School of Earth Sciences, Swami Ramanand Teerth Marathwada University, Nanded.

M.Sc. Environmental Science (2 Years, 100 Credits)

M.Sc. Environmental Science, I Year, I Semester (Total Credits 25)

Sr.No.	Subject	Code	Theory Paper	Credits
1	Core	ENS-C101	Ecology and Biodiversity	4
2	Core	ENS-C102	Environmental Microbiology	4
3	Core	ENS-C103	Environmental Chemistry and Analytical techniques	4
4	Open Elective (to be selected by the School Student within the subject)	ENS- E101	Environmental Geosciences	3
		ENS- E102	Indian Environment	
		ENS- E103	Environmental Impact Assessment	
		ENS- E104	Current Environmental Issues	
		ENS- E105	Wetland Ecology	
5	Open Elective (to be selected by the School Student from other schools in University/ Moocs/Swayam/NPTL/Skill oriented Course)			2
	Open Elective For Students from other schools in University	ENS-OE101	Water Pollution	
		ENS-OE102	Applied Microbiology	
		ENS-OE103	Global Climate change	
		ENS-OE104	Fundamentals of Environmental Chemistry	
		ENS-OE105	Soil science	
			Total	**17**

Sr.No.	Code	Practicals based on	Credits
1	ENS- C104	Ecology and Biodiversity	2
2	ENS- C105	Environmental Microbiology	2
3	ENS- C106	Environmental Chemistry and Analytical techniques	2
4	ENS- E106	Environmental Geosciences	1
	ENS- E107	Indian Environment	
	ENS- E108	Environmental Impact Assessment	
	ENS- E109	Current Environmental Issues	
	ENS- E110	Wetland Ecology	
5	ENS- C107	Seminar	1
		Total	**8**

ENS-C101: ECOLOGY AND BIODIVERSITY (THEORY); 4 CREDITS

Program: M.Sc. Environmental Science
Course: Ecology and Biodiversity (Theory)
Course code: ENS, Core
Semester: First Semester (winter session)
Credits: 4 credits;
Course duration: One semester (15 weeks of 6 day week)
Teaching hours: 4 hours/week;
Teaching module: Lectures, tutorials, Practicals
Examination & Evaluation: Continuous assessment and End semester Assessment (50% each)

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

Learning Objects: 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.

Utility: On successful completion of the module, students should be capable of identifying various ecosystems and their characteristics, functions and interactions, biodiversity and its distribution

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

Detailed Syllabus

ECOLOGY & BIODIVERSITY

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

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

REFERENCES:

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

Course Instructors: Dipali N Sable, School of Earth Sciences
Contact details: Email: dipali.sable29@gmail.com; **Mobile:** 07276872251

ENS-C102: Environmental Microbiology (THEORY); 4 CREDITS

Salient features:

Utilities/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 etc.
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.

Objectives:

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

Perquisites: NA

UNIT 1: History and scope of environmental microbiology 10 Lectures

History , Diversity and Scope of Microbiology: Importance of microbiology, Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming, General characteristics, Morphological Features and Significance: Virus, Bacteria Algae, Fungi and Protozoa Branches of microbiology: Food Microbiology, Dairy Microbiology, Industrial Microbiology, Soil Microbiology, Agricultural Microbiology. Introduction; cell elements its composition, Prokaryotic and Eukaryotic cell Microbes and their environmental niches, Microbial nutrition, Phototrophy, Chemolithotrophy, Anaerobic respiration, Nitrate and Sulphate reduction; Acetogenesis; Methanogenesis; Metal, Chlorate.

UNIT 2: Microbial growth 10 Lectures

Growth and Reproduction of Bacteria : Concept of Growth and reproduction, Mechanism of binary Fission, Growth, Growth rate and Generation time, Growth curve of bacterial population and its practical applications, Quantitative measurement of bacterial growth, Structure. endospore (germination, sporulation) Anatomy of Eukaryotic cell: structure of fungal, Algal and Protozoa Cell Structure, Function and Chemical Composition of: Flagella, Cell wall (Fungi and algae), Microbial metabolism and functional diversity of bacteria Prokaryotic diversity. Microbial ecosystem Population and communities Environment, micro-environment Microbial growth on surface environment effects on microbial growth, environmental and microbial ecology.

