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

प्रस्तुत विद्यापीठीय संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०—२१ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक २० जून २०२० रोजी संपन्न झालेल्या ४७व्या मा. विद्या परिषद बैठकीतील विषय क्र.११/४७—२०२०** च्या ठरावानुसार **प्रस्तुत विद्यापीठीय संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०—२१ पासून लागू करण्यात येत आहेत.

01. M.Sc.-II Year-Botany
02. M.Sc.-II Year-Analytical Chemistry
03. M.Sc.-II Year-Industrial Chemistry
04. M.Sc.-II Year-Medicinal Chemistry
05. M.Sc.-II Year-Organic Chemistry
06. M.Sc.-II Year-Physical Chemistry
07. M.Sc.-II Year-Polymer Chemistry
08. M.Sc.-II Year-Computer Application
09. M.Sc.-II Year-Computer Network
10. M.Sc.-II Year-Computer Science
11. M.C.A.-II Year (Master of Computer Applications)
12. M.Sc.-II Year-Environmental Science
13. M.A./M.Sc.-II Year-Geography
14. M.Sc.-II Year-Geophysics
15. M.Sc.-II Year-Geology
16. M.A./M.Sc.-II Year-Mathematics
17. M.Sc.-II Year-Microbiology
18. M.Sc.-II Year-Physics
19. M.Sc.-II Year-Zoology
20. M.Sc.-II Year-Biotechnology
21. M.A./M.Sc.-II Year-Statistics

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

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक—१/परिपत्रक/पदव्युत्तर(संकुल)—सीबीसीएस अभ्यासक्रम/२०२०—२१/**५१३**

स्वाक्षरित/—
उपकुलसचिव
शैक्षणिक (१—अभ्यासमंडळ) विभाग

दिनांक : ०८.०८.२०२०.

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

Swami Ramanand Teerth Marathwada University

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

Department of Environmental Science
School of Earth Sciences
SRTM University
NANDED

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

PROGRAM EDUCATIONAL OBJECTIVES (PEO):

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

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

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

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

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

PROGRAMME OUTCOMES (PO):

After completion of the program, the students have:

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

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

PO3: Obtained exposure to the environmental pollution control technologies.

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

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

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

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

PROGRAM SPECIFIC OUTCOMES (PSO):

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

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

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

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

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

PSO6: Understand the disaster management and industrial safety.

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

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

M.Sc. Environmental Science
Syllabus Pattern

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

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

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

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

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

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

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

Department of Environmental Science
School of Earth Sciences
SRTM University
NANDED

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

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

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

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

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

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

Course contents:

Unit I: Introduction to Ecology

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

Unit II: Population ecology

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

Unit III: Community ecology

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

Unit IV: Biodiversity 15 Lectures

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

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

Prescribed and Reference Books

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

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

Course Objectives:

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

Course Outcomes:

After learning the course the students should be able to:

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

Course Content

UNIT I:

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

UNIT II:

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

UNIT III:

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

UNIT IV:

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

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

Prescribed and Reference Books

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

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

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

Course Content

Unit I:

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

Unit II:

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

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

Prescribed and Reference Books

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

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

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

Course contents:

Unit I:

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

Unit II:

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

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

Prescribed and Reference Books

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

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

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

Course Objectives: This course aims to:

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

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

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

Course contents:

Unit I

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

Unit II

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

Unit III

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

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

Prescribed and Reference Books

Text Books:-

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

2. Principles of Geology—Charless Lyell

3. Fundamentals of Soil Science—Henry D. Foth

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

5. Weathering Hardcover – Lucy Wood

Reference Books:-

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

2. Essentials of Geology Loose Leaf – Stephen Marshak

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

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

Pre-requisites:

The aim of this module is to provide an understanding of

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

Course Objectives:

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

Course Outcomes:

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

Course contents:

UNIT-I

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

UNIT-II

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

UNIT-III

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

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

Prescribed and Reference Books

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

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

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

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

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

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

Course Outcomes:

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

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

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

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

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

Course contents:

Unit I:

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

Unit II:

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

Unit III:

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

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

Prescribed and Reference Books

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

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

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

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

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

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

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

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

10. Environmental Impact Assessment: R.R. Barthwal

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

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

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

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

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

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

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

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

Course contents:

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

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

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

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

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

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

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

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

Course contents:

Unit I:

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

Unit II:

Wetland classification, Wetland values, Human impacts, Wetland conservation

Unit III:

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

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

Prescribed and Reference Books

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

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

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

Course Outcomes:

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

1. Analyze and interpret the water pollution problems.

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

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

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

Course contents:

Unit I

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

Unit II

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

Prescribed and Reference Books

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

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

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

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

Course Objectives:

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

Course Outcomes:

After learning the course the students should be able to:

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

Course contents:

UNIT I: History and scope of environmental microbiology

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

UNIT II: Microbial techniques

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

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

Prescribed and Reference Books

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

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

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

Course Outcomes:

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

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

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

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

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

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

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

Course contents:

Unit 1: Introduction to Global Climate Change Science

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

Unit 2: Introduction to the International Legal and Policy Framework

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

Prescribed and Reference Books

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

2. Policymakers.

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

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

5. UNFCCC. CGE Climate Change Training Materials.

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

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

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

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

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

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

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

Course contents:

Unit I:

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

Unit II:

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

Prescribed and Reference Books

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

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

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

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

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

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

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

Course contents:

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

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

Prescribed and Reference Books

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

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

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

Department of Environmental Science
School of Earth Sciences
SRTM University
NANDED

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

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

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

Course Outcomes:

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

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

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

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

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

Course contents:

Unit I: Air Pollutants and effects:

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

Unit II: Ambient Air Sampling, Measurement:

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

Unit III: Basics of Water pollution

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

Unit IV: Sources and Effects of Water pollution

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

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

Prescribed and Reference Books

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

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

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

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

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

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

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

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

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

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

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

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

After successful completion of this course, a student should know

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

Course contents:

Unit I : Introduction to Energy :

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

Unit II : Non Renewable Energy Resources :

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

Unit III : Renewable Energy :

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

Unit IV : Biological Energy :

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

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

Prescribed and Reference Books

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

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

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

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

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

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

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

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

Course contents:

Unit I: Environmental Biotechnology

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

Unit II: Bio tools and Applications

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

Unit III: Biosensors and Uses

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

Unit IV: Bioremediation and Reclaimation

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

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

Prescribed and Reference Books

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

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

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

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

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

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

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

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

Course Outcomes:

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

1. Analyze and interpret the noise pollution problems.

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

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

Course contents:

Unit I: Basics of Noise pollution

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

Unit II: Impact of Noise pollution

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

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

Unit III: Noise measurement

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

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

Prescribed and Reference Books

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

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

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

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

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

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

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

Pre-requisites:

The aim of this module is to provide an understanding of

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

Course Objectives:

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

Course Outcomes:

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

Course contents:

UNIT-I

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

UNIT-II

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

UNIT-III

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

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

Prescribed and Reference Books

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

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

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

Course contents:

Unit I: Introduction of E-Waste:

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

Unit II: E Waste Management and legislation:

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

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

Prescribed and Reference Books

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

After successful completion of this course, a student should know

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

Course contents:

Unit I:

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

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

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

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

Prescribed and Reference Books

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

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

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

Course contents:

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

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

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

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

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

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

Course Outcomes:

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

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

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

Course contents:

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

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

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

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

Prescribed and Reference Books

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

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

Pre-requisites:

Basic (10+2) understanding of science

Course objectives:

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

Course outcomes:

At the completion of the course student would be able to

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

Course contents:

Unit I

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

Unit II

Satellite Remote Sensing and Applications of Remote Sensing:

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

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

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

Prescribed and Reference Books

1) Photogrammetry – Miller & Miller

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

3) Image Interpretation in Geology – Drury

4) Remote Sensing in Geoogy – Siegal

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

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

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

ENS-OE202: BIOINSTRUMENTATION (Theory: 2 credits)

Salient features of this course:

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

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

Course Objectives:

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

Course Outcomes:

After completion of the course the students will be able to

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

Course contents:

Unit I:

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

Unit II:

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

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

Prescribed and Reference Books

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

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

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

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

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

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

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

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

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

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

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

Course Outcomes:

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

1. Analyze and interpret the noise pollution problems.

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

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

Course contents:

Unit I: Basics of Noise pollution

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

Unit III: Noise measurement

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

Prescribed and Reference Books

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

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

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

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

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

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

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

1. To discuss the fundamentals of Computer Organization and Architecture

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

Course Outcomes:

After successful completion of this course, a student should know

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

Course contents:

Unit I:

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

Unit II:

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

Prescribed and Reference Books

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

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

ENS-OE205: BIOREMEDIATION
(Theory: 2 credits)

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

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

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

Course Outcomes:

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

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

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

Course contents:

Unit I:

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

Unit III

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

Prescribed and Reference Books

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

M.Sc. Environmental Science
II Year - III Semester
Syllabus

M.Sc. Environmental Science, II Year, III Semester (Total Credits 25)									
Sr.No.	**Subject**	**Code**	**Theory Paper**	**Credits**		**Sr.No.**	**Code**	**Practicals based on**	**Credits**
1	**Core**	ENS-C301	Environmental Toxicology	2		**1**	ENS- C305	Environmental Toxicology	1
2	**Core**	ENS-C302	Remote Sensing	2		**2**	ENS- C306	Remote Sensing	1
3	**Core**	ENS-C303	Water and Wastewater Treatment technology	4		**3**	ENS- C307	Water and Wastewater Treatment technology	2
4	**Core**	ENS-C304	Geographical information system	4		**4**	ENS- C308	Geographical information system	2
5	**Open Elective (to be selected by the School Student within the subject)**	ENS- E301	Soil Pollution	3		**5**	ENS- E306	Soil Pollution	1
		ENS- E302	Wildlife Management				ENS- E307	Wildlife Management	
		ENS- E303	Ground water hydrology				ENS- E308	Ground water hydrology	
		ENS- E304	Current Environmental Issues III				ENS- E309	Current Environmental Issues III	
		ENS- E305	Introduction to Environmental Modelling				ENS- E310	Introduction to Environmental Modelling	
	Open Elective For Students from other schools in University	ENS-OE301	Basics of Water and waste water treatment	2		**6**	ENS- C309	Seminar	1
		ENS-OE302	Aquaculture						
		ENS-OE303	Green Technology						
		ENS-OE304	Fundamentals of GIS						
		ENS-OE305	Water Conservation						
			Total	**17**				**Total**	**8**

Department of Environmental Science
School of Earth Sciences
SRTM University
NANDED

ENS-C301: ENVIRONMENTAL TOXICOLOGY (Theory: 2 credits & Practical: 1 credit)

Salient features of this Course: Definition and scope of Toxicology- Toxic substances, Basic principles of toxicology, Absorption and distribution of toxicants, Hazardous waste management

Pre-requisite: Knowledge about chemicals, environmental health and factors affecting it

Course Objectives: This course aims to enable the students to gain in depth knowledge about the basics and uses of toxicology in environmental science. This basic knowledge is useful for better understanding of Environmental health.

Course Outcomes: This course is useful in understanding about basics of Toxicology. This will be useful for Toxicological interpretations by environmentalists. On successful completion of the course, students should be capable of

1. Identifying different kinds of toxic substances
2. Understand toxic substances and their metabolism and effects on environmental components.

Course contents:

Unit I: Introduction

Introduction and scope, Toxic substances, Basic principles of toxicology, Damage Process and Action of Toxicants, Factors Affecting Xenobiotic Action, Metabolism of Environmental Chemicals, Defense Responses to Toxicants, Evaluation of toxicity

Unit II: Metal and Pesticide Toxicity

Metal toxicity- Metals in bio-sorption- Air, Water, Soil, Plants, Animals, Microorganisms, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Mercury.

Pesticide toxicity, Organo-chlorines, DDT, Carbamates, Organo-phosphotes, Chlorinated phenoxy substances

Unit III: Mutagenic Pollutants & Environmental Cancer

Types of Mutation, Effect of Mutations,Induction of Mutation, Causes of Cancer, Stages in the Development of Cancer, Metastasis, Classification of Carcinogens, Metabolism of Chemical Carcinogens

ENS-C305: Practical based on ENS-C301 (1 Credit)

Prescribed and Reference Books

01. Water Toxicology : V. V. Metelev, A. I. Kanaev, N. G. Dzasokhova, Amerind Publishiing Company, Pvt, Ltd, New Delhi (1971).

02. Water Pollution and Toxicology : S. K. Shukla & P. R. Srivastava,, Commonwealth Publisher, New Delhi (1992).

03. Toxicology – Principles & Methods : M. A. Subramanian, MJP, Publishers, Chennai (2004).

04. Industrial Toxicology : Raymond D Harbison, A Times Mirror Company, 5th Edition, New Delhi (2006).

05. 06. Environmental Pollution Health & Toxicology : S V S Rana, Narosa Publishing House, New Delhi (2006).

07. Environmental Science Hazardous Gas & Waste : R K Sinha, Commonwealth Publisher, New Delhi (1994).

08. Toxicology : P D Sharma, Rastogi & Company, Meerut (1995).

09. Principles of Environmental Toxicology : Ian Shaw & John Chadwick, Taylor & Francis, Padstow UK (1998).

10. Industrial & Hazardous Wastes (Health Impacts & Management Plans) : R K Sinha & Sunil Herat, Pointer Publisher, Jaipur (2004).

11. Environmental Pollution: Radiation : D Prasad & M L Choudhary, Venus Publishing House, New Delhi (1992).

12. A textbook of Environmental Chemistry & Pollution Control : S S Dara, S Chand & Company Ltd, New Delhi (2002).

ENS-C302: REMOTE SENSING
(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) understanding of science

Course objectives:

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

Course outcomes:

At the completion of the course student would be able to

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

Course contents

Unit I

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

Unit II

Satellite Remote Sensing and Applications of Remote Sensing:

Principles of Remote Sensing, Process of Remote Sensing, Indian Remote Sensing Programme, Types of Satellites- Sun-synchronous and Geostationary Satellites, Launch Vehicles- PSLV, GSLV, Payloads, Active and Passive Remote Sensing, Classification of Remote Sensors, Resolution- Spatial, Spectral, Radiometric, Temporal, Microwave Sensors, SLAR, Digital Image Processing- Image Classification, Supervised and Unsupervised Classification, Image Enhancement, Filtering, PCA etc.

