# Prescribed and Reference Books


01. Evolution Biostatistics & Computer Applications: A. Gopi, A. Meena, N. Arumugam, Saras Publications, Kanyakumari, 2003
02. Fundamentals of Computer: V. Rajaraman, Prentice Hall of India, New Delhi, 2008
03. Computer Fundamentals: Pradeep K. sinha, Preeti Sinha, BPB Publications, New Delhi
04. Computer: Malhar V. Lathkar, Sadhusudha Prakashan, Nanded, 1995
05. Computer Fundamentals: A. Goel, , Pearson Education, 2010.
06. Fundamentals of Computers: P. K.Sinha, P. Sinha, BPB Publishers, 2007
07. Digital Computer Fundamentals, Tata McGraw Hill, 6th Edition, Thomas C. Bartee
08. Sinha P. K. "Computer Fundamentals, BPB.
09. Jain, Chaturvedi and Sahu, "Overview of Operating Systems", Pragya Pub. Mathura.
10. Hansen G. W. & Hansen J. V. "Database Management & Design".
11. Silberschqtz, Korth & sudarshan Database System Concepts " 5th Edition "PHI"
12. Tanenbaum A. S., "Computer Networks", PHI.
13. Database Systems and Concepts, Henry F. Korth
14. Database Management System by Bipin Desai
15. A. Goel, Computer Fundamentals, Pearson Education, 2010.
16. P. Aksoy, L. DeNardis, Introduction to Information Technology, Cengage Learning, 2006
17. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2007
18. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008
19. R. Elmsasri,S. Navathe, Fundamentals of Database Systems, Pearson Education, 5th edi. 2007
20. Computer Networks, Andrew S.Tanenbaum, Prentice Hall of India.

# ENS-E205: Current Environmental ISSUES-II
# (Theory: 3 credits & Practical: 1 credit)

## Salient features of this Course:

This interdisciplinary course aims to increase the basic understanding of current environmental problems and their probable solutions. Our environment is changing constantly due to the natural and anthropogenic activities. The students should be aware about these changes, their consequences and solutions to cope up with the situation. These events required urgent attention as they are making us more vulnerable to disasters. Environmental issues are a warning of the future disaster and if they are not controlled, soon earth may become lifeless.

## Pre-requisites:

This course may be taken up by students from any discipline to understand the fundamental concepts related to the environmental issues and the science behind them.

## Course Objectives:

1. To make students aware with present issues obstructing the sustainable environmental development.
2. To enhance the knowledge about environmental concerns.
3. To develop new methodologies to tackle environmental problems.
4. To encourage students to develop and promote awareness among the society regarding current environmental issues and related information with development of common solutions to the environmental issues.
5. To undertake the role of individual/volunteer in managing these issues and to develop an awareness about environmental issues.

## Course Outcomes:

At the completion of the course the students will be able to

1. It will help students to understand burning current environmental problems like epidemic issues, problems associated with various pollutions like Green house effect, global warming, ozone depletion, solid waste and its management etc.
2. Students will learn about the basic environmental issues caused by anthropogenic and natural activities and their impact as well as they will understand preventive and corrective measures to deal with.
3. It may recognize potential environmental impacts of associated problems.
4. Students can think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

## Course contents:

The Syllabus includes recent developments in relation to the environmental sciences including Global Environmental problems like global warming, climate change, pollution and pollution mitigation studies, energy resources, green energy, Environmental Education and Awareness, and other aspects in the field of environmental sciences. It will also cover happenings at national and international level, environmental amendments etc.

**ENS-E211: Practical based on ENS-E205 (1 Credit)**

# ENS-E206: BIOREMEDIATION
# (Theory: 3 credits & Practical: 1 credit)

**Salient features of this Course:** Bioremediation techniques- Insitu & Exsitu bioremediation techniques, Use of bioreactors for bioremediation, Phytoremediation, Molecular techniques in bioremediation

**Pre-requisite:** The student should be aware of different Environmental Pollutants, Industrial Wastes and their treatments, Basics of Biotechnology

**Course Objectives:** The purpose of this course is to introduce the use of living organisms such as plants and microbes or their systems to the treat contaminants. In addition, the course is expected to develop an efficient, eco-friendly and economical novel alternative treatment technologies.