UNIT 3: Basic methods in microbiology 15 Lecture

Microscopy and Staining: Microscope, Types (Light and Electron Overview), Magnification, Resolution, Numerical Aperture, Use of Oil immersion objective, Compound Microscope: Principle, Working and Significance, Concept and Types of Stains (Acidic and Basic stain, Mordant), Smear Preparation, Simple and Differential staining, Acid fast staining. Nutritional Requirements, Classification of bacteria based on: Nutrition, Physical Factors: pH, Temperature, water activity, aeration Chemical factors: Media, Types of media, Media Ingredients. Pure culture technique: Streak plate, Pour plate, spread plate and Roll tube method. Sterilization by Physical agents, Dry heat and Moist heat Chemical Sterilization: Ethylene oxide, Formaldehyde, Control of Microbes: Significance of following in control of microorganisms: Pasteurization, Ultraviolet light, Low Temperature, Desiccation, Bacteriological examination of potable water MPN (Presumptive, Confirmative and Completed tests) Soil Microbiology Soil Microflora, Rhizosphere. Role of microbes in carbon cycle; Role of microbes in Nitrogen cycle.

UNIT 4: Microbial Techniques 10 Lectures

Microbial symbiosis and virus, Application of environmental microbes. Investigations in environmental microbiology: sampling, detection, isolation, Microbial sampling Culture based and culture independent tools Case study Bioremediation and wastewater microbiology, Bioremediation and examples, Acid mine drainage, Enhanced metal recovery, Wastewater microbiology application. Drinking water microbiology, Drinking water microbes and treatment, Microbial instability Waterborne microbial diseases. Solid waste microbiology and antimicrobial resistance, Landfills, Anaerobic degradation phases, Antimicrobial resistance Epidemiology and biosensors Public health, Epidemics, Biosensors.

References

- **Environmental Microbiology** : Ralph Mitchell
- **Engineering- Treatment and Reuse** :Metcalf and Eddy, Inc., Revised by Tchobanoglous, Burton and Stensel
- **Introduction to Microbiology**: A.S. Rao
- **Environmental Microbiology**: Manish L. Shrivastva
- **Handbook of Bioremediation Edited** : Norris et al, Robert S. Kerr; Environmental Research Laboratory
- **Bioremediation Principles:** Ewies, Ergas, Chang and Schroeder
- **General microbiology Volume I & II:** C. B. Powar & H. F. Daginawala (Himalaya publishing House, Mumbai), 2002
- **Fundamental principles of Bacteriology:** A. J. Salle, (Tata McGraw-Hill Publishing Company, New Delhi), 1974
- **Microbiology:** P. D. Sharma (Rastogi publication Meerut)
- **Microbiology:** Pelczer, Reid & Chan (Tata McGraw-Hill Publishing Company Limited, New Delhi)

- **Hand book of Microbiology**: Yu. S. Krivashein (Mir Publishers Moscow)
- **Microbiology for Environmental Engineering:** M. C. Kinnery (Tata McGraw-Hill Publishing Company New Delhi)
- **Introduction to Virology:** S. B. Biswas
- **General microbiology:** Stainier
- **Applied Microbiology:** Kale & Kishore Bhusari (Himalaya Publishing House, Mumbai)

Course code: ENS-C103 (A) Environmental Chemistry

Program : M.Sc. Environmental Sciences

Course: Environmental Chemistry (Theory);

Credits: 2 credits;

Instructor: Dr. Yogesh P. Lolage, Assistant Professor, School of Earth Sciences

Contact details: email: lolage.yogesh@gmail.com; Mobile: 9552545248

Semester: I Semester (Summer session)

Teaching hours: 2 hours/week

Assessment:

Continuous Internal Assessment (CIA) - 50 % - During the semester

End Semester Assessment (ESA). - 50 % - At the end of the semester

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.

Perquisites:

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.

Utilities/Learning 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

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.

ENS-C103: ENVIRONMENTAL CHEMISTRY (2 CREDITS)

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. (15)

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. (15)

References:

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

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ENS-C103 (B): ANALYTICAL TECHNIQUES (2 CREDITS)

Salient features:

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.

Utilities/outcomes:

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

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

Objectives:

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

Perquisites:

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.

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, 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.

References:

Instrumental Methods of Chemical Analysis : Gurdeep Chatwal (Himalaya Publishing House, New Delhi), 2000

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

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

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

Standard Methods for the Examination of Water and Waste Water : (APHA, AWWA & WPCF), 1985

Instrumental Methods and chemical Analysis: H. Kaur, Pragati Prakashan, Merrut (2009).