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

ENS-C306: Practical based on ENS-C302 (1 Credit)

Prescribed and Reference Books

1. Image Interpretation in Geology by Drury
2. Introduction to Remote Sensing by J. B. Campbell
3. Photogrammetry by Miller and Miller
4. Principles & Applications of Photogeology by S. N. Pande
5. Remote Sensing & Image Interpretation by T. M. Lillesand and W. K Ralph
6. Remote Sensing in Geology by Siegal
7. Remote Sensing: Principles and Interpretation by F. F. Sabins

ENS-C303: WATER & WASTEWATER TREATMENT TECHNOLOGY
(Theory: 4 credits & Practical: 2 credits)

Salient features of this course: This course is far related to water, its form which indicates the depth of impurities within the water, one which use this subject/paper, can easily treat it with a perfect technique/knowledge will achieve best quality of water for sustaining prosperous lifestyle, society with health benefits.

Pre-requisites: This course useful in any discipline of Science would understand the need of water and its importance, it helps to regenerate the opportunities for students and highly beneficial for societies.

Course Objectives:

1. Achieve an interim level of water quality that provides for the protection for fish, wetlands, and wildlife with recreation.
2. To understand and mitigate the possible techniques to reduce water pollution.
3. To predict water pollution and reuse the waste water after treatment.
4. It enhances the new materials and process technologies for water and wastewater treatment, including membranes, advanced oxidation, other processes.

Course Outcome:

1. Treatment technology includes physical, biological and chemical methods which improves the quality for reuse.
2. This paper as benefited as in the water scared area while applying the technology will receive the outcome in the form of clean water.
3. Agricultural sector is highly benefited for it.
4. It is one the best way for students who utilize the ideas and apply on it and get opportunities for their carrier.
5. It helps in removing in residual substances by treatment processes and again discharging them on surface water as well as for ground water recharge.
6. It helps in reduce organic and suspended solids to limit pollution to the environment.

Course contents:

Unit I:

Introduction
Wastewater Treatment: Characterization of Industrial wastewater, primary, secondary and

tertiary treatment, segregation, screening, equalization, coagulation, precipitation, sedimentation, absorption, ion exchange, membrane filtration.

Important terminologies in waste water treatment
Water quality parameters: Physical, Chemical, Biological characteristics, pH, Alkalinity, Electrical conductivity, Taste, Colour, Odour, Solids, Turbidity, Hardness, Most probable number (MPN). Sludge, aerobic treatments, anaerobic treatments, bioengineering, wetland, disinfection, influent, effluent, scum, anaerobic digestion, trickling filters, water quality standards for drinking purpose.

Unit II:

Water Treatment and Distribution System: Quantity and Source of wastewater, intakes, unit operations for water treatment, plain sedimentation, aeration, sedimentation tank and its design**,** coagulation, filtration, disinfection, softening, ion exchange and adsorption. Water storage and distribution system**.** Different types of sewers, design period, variations in sewage flow, estimation of waste water discharge and Storm water discharge.

Unit III:

Waste Water Characteristics: Chemical oxygen demand (COD), Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Ions like chloride, fluoride, sulphate, Nutrients i.e. Nitrogen and phosphorous. Treatment Fundamentals: Flow-sheets, physico-chemical and biological
processes for water quality control. Use of microbial systems. Reclamation of wasteland: biomass production for Biogas.

Unit IV:
Sludge Disposal: Sources and effects of sludge on environment. Methods of sludge disposal. Process dynamics and reaction, Screens comminutors. Grit chambers, equalization, floatation and chemical treatment. Types, modifications, activated sludge process, unit trickling filters, aerated lagoons, stabilization ponds, oxidation ditches, aerators. Theory of sludge handling and disposal, stabilization ponds.

ENS-C307: Practical based on ENS-C303 (2 Credits)

Prescribed and Reference Books

1.Biotreatment Systems , Volume II ; D.L. Wise.
2.Advances in Biotechnological Process ; Mizrahi & Wetzel.

3. Biodegradation and Bioremediation. Academic Press; 2nd Edn. Martin Alexander.
4.Gabriel Bitton (Author). Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edn (1999).
5.Milton Wainwright. An Introduction to Environmental Biotechnology.

6.Kluwer Academic Publishers, Boston. Hardbound, ISBN 0-7923-8569-1.July 1999, 192.