## Course Outcomes:

1. This course tends to impart sufficient scientific understanding of the current environmental tribulations and global concern.

2. It focuses the process of bioremediation, mechanisms, types, success stories& monitoring strategies and the advance techniques to facilitate bioremediation technology.

3. The course designed to apply the concepts of bioremediation technology to the real time problems.

## Course contents:

**Unit I:**
Introduction to bioremediation, Microbes for bioremediation, Metabolic process involved in bioremediation, Bioremediation techniques, Insitu & Exsitu bioremediation techniques, Phytoremediation

**Unit II:**
Application, advantages and disadvantages of specific bioremediation technologies, Land farming, Prepared beds, Biopiles, Composting, Bioventing, Biosparging, pump and treat method, constructed wet lands, Use of bioreactors for bioremediation

**Unit III**
Bioremediation of phenols, chlorinated phenols, chlorinated aliphatic compounds, heterocyclic compounds, cyanides, dyes, Rhizoremediation, Molecular techniques in bioremediation- Pathway engineering, Biodegradation of polyhalogenated compounds by genetically engineered bacteria

### ENS-E212: Practical based on ENS-E206 (1 Credit)

## Prescribed and Reference Books


1. Bruce e. Rittmann, perry l. Mccarty, "environmental biotechnology: principles and applications" mcgraw-hill, 2001.
2. Phillip l. Buckingham , jeffrey c. Evans," hazardous waste management" waveland pr inc reissue edition 1, 2010.
1. S. K. Agarwal, "environmental biotechnology", APH publishing, 2000
2. Martin alexander, "biodegradation & bioremediation", academic press, 1999.
3. Karrely d., chakrabarty k., omen g.s, "biotechnology and biodegradation", portfolio pub. Co., 1990.
4. P. Rajendran, p. Guansekaran, "microbial bioremediation", MJP publishers, 2011.
5. Handbook of Bioremediation Editedby Norris et al, Robert S. Kerr; Environmental Research Laboratory.
6. Bioremediation Principles: Ewies, Ergas, Chang and Schroeder

# ENS-OE201: BASICS OF REMOTE SENSING
# (Theory: 2 credits)

## Pre-requisites:

Basic (10+2) understanding of science

## Course objectives:

1. To attain fundamental knowledge of basics of Remote Sensing.
2. To identify different features with the help of Photo-interpretation Elements.
3. To apply Remote Sensing knowledge for different applications in Earth Sciences.

## Course outcomes:

At the completion of the course student would be able to

1. Explain the Fundamental principles of Remote Sensing.
2. Explain basic properties of Remote Sensing, Data acquisition, Storage and Processing.
3. Identify different features with the help of Photo interpretation Elements.
4. Apply the knowledge of Remote Sensing for applications in different fields.

## Course contents:

**Unit I**

**Introduction and Aerial Photography:** Introduction to Remote Sensing, Definition, Characteristics of EMR, Platforms, Fundamentals of Aerial Photography, History of Aerial Photographs, Types of Aerial Photographs- Vertical and Oblique Photographs, Aerial Cameras, Flying Plan, Photogrammetry -- Basic Geometric Characteristics- Scale, Overlap, Tilt, Distortion and Displacement of Aerial Photographs, Advantages and Disadvantages of Aerial Photographs, EMR and its interaction with matter, Reflection, Absorption, Transmission, Scattering. Concept of Signatures- Photo Interpretation Elements.

**Unit II**

**Satellite Remote Sensing and Applications of Remote Sensing:**

Principles of Remote Sensing, Process of Remote Sensing, Indian Remote Sensing Programme, Types of Satellites- Sun-synchronous and Geostationary Satellites, Launch Vehicles- PSLV, GSLV, Payloads, Active and Passive Remote Sensing, Classification of

Remote Sensors, Resolution- Spatial, Spectral, Radiometric, Temporal, Microwave Sensors, SLAR, Digital Image Processing- Image Classification, Supervised and Unsupervised Classification, Image Enhancement, Filtering, PCA etc.