Instrumental Analysis : Shoog Holler (Harcourt Asia Publishers Ltd., New Delhi), 1952

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

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

Instrumental Analysis for science and technology: W. Ferren (Agrobios India, Jodhpur)

ENS-E101 Environmental Geoscience **3 Credits**

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 (CO): 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.

Unit I **10 Lectures**

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 **10 Lectures**

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 **10 Lectures**

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.

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 3 Credits

Silent Features: The Course indeed thorough information about Indian Environment as well the pattern of Nature and its habitat with respect to soil, Meteorology, Forests, and the related Environment.

Outcomes:

Students completing this course should be able to:

1. This course is designed to help you gain a scientific understanding of the physical aspects of Earth's climate system and the factors that influence climate change.
2. It will explore the global balance of energy and transfer of radiation in the atmosphere through in-depth quantitative analysis, as well the hydrologic cycle and the general circulation of the oceans and atmosphere.
3. One who attends this course can demonstrate knowledge of the role of water in the atmosphere.

Objectives:

1. To produce students who posses quantitative, scientific reasoning skills that can be applied to atmosphere problems.
2. Describe the hydrologic cycle and feedbacks associated with the cycle that may stabilize or amplify climate change.
3. Read, evaluate, and discuss current climate research articles regarding present and future climate change.

Perquisites:

This course useful in any discipline of science would understand the role of Bio-geochemical cycles, Atmospheric stability as well as climate change factors.

Unit- I (12 Lectures)

Climatology: Temperature and pressure belts of India; Heat budget of the earth; Atmospheric circulation; atmospheric stability and instability. Planetary and local winds; Monsoons and jet streams; Temperate and tropical cyclones; Types and distribution of precipitation; Hydrological cycle; Global climatic change and role and response of man in climatic changes, Applied climatology and Urban climate in India.

Unit –II (12 Lectures)

Environment and Geographic Factors:

Principle of ecology; Human ecological adaptations; Influence of man on ecology and environment; Global and regional ecological changes and imbalances; Ecosystem their management and conservation; Environmental degradation, management and conservation; Biodiversity and sustainable development; Environmental policy; Environmental hazards and remedial measures; Environmental education in India, legislation and implementation.

Unit- III (12 Lectures)

Environment and India:

Factors Affecting Wind movement , Types of Winds: Permanent, Secondary & Local Winds, Temperature Inversion: Types & Effects on Weather, Jet Streams & Rossby Waves, Humidity: Relative Humidity & Dew point, Condensation, Forms of Condensation: Dew, Fog, Frost, Mist | Types of Clouds, Smog: Photochemical smog & Sulfurous smog, Precipitation: Types of Precipitation | Types of Rainfall, Comparison of Tropical Cyclones & Temperate Cyclones, Rainforest Climate (Tropical Evergreen Climate), Monsoon Climate | Monsoon Forests.

Books:

1. Verma & Agarwal (1995) Environmental Biology (Principles of ecology) Chand & co.,New Delhi
2. Mills, D.H. (1972) An introduction to freshwater Ecology. Liver & Boyd, Edinburg.
3. Environmental Science New Central Book Agency; 3rd Revised edition edition (1 January 2011) by S C. Santra.
4. Flora and Fauna of India, Abhijeet Publications; 1 edition (2012) by H S Pandey
5. Sacred plants of India by Nanditha Krishna.
6. Climatology, Sharda Pustak Bhawan (2011) by Lal D. S.
7. Geography of India, Periyar Prakashan Patna (2018) by by Arvind Kumar.
8. Megadiversity Conservation : Flora, Fauna and Medicinal Plants of India's Hot Spots (2012) by A.B. Chaudhuri and D.D. Sarkar.

ENS- E103 Environmental Impact Assessment (3 credit)

Salient features:

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

Utilities/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.

Objectives:

- 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.
- To understand the EIA process and their role in developmental projects and conservation.
- To study and analyse the impacts of flows (energy, water, resources/waste) within the built, urban, agricultural and natural environments.

Perquisites:

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.

Unit I: 15 hrs

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: 15 hrs

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: 15 hrs

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.

REFERENCES

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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. 2nd edition.