7. Water Supply & Sanitary Engineering by S C Rangwala.

8. Water & Wastewater Disposal Reuse by Metcalf & Eddy.

ENS-C304: Geographical Information Systems (Theory: 4 credits & Practical: 2 credits)

Salient features of this Course:

Geographical information system knowledge is very essential to solve various problems and issues in society. It is map-based decision support system and the students will learn about spatial and non spatial data and mapmaking techniques using GIS softwares. Currently, it is one the most important and job giving sector for GIS trained persons both in government and private field.

Pre-requisites: Basic understanding about Remote sensing and GIS techniques.

Course Outcomes:

After successful completion of this course, a student should know

1. Differentiate between different data types in GIS.
2. Georeference the spatial data and work on spatial and nonspatial database
3. Describe various GIS tools and techniques
4. Explain the fundamental principles behind GPS technology
5. Visualize GIS outputs in different dimensions
6. Create digital GIS maps
7. Apply spatial data analysis for various applications to deal with natural and environmental problems.

Course Objectives:

This course aims to:

1. Introduce the students to the fundamental concepts of GIS and GPS technologies
2. It will make them familiar with the most essential GIS techniques with hands on practical experience.

3. Students will learn about creation and organization of spatial and non spatial data.
4. Learn different GIS based techniques to identify and solve the actual natural, environmental and community problems.
5. Learn application of GIS and GPS.
6. Use GIS techniques to identify and solve the actual natural, environmental and community problems.

Course contents:

Unit I:

Introduction to GIS, Definition, History of GIS, Scope and Importance of GIS, Contributing disciplines, Development of GIS, Components of GIS, Hardware and Software components, GIS diversity

Unit II:

Data models in GIS - Raster data model, Vector data model, basic entities of GIS: line, point and polygon, Geodatabase, Map Projection, Types and Need of projection system, Data: Primary and Secondary, Spatial and Attribute data, data editing in GIS, Acquisition of spatial data: Scanning, Georeferencing, concept of layer, digitizing, error detection and correction, Data Base Management System: Concept, types of DBMS, Hierarchical, Network and relational data models, advantages and disadvantages

Unit III:

Global Positioning Systems, History and developments in GPS, Trilateration process, types of GPS, GPS Surveys, Applications of GPS technology Mapping and layout, General processes involved in image processing, mosaic, subset, Point interpolation techniques: Krigging, IDW, Introduction and Methods of Interpolation, Data analysis, network analysis, DEM and DTM, Thematic maps.

Unit IV:

Introduction, Digital Image Processing- Image Classification, Supervised and Unsupervised Classification, Applications of GIS: Agricultural applications, Forest Applications, Land use Land Cover mapping, Natural hazards identification and management, Water resources, Snow and glaciers studies, Coastal zone management, Marine fisheries etc.

ENS-C308: Practical based on ENS-C304 (2 Credits)

Prescribed and Reference Books

Ahmed, E. L. Rabbany (2002): Introduction to Global Positioning Systems, Artech House, Boston

Anji Reddy, M. (2008): Textbook of Remote Sensing and Geographic Information System, B.S. Publication, Hyderabad

Burrough, P. A. and McDonnell, R. A. (2000): Principles of Geographical Information Systems, Oxford University Press, New York

Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw-Hill, New York

Demers, M. N. (2000): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi

Heywood, I., Cornelisus, S., Carver, S. (2011): An Introduction to Geographical Information Systems, Pearson Education, New Delhi

Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey

Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore

Lo, C. P., Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi

Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester

ENS-E301: Soil Pollution
(Theory: 3 credits & Practical: 1 credit)

Salient features of this Course:

The course may be learned by any students of any discipline as soil pollution and solid waste problems and their associated environmental problems. Students from any discipline can understand the pathway of pollutants in environment.

Pre-requisites:

This course may opt by any students from any discipline to understand the environmental pollutants and their pathway. Students will learn how to mitigate the solid waste problems by 4 R principle and product development from waste to wealth.

Course Objectives:

1. The aim of this paper is to enhance the knowledge of soil pollution and their sources and impacts.
2. To promote awareness among individual and societal level regarding do and don'ts of hazardous waste.
3. To undertake the role of individual/volunteer in mitigation & environmental pollution problems.
4. To understand the remedial measures/techniques for soil remediation.

Course Outcomes:

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

1. Analyze and interpret the solid waste pollution problems and associated risk to environment.
2. Students are able to design environmental engineering and eco-friendly systems to mitigate solid waste problems.
3. It helps to forecast and predict fate of pollutants in the environment.
4. It may help to identify best waste management practices, modern tools and techniques.
5. It is important to predict the environmental impacts of developmental projects and engineered solutions in global and socio-economic context.
6. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

Course contents:

Unit I: Introduction of soil:

Importance of soil, Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality, Soil nutrients, Soil profile, soil permeability, soil porosity, Soil pollution problems, Soil salinity, Saline soil indicators, Reclamation of saline soil, pollution minimization technologies.