**Applications of Remote Sensing:** Interpretation of Visual and Digital data, Applications in- Geology, Geography, Environment, Water Resources, Land use/Land Cover Mapping, Agriculture, Forest, Oceanography, Snow and Glaciers, Coastal etc.

## Prescribed and Reference Books


1) Photogrammetry – Miller & Miller

2) Remote Sensing & Image Interpretation – Lillesand, T. M. & Ralph, W. K.

3) Image Interpretation in Geology – Drury

4) Remote Sensing in Geoogy – Siegal

5) Principles & Applications of Photogeology – Pande S. N.

6) Remote Sensing: Principles and Interpretation—Sabins, F. F.

7) Introduction to Remote Sensing—Campbell, J. B.


# ENS-OE202: BIOINSTRUMENTATION (Theory: 2 credits)

### Salient features of this course:

This course may learn by any Science stream discipline as well as the Engineering students. The Student learns about how use the instruments/equipments for various sample analysis for solving the problems in terms of quality and quantity. It is widely applicable in the field of agriculture, biotechnology, environmental samples, medical & several other fields.

**Pre-requisites:** This course can prefer by any students of Science discipline to understand the various micro and macro constituents in different sectors including all living beings with non living samples.

### Course Objectives:

1. To bring about improvement in quality and quantity analysis by help of these instruments/equipments.
2. To identify the various constituents including organic, inorganic & miscellaneous.
3. Using different instruments/equipments for environmental studies and for acquiring information in the field of science & technology.
4. Minimal expenditure cost effective benefits for researchers and scientists etc.
5. To work out a suggestive action plan for implementation of suitable / feasible technologies / measures for better environment.

## Course Outcomes:

After completion of the course the students will be able to

1. Student can expert in handling various instruments/equipments for research and the field of analysis.
2. The course indeed useful for Industrial samples, Soil, Air, Water as well as Environment.
3. To evaluate solutions for quantitative analysis for better performance and results.
4. It may be helpful to distinguish between various samples amongst plant, animal and microbes.
5. Organic and inorganic estimations and result evaluation with statistical studies.

# Course contents:

### Unit I:

History and scope of instruments, equipments, tools, standardization methods, sample preparation, preservation and processing of Air, Water and Soil samples; Temperature measurement: principle, types of thermometers, operation and measurement; Turbidity measurement; Rain gauges: Types: Recording type rain gauge, Non recording type rain gauge; pH meter: working and applications. Microbiological and various sample study equipments.

### Unit II:

Principle and working of Spectrophotometer, Ultra Violet (UV) Spectrophotometer: working and applications; nuclear magnetic resonance (NMR): working and applications; Atomic Absorption Spectrophotometer (AAS): working, applications; flame photometer: working and applications; Fluoride meter: utility and significance; conductivity meter: Working and applications; Nephalo turbidity meter: working and utility. Principles, Methods and

applications of Thin Layer Chromatography (TLC): working and applications; Column chromatography: working and applications; Gas chromatography (GC): working and applications; High performance liquid chromatography (HPLC): working and applications with biological materials;