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 (3 CREDITS)

Course code: ENS-E104

Program : M.Sc. Environmental Sciences

Course: Current Environmental Issues (Theory);

Credits: 3 credits;

Instructor: Dr. Yogesh P. Lolage, Assistant Professor, School of Earth Sciences

Contact details: email: lolage.yogesh@gmail.com; Mobile: 9552545248

Semester: I Semester (Summer session)

Teaching hours: 3 hours/week

Assessment:

Continuous Internal Assessment (CIA) - 50 % - During the semester

End Semester Assessment (ESA). - 50 % - At the end of the semester

Syllabus:

The Syllabus includes recent developments in relation to the environmental sciences including pollution and pollution mitigation studies, renewable and non renewable energy resources, green energy and other aspects in the field of environmental sciences. It will also cover happenings at national and international level, environmental amendments etc.

ENS-E105: WETLAND ECOLOGY(THEORY); 3 CREDITS

Program: M.Sc. Environmental Science
Course: **WETLAND ECOLOGY** (Theory)
Course code: **ENS-E105**, Elective
Semester: First Semester (winter session)
Credits: 3 credits;
Course duration: One semester (15 weeks of 6 day week)
Teaching hours: 3 hours/week;
Teaching module: Lectures, tutorials, Practical's
Examination & Evaluation: Continuous assessment & End semester Assessment (50% each)

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

- Know the process for delineating a wetland and be able to classify a wetland while standing in one
- Be familiar with the value of wetlands so you can have an informed conversation with someone unfamiliar with the value and ecology of wetlands
- Have a working knowledge of management techniques, creation/restoration, and regulation of wetlands

Learning Objects: 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. The course covers topics common to all wetlands such as hydrology, biogeochemistry, and soils. We also review human impacts and wetland value. The course will provide working knowledge of management techniques, creation/restoration, utilization, conservation and regulation of wetlands

Utility: This class is appropriate for students planning careers in natural resource management while working in consulting, industry, government, or a non-profit organization. While students will have the basis for conducting wetland delineations or wetland functional assessments, they will require more training to professionally conduct such assessments.

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

Detailed Syllabus

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

References:

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

Course Instructors: Dipali N Sable, School of Earth Sciences
Contact details: Email: dipali.sable29@gmail.com; **Mobile:** 07276872251

ENS-OE101 Water Pollution **2 Credit**

Unit I **15 Lectures**

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 **15 Lectures**

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

ENS-OE102 Applied Microbiology 2 Credits

Salient features:

Utilities/outcomes:

After learning the course the students should be able to:

1. Applications of overall microbes for industry, agriculture and social study.
2. Microbiological examination of water/soil/ food sectors and techniques.
3. Role of microorganisms in study of industrial useful, research and innovatins.

Unit 1: General introduction of applied microbiology 10 Lectures

Introduction and scope of applied microbiology, microbial types, general characteristics of microbes, structure, function of bacteria and other microbes. soil and food microbes, agricultural microbiology and its applications. Protista, concepts, prokaryotes and eukaryotes. Classification of microbes depending up on temperature, oxygen requirements, based on pH, symbiotic microbes and their role in nutrient supplementation, biogas production by microbes, organic waste recycling by microbes, bio-fertilizers and microbial applications.

Unit 2: Microbial culture and applications 10 Lectures

Growth, types, growth rate and Generation time and growth curve of microbes, measurement microbial growth, micro and macro nutrient requirement to organisms, role of microbes in decomposition, pasteurization, fermentation technology, culture media and its types, pure culture techniques, streak plate, pour plate, spread plate method, serial dilution, continuous culture, synchronous culture, industrial useful microbes advantages and disadvantages.

References

- **Environmental Microbiology** : Ralph Mitchell
- **Engineering- Treatment and Reuse** :Metcalf and Eddy, Inc., Revised by Tchobanoglous, Burton and Stensel
- **Introduction to Microbiology**: A.S. Rao
- **Environmental Microbiology**: Manish L. Shrivastva
- **Handbook of Bioremediation Edited** : Norris et al, Robert S. Kerr; Environmental Research Laboratory
- **Bioremediation Principles:** Ewies, Ergas, Chang and Schroeder
- **General microbiology Volume I & II:** C. B. Powar & H. F. Daginawala (Himalaya publishing House, Mumbai), 2002
- **Fundamental principles of Bacteriology:** A. J. Salle, (Tata McGraw-Hill Publishing Company, New Delhi), 1974
- **Microbiology:** P. D. Sharma (Rastogi publication Meerut)
- **Microbiology:** Pelczer, Reid & Chan (Tata McGraw-Hill Publishing Company Limited, New Delhi)

Global Climate change (ENS- OE103) (2 credit)

Salient features:

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

Utilities/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.