Unit II: Sources and effects of soil pollution:

Sources of soil pollution: Industrial wastes, Urban wastes, Radioactive wastes, Agricultural practices, Biological agents; Absorption of toxic metals by soil; Waste water added to soil, Solid waste applied to soil, Detrimental effects of soil pollution: Effects of Industrial pollutants, Effects of urban waste products, Effects of radioactive pollutants, Effects of modern agro technology. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions, degradation of pesticides and synthetic fertilizers. Soil sampling, Soil fertilizers, Monitoring and Analysis of Pesticides, Herbicides, Fungicides, Carcinogens, Industrial pollutants; Remedial measures for soil pollution, Green manure, Vermi-composting

Unit III: Soil pollution control:

Specifications for disposal of sewage & effluent on land for irrigation & ground water recharge. Control wastewater disposal on land. Impact of usage of land for solid waste disposal both municipal solid waste & industrial solid wastes (fly ash from thermal power station, lime sludge from pulp & paper mills). Control of Disposal of hazardous solid waste (heavy metals, toxic organic compounds) on land. Deterioration of soil due to mining activities. Soil reclamation, Case study of soil restoration

ENS-E306: Practical based on ENS-E301 (1 Credit)

Prescribed and Reference Books

01. **Soil and Noise Pollution :** B. K. Sharma, H. Kaur, Goel Publishing House, Meerut 1994
02. **Solid waste pollution :** Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008
03. **Principals of soil science :** M. M. Rai
04. **Soil pollution & Soil organisms :** P. C. Mishra
05. **Environmental Chemistry :** B. K. Sharma
06. **Environmental Science :** S. C. santra, New Central Book Agency, Kolkata, 2005
07. **Environmental Pollution Control Engineering,** C. S. Rao, New age International, Mumbai, 2003
08. **Fundamentals of Soil Science :** Henry D. Foth, John Wiley & Sons, New York, 1984
09. **Environmental Engineering :** Davis & Cornwell, McGraw – Hill Publications, New York, 1998
10. **Environmental Science Principles and Practices :** R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008

ENS-E302: WILDLIFE MANAGEMENT
(Theory: 3 credits & Practical: 1 credit)

Salient features of this course: Provides students with a working knowledge of the application of basic concepts in ecology and animal behavior to the management of wildlife resources to achieve diverse objectives of conservation, control or cropping.

Pre-requisites:

This course useful in any discipline of science would understand the role of wildlife on earth and its need with a life supporting manner.

Course Objectives:

1. Understanding the social context in which wildlife conservation and management is Conducted, includes basic understanding of relationships between socio-economics, governance, wildlife management, ecosystem services that wildlife, their habitats.
2. Ability to communicate includes the ability to understand scientific and other documents in order to critically evaluate opposing viewpoints in wildlife science and management; to prepare and deliver effective oral presentations to professionals and stake holders; to write clearly for both technical and non-technical audiences.
3. Understanding of and ability to apply what is learned in the major program to wildlife.
4. Ability to research possible solutions to wildlife management problems.

Course Outcomes: Students completing this course should be able to:

1. Communicate using the language of natural resource management generally and wildlife ecology and management specifically.
2. Apply ecological and behavioral concepts and principles to the management of wildlife populations and habitats to achieve a diversity of objectives, including sustained harvest, control, conservation and restoration.
3. Understand key ecological principles that apply to wildlife and habitat at the organism, population, community and ecosystem levels, with an understanding of their relevance to wildlife management practices.
4. Understand the policy framework, decision processes and social and political considerations that influence decisions in wildlife management at the state and federal levels.

Course contents:

Unit- I

Define wildlife, explain the importance of wildlife and wildlife management and identify the role of Government and private wildlife organizations in managing wildlife resources. Describe basic components of ecosystems and analyze the relationship between living organisms and their environment. Compare and contrast the habitat needs of selected wildlife species native to Its habitat identifies wildlife species from physical characteristics and/or evidence, identify the role of selected species in their environment and explain biological processes related to reproduction and survival of selected species. Species indication, endangered species, species extant, gene pool.

Unit- II

Habit and Habitat: Identify and explain practices for managing wildlife populations and their habitats for the benefit of the entire biota. Identify, research and discuss factors related to birth rate and mortality rate of wildlife and recognize the relationship between the biotic potential of wildlife species and their management. Calculate population size, carrying capacity, annual change in population size and maximum rate of population increase. Using mastered concepts, conduct a field evaluation of wildlife habitats to investigate wildlife management practices to improve the habitat for selected species and develop a habitat management plan.