## Prescribed and Reference Books


01. Instrumental Methods of Analysis: Willard Merit and Dean (CBS Publication, New Delhi)

02. Instrumental Methods of Environmental Analysis: Karan Sareen, ( Sarup ans Sons Publishers, New Delhi ), 2001.

03. Instrumental Methods of Chemical Analysis: B. K. Sharma, Goel Publishing House, Meerut (1996).

04. Standard Methods for the Examination of Water and Waste Water : ( APHA, AWWA & WPCF ).

05. Instrumental Methods and chemical Analysis: H. Kaur, Pragati Prakashan, Merrut .

06. Instrumental Analysis: Shoog Holler (Harcourt Asia Publishers Ltd., New Delhi).

07. Instrumental Methods of chemical Analysis: Chatwal and Anand (Himalaya Publishing House, New Delhi), 1994.

08. Instrumental Analysis: Gurdeep Chatwal (Himalaya Publishing House, New Delhi), 2000

09. Instrumental Methods: V. B. Borade (Nirali Prakashan, Mumbai)

10. Instrumental Analysis for Science and Technology: W. Ferren (Agrobios India, Jodhpur)

# ENS-OE203: BASICS OF NOISE POLLUTION
# (Theory: 2 credits)

## Salient features of this Course:

The course content is very important to students to know the noise pollution related problems and its control measures.

## Pre-requisites:

This course may opt by any students from science discipline to understand the noise pollution and its control measures.

## Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of air pollution problems and there control measures.

2. To study the impacts of noise pollution and control measures

## Course Outcomes:

At the completion of the course the students will be able to

1. Analyze and interpret the noise pollution problems.

2. It is important to predict the noise pollution impacts due to developmental projects and engineered solutions in global and socio-economic context.

3. Students are able to think critically and contribute to research in solving contemporary noise pollution problems with professional accountability .

## Course contents:

### Unit I: Basics of Noise pollution

Concept of Noise pollution, sources: point and line sources, multiple sources; outdoor and indoor noise propagation , weighting networks, Noise control and abatement measures: Active and Passive methods, Impact of noise and vibrations on human health. Noise Menace– Prevention and Control of Noise Pollution, control of transmission, protection of exposed person, Absorbent Annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom.

**Unit III: Noise measurement**

Noise measurement, noise standards and limit values; measurement of noise indices (Leq, L10, L90, L50, LDN, TNI). Noise measuring instruments and monitoring procedure, case studies

## Prescribed and Reference Books


1. Environmental Engineering – Arcadio P. Sincero and Gregoria A. Sincero, Prentice Hall of India, 1999.

2. Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996.

3. Environmental Noise Pollution – PE Cunniff, McGraw Hill, New York, 1987.

4. Handbook of Noise Measurement – APG Peterson & EE Gross PH, Englewood cliffs New Jersey, latest edition.

5. C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2000


# ENS-OE204: COMPUTER FUNDAMENTALS (Theory: 2 credits)

### Salient features of this Course:

This course aims to empower students in learning fundamental knowledge about computers and their applications. It will help students to make the optimum utilization of computer resources in their daily activities.

### Pre-requisites:

Basic understanding and interest about Computer system, its applications and working.

### Course Objectives:

1. To discuss the fundamentals of Computer Organization and Architecture

2. To generate qualified manpower in the area of information and technology who can work anywhere seamlessly
3. Introduction to various aspects of computer applications and to equip students with emerging technologies in the computer field.

### Course Outcomes:

After successful completion of this course, a student should know

1. The fundamental knowledge about computers and computer applications.
2. Students will get the knowledge of computer organization and architecture and will know the actual working and organization of digital computer system.
3. They will be familiar with basics of computer applications and other important concepts like networking concepts.
4. They can easily use computers for day to day activities.

## Course contents:

**Unit I:**

Introduction to computer: Definition, Scope of Computers, Components of computer, Computer organizations, Basic block diagram of computer, storage devices, input/output devices, Binary number system, Input and output devices, Computer memory, Types of computers; Computer generations, Types of software, Applications of computer

**Unit II:**

Number systems: Binary, decimal and hexadecimal number system in computers, MS office, Data: Classification of Data; Collection of Data: Collection of primary data, Collection of Secondary data; DBMS, Diagrammatic presentation of Data: Simple bar diagram, Multiple bar diagram, Pie diagram; Graphical data presentation, Basic concepts of data communication and networking, Website, Applications of Google Earth