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.

Perquisites:

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

Unit 1: Introduction to Global Climate Change Science 15 hrs

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 15 hrs

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.

References:

1. Cambridge University (2013). Climate Change: Action, Trends and Implications for Business.
2. IPCC (2013). Climate Change 2013. The Physical Science Basis - Summary for 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.

Program : M.Sc. Environmental Sciences

Course: Environmental Chemistry (Theory);

Course code: ENS-OE104

Credits: 2 credits;

Instructor: Dr. Yogesh P. Lolage, Assistant Professor, School of Earth Sciences

Contact details: email: lolage.yogesh@gmail.com; Mobile: 9552545248

Semester: I Semester (Summer session)

Teaching hours: 2 hours/week

Assessment:

Continuous Internal Assessment (CIA) - 50 % - During the semester

End Semester Assessment (ESA). - 50 % - At the end of the semester

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.

Perquisites:

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.

Utilities/Learning 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

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.

ENS-OE104 : FUNDAMENTALS OF ENVIRONMENTAL CHEMISTRY

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. (15)

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. (15)

References:

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

Program: M.Sc. Environmental Science
Course: Soil Science (Theory)
Course code: **ENS-OE105** , Open Elective
Semester: First Semester (winter session)
Credits: 2 credits;
Course duration: One semester (15 weeks of 6 day week)
Teaching hours: 2 hours/week;
Teaching module: Lectures, tutorials
Examination & Evaluation: Continuous assessment and End semester Assessment (50% each)

Prerequisite: Basic knowledge about components of environment and their interactions
Learning Objects: This course aims to enable the students to gain knowledge about how the Soil, its formation and its importance for plants and their growth
Utility: On successful completion of the module, students should be capable of identifying various physical and chemical properties of soil and its effect on plants
Salient features: Formation, physical and chemical composition of soil, erosion & ecology of soil

Detailed Syllabus
Soil science

Unit 1:
1. Soil as a medium for plant growth
Factors of plant growth
Plant roots and soil relations
Soil fertility and soil productivity
2. Soil as a natural body
The parent material of soil
Soil formation
Soils as natural bodies
3. Soil physical properties
Soil texture
Soil structure
Soil consistence
Density and weight relationships
Soil pore space and porosity
Soil colour
Soil temperature
Unit 2:
4. Soil water
Soil water energy continuum
Energy and pressure relationships
The soil water potential
Soil water movement
Plant and soil water relations
Soil water regime
5. Soil erosion
Water erosion

Wind erosion

6. Soil ecology

The ecosystem
Microbial decomposers
Soil animals
Nutrient cycling
Soil microbe and organism interactions
Soil organisms and environmental quality
Earth moving by soil animals

Unit 3:

7. Soil organic matter

The organic matter in ecosystems
Decomposition and accumulation
Organic soils
The equilibrium concept
Horticultural use of organic matter

8. Soil mineralogy

Chemical and mineralogical composition of the earth's crust
Weathering and soil mineralogical composition
Soil clay minerals
Ion exchange systems of soil clays

9. Soil chemistry

Chemical composition of soils
Ion exchange
Soil ph
Significance of soil ph
Management of soil ph
Effects of flooding on chemical properties

Unit 4:

10. Plant-soil macronutrient relations

Deficiency symptoms
Nitrogen
Phosphorus
Potassium
Calcium and magnesium
Sulphur

11. Micronutrients and toxic elements

Iron and manganese
Copper and zinc
Boron
Chlorine
Molybdenum
Cobalt
Selenium
Potentially toxic elements from pollution
Radioactive elements

12. Soil fertility evaluation and fertilizer use

Soil fertility evaluation
Application and use of fertilizers
Animal manures

Land application of sewage sludge
Fertilizer use and environmental quality
Sustainable agriculture

REFERENCES:

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

Course Instructors: Dipali N Sable, School of Earth Sciences
Contact details: Email: dipali.sable29@gmail.com; **Mobile:** 07276872251

M.SC. ENVIRONMENTAL SCIENCE (I YEAR SEMESTER II)