Unit- III

Vegetative analyses, Point centered quadrate, quadrate, strip transect; GIS and Remote sensing in wildlife habitat surveys, Habitat manipulation: food, watershed improvement; impact and removal of invasive alien species; making observations and records, field notes, datasheets; wildlife photography, types of cameras, camera traps; field equipments-altimeter, pedometer, field compass, binoculars; radio collaring; GPS; GIS; Remote sensing in Wildlife management, wildlife act, Biodiversity act, forest act, environment protection act.

ENS-E307: Practical based on ENS-E302 (1 Credit)

Prescribed and Reference Books

1. An Introduction to Plant Ecology by Maurice Ashby.
2. Flora of Dehradun by U. Kanjilal.
3. Flora of Upper Gangetic Plain by J. F. Duthei.
4. The Forest Types of India by Champions and Seth.
5. Forest Ecology: Phyto-geography and Forest Conservation by G. S. Puri.

6. The Grasses of Burma, Ceylon, India and Pakistan by N. L. Bor.
7. Grasses of Western India by Tobby and Hodd.
8. Himalaya: Our Fragile Privilege by N. D. Jayal.
9. A Handbook on the Identification and Description of Trees and Shrubs by T. R. Somasundaram
10. A Class book of Botany by A. C. Dutta.
11. An Introduction to World Vegetation by A. S. Collinson.

ENS-E303: GROUNDWATER HYDROLOGY (Theory: 3 credits & Practical: 1 credit)

Salient features of this Course:

Introduction to groundwater hydrology and role of groundwater in water resources system and management , movement of groundwater through saturated and unsaturated porous media, well hydraulics, groundwater management and groundwater transport process.

Course Objective:

To equip the students with capabilities required to explain groundwater occurrences, aquifer classification and aquifer properties in the many different geological environments.

Course Outcomes: Students completing this course should be able to:

1. Carry out comprehensive hydrological flow systems analyses in groundwater systems.
2. Performing detailed groundwater balances, interpreting and working with the concepts of groundwater recharge, storage, and discharge.
3. Knowledge of the steady-state and transient groundwater flow processes and their physical description, and application of analytical solutions to solve the groundwater management problems.

Course contents:

Unit I

Role of groundwater in the hydrologic cycle, problems and perspectives. Occurrence and movement of groundwater, hydrogeology of aquifers, Darcy's law, general flow equations.

Unit II

Groundwater and Well Hydraulics steady and unsteady radial flows in aquifers, partially penetrating wells, characteristic well losses, specific capacity. Surface and Subsurface investigations of Groundwater: Geologic methods, remote sensing, geophysical exploration, electrical resistivity and seismic refraction, logging techniques. Water wells: methods of construction, yield tests, protection and rehabilitation of wells.

Unit III

Management of Groundwater: concepts of basin management, conjunctive use, mathematical modelling, artificial groundwater recharge: concepts, recharge methods, recharge mounds, induced recharge. Saline water intrusion in aquifers

ENS-E308: Practical based on ENS-E303 (1 Credit)

Prescribed and Reference Books

1. Todd D.K., Mays L.W. , Groundwater Hydrology,Wiley, (2004).

2. Raghunath H.M., Ground Water ,New Age International Publishers, (2007).

3. Schwarz F., Zhang H., Fundamentals of Ground Water,Wiley, (2002).

4. Fitts C., Groundwater Science,Academic Press, (2012).

5. Bear J., Hydraulics of Groundwater,Dover Publications, (2007)

ENS-E304: Current Environmental ISSUES III (Theory: 3 credits & Practical: 1 credit)

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

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

Course Outcomes:

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

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

Course contents:

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

ENS-E309: Practical based on ENS-E304 (1 Credit)

ENS-E305: INTRODUCTION TO ENVIRONMENTAL MODELLING (Theory: 3 credits & Practical: 1 credit)

Salient features of this Course: Introduction of models and methods of data analysis and different methods of environmental modelling.

Pre-requisite: Knowledge about basics of mathematics, Environmental issues and processes

Course Objectives:

Environmental Modelling aims at providing the necessary knowledge for the development of models and methods of data analysis. The study course deals in a cross-disciplinary way with different methods of environmental modelling.

Course Outcomes: On completion of this course, Student will be capable of

1. Development of models and methods of data analysis which will increase competency in various fields of disciplinary and interdisciplinary environmental research in environmental monitoring, environmental statistics, management of environmental

databases, and development of environmental information systems, environmental planning or environmental education.

2. The huge scope is in planning offices, statistics agencies, ministries and public authorities, management of medium-sized enterprises, policy advice and environmental education.