## Prescribed and Reference Books


01. Evolution Biostatistics & Computer Applications: A. Gopi, A. Meena, N. Arumugam, Saras Publications, Kanyakumari, 2003
02. Fundamentals of Computer: V. Rajaraman, Prentice Hall of India, New Delhi, 2008
03. Computer Fundamentals: Pradeep K. sinha, Preeti Sinha, BPB Publications, New Delhi
04. Computer: Malhar V. Lathkar, Sadhusudha Prakashan, Nanded, 1995
05. Computer Fundamentals: A. Goel, , Pearson Education, 2010.
06. Fundamentals of Computers: P. K.Sinha, P. Sinha, BPB Publishers, 2007
07. Digital Computer Fundamentals, Tata McGraw Hill, 6th Edition, Thomas C. Bartee

08. Sinha P. K. “Computer Fundamentals, BPB.
09. Jain, Chaturvedi and Sahu, “Overview of Operating Systems”, Pragya Pub. Mathura.
10. Hansen G. W. & Hansen J. V. “Database Management & Design”.
11. Silberschqtz, Korth & sudarshan Database System Concepts “ 5th Edition “PHI”
12. Tanenbaum A. S., “Computer Networks”, PHI.
13. Database Systems and Concepts, Henry F. Korth
14. Database Management System by Bipin Desai
15. A. Goel, Computer Fundamentals, Pearson Education, 2010.
16. P. Aksoy, L. DeNardis, Introduction to Information Technology, Cengage Learning, 2006
17. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2007
18. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008
19. R. Elmsasri,S. Navathe, Fundamentals of Database Systems, Pearson Education, 5th edi. 2007
20. Computer Networks, Andrew S.Tanenbaum, Prentice Hall of India.

# ENS-OE205: BIOREMEDIATION
# (Theory: 2 credits)

**Salient features of this Course:** Bioremediation techniques- Insitu & Exsitu bioremediation techniques, Use of bioreactors for bioremediation, Phytoremediation, Molecular techniques in bioremediation

**Pre-requisite:** The student should be aware of different Environmental Pollutants, Industrial Wastes and their treatments, Basics of Biotechnology

**Course Objectives:** The purpose of this course is to introduce the use of living organisms such as plants and microbes or their systems to the treat contaminants. In addition, the course is expected to develop an efficient, eco-friendly and economical novel alternative treatment technologies.

## Course Outcomes:

1. This course tends to impart sufficient scientific understanding of the current environmental tribulations and global concern.

2. It focuses the process of bioremediation, mechanisms, types, success stories& monitoring strategies and the advance techniques to facilitate bioremediation technology.

3. The course designed to apply the concepts of bioremediation technology to the real time problems.

## Course contents:

**Unit I:**

Introduction to bioremediation, Microbes for bioremediation, Metabolic process involved in bioremediation, Bioremediation techniques, Insitu & Exsitu bioremediation techniques, Phytoremediation. Application, advantages and disadvantages of specific bioremediation technologies, Land farming, Prepared beds, Biopiles, Composting, Bioventing, Biosparging, pump and treat method, constructed wet lands, Use of bioreactors for bioremediation

**Unit III**

Bioremediation of phenols, chlorinated phenols, chlorinated aliphatic compounds, heterocyclic compounds, cyanides, dyes, Rhizoremediation, Molecular techniques in bioremediation- Pathway engineering, Biodegradation of polyhalogenated compounds by genetically engineered bacteria

## Prescribed and Reference Books


1. Bruce e. Rittmann, perry l. Mccarty, "environmental biotechnology: principles and applications" mcgraw-hill, 2001.
2. Phillip l. Buckingham , jeffrey c. Evans," hazardous waste management" waveland pr inc reissue edition 1, 2010.
3. S. K. Agarwal, "environmental biotechnology", aph publishing, 2000
4. Martin alexander, "biodegradation & bioremediation", academic press, 1999.
5. Karrely d., chakrabarty k., omen g.s, "biotechnology and biodegradation", portfolio pub. Co., 1990.
6. P. Rajendran, p. Guansekaran, "microbial bioremediation", mjp publishers, 2011.
7. Handbook of Bioremediation Editedby Norris et al, Robert S. Kerr; Environmental Research Laboratory.
8. Bioremediation Principles: Ewies, Ergas, Chang and Schroeder