Sr.No.	Subject	Code	Theory Paper	Credits
1	Core	ENS-C201	Air and Water Pollution	4
2	Core	ENS-C202	Energy Resource management	4
3	Core	ENS-C203	Environmental Biotechnology	4
4	Open Elective (to be selected by the School Student within the subject)	ENS- E201	Noise Pollution	3
		ENS- E202	Fresh water biology	
		ENS- E203	E- Waste	
		ENS- E204	Computer Applications in Earth Sciences	
		ENS- E205	Bioremediation	
5	Open Elective (to be selected by the School Student from other schools in University/ Moocs/Swayam/NPTL/Skill oriented Course)			2
	Open Elective For Students from other schools in University	ENS-OE201	Basics of Remote Sensing	
		ENS-OE202	Bioinstrumentation	
		ENS-OE203	Basics of Noise Pollution	
		ENS-OE204	Computer applications in Earth sciences	
		ENS-OE205	Bioremediation	
			Total	**17**

Sr.No.	Code	Practicals based on	Credits
1	ENS-C204	Air and Water Pollution	2
2	ENS-C205	Energy Resource management	2
3	ENS-C206	Environmental Biotechnology	2
4	ENS-E206	Noise Pollution	1
	ENS-E207	Fresh water biology	
	ENS-E208	E- Waste	
	ENS-E209	Computer Applications in Earth Sciences	
	ENS-E210	Bioremediation	

5	ENS-C207	Seminar	1
		Total	**8**

M.SC. ENVIRONMENTAL SCIENCE (I YEAR SEMESTER II)
Air and Water pollution (ENS-C201) (4 credit)

Salient features:

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.

Utilities/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.

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.

Perquisites:

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.

Unit I: Air Pollutants and effects: (15 hrs)

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: (15 hrs)

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 **(15 hrs)**

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 **(15 hrs)**

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.

References:

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

Program : M.Sc. Environmental Sciences

Course: Energy Resource management (Theory);

Course code: ENS-C202

Credits: 04 credits;

Instructor: Dr. Yogesh P. Lolage, Assistant Professor, School of Earth Sciences

Contact details: email: lolage.yogesh@gmail.com; Mobile: 9552545248

Semester: II Semester (Winter Session)

Teaching hours: 4 hours/week

Assessment:

Continuous Internal Assessment (CIA) - 50 % - During the semester

End Semester Assessment (ESA). - 50 % - At the end of the semester

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.

Perquisites:

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

Utilities/Learning 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

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.

ENS-C202: ENERGY RESOURCE MANAGEMENT (04 CREDITS)

Unit I : Introduction to Energy :

Different forms of energy; Sources and requirements of Energy: Non renewable energy, Renewable energy, energy and the environment (10)

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. (20)

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. (20)

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. (10)

References:

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

Program: M.Sc. Environmental Science
Course: Environmental Biotechnology (Theory)
Course code: ENS,Core
Semester: Second Semester (winter session)
Credits: 4 credits;
Course duration: One semester (15 weeks of 6 day week)
Teaching hours: 4 hours/week;
Teaching module: Lectures, tutorials, Practicals
Examination & Evaluation: Continuous assessment and End semester Assessment (50% each)

Prerequisite: Knowledge about different kinds of pollution and their sources, different types of microbes, composition and decomposition of wastes.

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

Utility: On successful completion of the module, students should be capable of identifying the suitable biotechnological solution to the environmental problem

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

Detailed Syllabus

ENVIRONMENTAL BIOTECHNOLOGY

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

REFERENCES:

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

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

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

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

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

Course Instructors: Dipali N Sable, School of Earth Sciences
Contact details: Email: dipali.sable29@gmail.com; **Mobile:** 07276872251

NOISE POLLUTION (ENS-E201) (3 credit)

Salient features:

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

Utilities/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.

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

Perquisites:

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

Unit I: Basics of Noise pollution (15hrs)

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 (15hrs)

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

References:

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 Fresh Water Biology (3 credit)

Silent features: 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.

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 sciences.
4. Comprehensive understanding of the contribution of environmental science to knowledge.

Objectives:

1. Gain 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 ecosystems.
3. Critically analyze information about freshwater ecosystems, with an emphasis on Primary scientific literature.

Perquisites:

The aim of this module is to provide an understanding of…

(i) Freshwater ecosystems and the factors influencing their ecosystem function and

(ii) Interactions between humans and freshwater ecosystems.

UNIT-I **(12 Lectures)**

Introduction and Scope: Hydrosphere, hydrocycle, aquatic systems, subdivisions, Freshwater, Wetlands, Estuarine and marine ecosystems. Freshwater ecosystem, lentic water bodies, Pond, lakes, streams, water reservoirs, perenial and non- perenial water bodies, types based on thermal stratification, based on origin, lotic water bodies, major Indian rivers, status of physico-chemical parameters, biotic communities, aquatic plants, micro and macro, primary productivity and its uses for aquatic organisms.

UNIT-II **(10 Lectures)**

Wetlands and wetland ecosystem: Fauna, flora and ecological characteristics, perspectives, freshwater and freshwater ecosystems, divisions, characteristics, abiotic parameters,

distribution of biotic communities-major sources and types of pollutants. Water quality assessment of wetlands, wetland communities and diversity, symbiotic and non-symbiotic organisms, growth, production and factors influencing wetland ecosystem.

UNIT-III **(12 Lectures)**

Ecological adaptations: Aquatic fauna and flora, kinds of adaptations primary and secondary aquatic adaptations, freshwater. Aquatic system study, measurement of water temperature, light transmission in the water column, types of water layers in fresh water bodies, water transparency, dissolved oxygen, collection and identification of hydrophytes, wetland plants, report writing, plankton types, plankton feeding in aquatic ecosystem, net productivity, conservation of freshwater organisms.

References:

Text Books

1. Mills, D.H. (1972) An introduction to freshwater Ecology. Liver & Boyd, Edinburg
2. Coker, R.E. (1954) Streams, Lakes & Ponds. Universityof North carolina Press, chapel Hills, USA
3. Das, S.M. (1989)Hand book on Linology & Water pollution.South Asian Publishers,New Delh
4. Verma & Agarwal (1995) Environmental Biology (Principles of ecology) Chand & co.,New Delhi

E- WASTE (ENS-E203) (3 credits)

Salient features:

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.

Utilities/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

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.

Perquisites:

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.

Unit I: Introduction of E-Waste: 20hrs

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 e-waste disposal, e-waste management, occupational and environmental health perspectives of recycling e-waste in India.

Unit II: E Waste Management and legislation: 25 hrs

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 e-waste pollution. The e-waste (Management) Rules 2016

REFERENCES

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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.

Program : M.Sc. Environmental Sciences

Course: Computer Applications in Earth Sciences (Theory);

Course code: ENS- E204

Credits: 03 credits;

Instructor: Dr. Yogesh P. Lolage, Assistant Professor, School of Earth Sciences

Contact details: email: lolage.yogesh@gmail.com; Mobile: 9552545248

Semester: II Semester (Winter Session)

Teaching hours: 3 hours/week

Assessment:

Continuous Internal Assessment (CIA) - 50 % - During the semester
End Semester Assessment (ESA). - 50 % - At the end of the semester

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.

Perquisites:

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

Utilities/Learning 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.

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.

ENS- E204: COMPUTER APPLICATIONS IN EARTH SCIENCES (3 CREDITS)

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 (15)

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 (15)

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 (15)

REFERENCES:

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: BIOREMEDIATION (THEORY); 3 CREDITS

Program: M.Sc. Environmental Science
Course: **BIOREMEDIATION** (Theory)
Course code: **ENS-E205**, Elective
Semester: Second Semester (winter session)
Credits: 3 credits;
Course duration: One semester (15 weeks of 6 day week)
Teaching hours: 3 hours/week;
Teaching module: Lectures, tutorials, Practical's
Examination & Evaluation: Continuous assessment and End semester Assessment (50% each)

Prerequisite: The student should be aware of different Environmental Pollutants, Industrial Wastes and their treatments, Basics of Biotechnology

Learning Objects: 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.
This course tends to impart sufficient scientific understanding of the current environmental tribulations and global concern. It focuses the process of bioremediation, mechanisms, types, success stories& monitoring strategies. It also focuses the advance techniques to facilitate bioremediation technology. The course designed to apply the concepts of bioremediation technology to the real time problems

Utility: This course tends to impart sufficient scientific understanding of the current environmental tribulations and global concern. It focuses the process of bioremediation, mechanisms, types, success stories& monitoring strategies. It also focuses the advance techniques to facilitate bioremediation technology. The course designed to apply the concepts of bioremediation technology to the real time problems

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

Detailed Syllabus

Bioremediation

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

Unit IV
Spent fuel characterisation, storage and disposal;
partitioning, transmutation and conditioning;
measurement of radioactivity in the environment; basic actinide research
Biosorption of heavy metals by biosurfactants
Advantages of biosurfactants over chemical surfactants
Biotechnology and oil spills

References

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

Course Instructors: Dipali N Sable, School of Earth Sciences
Contact details: Email: dipali.sable29@gmail.com; **Mobile:** 07276872251

ENS-OE201 Basics of Remote Sensing **2 Credit**

Unit I **15 Lectures**

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 **15 Lectures**

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.

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 2 Credits**

Silent features:

This course is useful for studying use of instruments in analysis of various environmental parameters in the field of Science, Agricultural, Biotechnological and as well as engineering etc. Instruments play vital role in assessment and output of any system of environmental concern.

After completion of the course the students will be able to:

1. After completion the course the student can study and apply various instruments.
2. The course indeed useful for Air, Water, Soil and Effluents analysis.
3. Instrumental significance and awareness for mass societal study.
4. Opportunities in various scientific laboratories and research centers.
5. The application and accuracy of instruments will be benefited to the peoples.

Objectives:

1. To bring about all round improvement in the quality of instrumental and knowledge.
2. To Identifications of the different instruments and their handling with specific working pattern.
3. By using different types of Environmental cleaning device can create a healthy and natural Environment.
4. Several instruments help for serving for the society by getting baseline data.

Unit I: Introduction and scope 10 Lectures.

Significance and the role of instruments in various analysis, factors affecting measurement, precision and accuracy, calibration of instruments, colorimeter **t**heory, working and applications, fluoride meter **p**rinciple, working, salient features, Working of High Volume Air Sampler, Respirable Dust Sampler uses, CO detector and its applications, digital pH meter, conductivity meter and its working, turbidity meter **a**pplications in Environmental studies, applications of Thin Layer Chromatography, chromatography, working and applications high performance liquid chromatography, ion exchange chromatography.

Unit II: Spectrophometer applications 10 Lectures.

Significance and scope of spectroscopy, principle and working of spectrophotometer, UV spectrophotometer, infra red spectrophotometer and its working, applications, Atomic Absorption Spectrophotometer working and applications. 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, Chlorine testing kit applications, Soil testing kit and its importance in nutrient study.

References

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)

Program : M.Sc. Environmental Sciences

Course: Computer Applications (Theory);

Course code: ENS- OE204

Credits: 02 credits;

Instructor: Dr. Yogesh P. Lolage, Assistant Professor, School of Earth Sciences

Contact details: email: lolage.yogesh@gmail.com; Mobile: 9552545248

Semester: II Semester (Winter Session)

Teaching hours: 2 hours/week

Assessment:

Continuous Internal Assessment (CIA) - 50 % - During the semester
End Semester Assessment (ESA). - 50 % - At the end of the semester

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.

Perquisites:

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

Utilities/Learning 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.

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.

ENS- E204: COMPUTER APPLICATIONS IN EARTH SCIENCES (2 CREDITS)

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 (15)

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 (15)

REFERENCES:

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
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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: BIOREMEDIATION (THEORY); 2 CREDITS

Program: M.Sc. Environmental Science
Course: **BIOREMEDIATION** (Theory)
Course code: **ENS-E205**, Elective
Semester: Second Semester (winter session)
Credits: 2 credits;
Course duration: One semester (15 weeks of 6 day week)
Teaching hours: 2 hours/week;
Teaching module: Lectures, tutorials, Practical's
Examination & Evaluation: Continuous assessment and End semester Assessment (50% each)

Prerequisite: The student should be aware of different Environmental Pollutants, Industrial Wastes and their treatments, Basics of Biotechnology

Learning Objects: 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.
This course tends to impart sufficient scientific understanding of the current environmental tribulations and global concern. It focuses the process of bioremediation, mechanisms, types, success stories& monitoring strategies. It also focuses the advance techniques to facilitate bioremediation technology. The course designed to apply the concepts of bioremediation technology to the real time problems

Utility: This course tends to impart sufficient scientific understanding of the current environmental tribulations and global concern. It focuses the process of bioremediation, mechanisms, types, success stories& monitoring strategies. It also focuses the advance techniques to facilitate bioremediation technology. The course designed to apply the concepts of bioremediation technology to the real time problems

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

Detailed Syllabus

Bioremediation

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 II

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

Spent fuel characterisation, storage and disposal;
partitioning, transmutation and conditioning;
measurement of radioactivity in the environment; basic actinide research
Biosorption of heavy metals by biosurfactants
Advantages of biosurfactants over chemical surfactants
Biotechnology and oil spills

References

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

Course Instructors: Dipali N Sable, School of Earth Sciences
Contact details: Email: dipali.sable29@gmail.com; **Mobile:** 07276872251