Course contents:

Unit I:
Introduction to Environmental Modelling, Necessity of Model, Structure of Model, Types of Models

Unit II:
The Role of Modeling, Environmental Models, The Model Life-cycle, An Alternative Life-cycle, Quality Assurance

Unit III:
Engineered Environmental Systems, Natural Environmental Systems, Software for Developing Mathematical Models

ENS-E310: Practical based on ENS-E305 (1 Credit)

Prescribed and Reference Books

1. Modeling Tools for Environmental Engineers and Scientists, Nirmalkhandan N., CRC Press, Boca Raton, Florida.
2. Integrated Environmental Modelling, Ramaswami A., Milford J.B. and Small M.J., John Wiley and Sons, Inc., New Jersey.
3. Environmental Modeling, Schnoor J.L., John Wiley & Sons, Inc., New York

ENS-OE301: BASICS OF WATER AND WASTE WATER TREATMENT
(Theory: 2 credits)

Salient features of this course: This course is designed to cover details of water and waste water treatment methods which includes primary, secondary and tertiary treatment methods

Course Objectives:

1. Learn the basic concepts of water treatments according to the source and its uses
2. Explore different methods of water and waste water treatments

Course Outcomes:

On completion of this course, Student will be capable of

1. Acquire the basic knowledge of water treatments according to the source and its uses
2. Can suggest and apply different methods of water and waste water treatments

Course contents:

UNIT I:

Concept of treatment, Unit operations and processes, Physical, chemical and biological methods, Domestic Wastewater Treatment, Wastewater characteristics; Primary, secondary and tertiary treatment ; Physical Unit Processes Screening; Commutation; Grit Removal ; Equalization; Sedimentation; Microbial ecology and Growth kinetics; Types of microorganisms; aerobic and anaerobic processes, Biological Unit Processes Aerobic treatment; Suspended growth aerobic treatment processes; Activated sludge process and its modifications; Attached growth aerobic processes; Tricking filters and Rotating biological contactors; Anaerobic treatment ; suspended growth, attached growth, fluidized bed and sludge blanket systems; nitrification, denitri fication; Phosphorus removal

UNIT II:

Sludge Treatment, Thickening; Digestion; Dewatering; Sludge drying; Composting, Natural Wastewater Treatment Systems: Ponds and Lagoons; Wetlands and Root -zone systems. Chemical Unit Processes Coagulation, Flocculation; Filtration; Disinfections;

Aeration and Gas transfer; Precipitation; Softening; Adsorption and Ion exchange; Membrane processes, Rural Water Supply; Low Cost Sanitation; Septic tanks, Soak-pits.

Prescribed and Reference Books

1. Water Supply & Sanitary Engineering by S C Rangwala.
2. Environmental engineering, by Gidde and lad
3. Biodegradation and Bioremediation. Academic Press; 2nd Edn. Martin Alexander.
4. Wastewater Microbiology, Gabriel Bitton, 2nd Edition. Wiley-Liss; 2nd Edn (1999)
5. Waste treatment and disposal, Wiley publications
6. Water & Wastewater Disposal Reuse by Metcalf & Eddy.

ENS-OE302: AQUACULTURE
(Theory: 2 credits)

Salient features of this course: This course will give the student an understanding of the basic principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and grow-out, and culture methodologies of fish, reptiles, invertebrates (zooplankton, molluscs, crustaceans, corals) and algae.

Pre-requisites:

This course useful in any discipline of science would understand different types of aquaculture practices indeed fresh water aquaculture and its benefits.

Course Objectives:

1. Production of low cost protein rich, nutritive, palatable and easily digestible human food.
2. Providing new species and strengthening stocks of existing fish in natural and man-made water-bodies through artificial recruitment.
3. Production of ornamental fish for aesthetic appeal.
4. Effective utilization of aquatic and land resource.

Course Outcomes:

Students completing this course should be able to:

1. Describe the different types of aquaculture systems.

2. Understand conditioning factors and how they can be manipulated.
3. Describe water depuration mechanisms.
4. Describe basic culture methodologies, common problems and solutions of commercially important species.
5. Understand the environmental impacts of aquaculture.

Course contents:

Unit-I

Basics of aquaculture, definition and scope, history of aquaculture, present global and national scenario. Aquaculture vs agriculture, overview of national and international agricultural systems, systems of aquaculture - pond culture, pen culture, cage culture, running water culture, zero water exchange system, etc. Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water and inland saline water.

Unit-II

Principles of organic aquaculture. Pre-stocking and post stocking pond management. Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture: freshwater, brackish-water and marine. Monoculture, polyculture and integrated culture systems. Water and soil quality in relation to fish production and estimation of productivity. Physical, chemical and biological factors affecting productivity of ponds. Nutrition, health management and economics.

Prescribed and Reference Books

1. Lucas J.S and Southgate, P.C. Aquaculture, farming aquatic animals and plants. Wiley-Blackwell

2. Tidwell, J.H. Aquaculture Production Systems. Wiley-Blackwell.

3. Parker R. Aquaculture Science. Delmar Cengage Learning.

4. Hoff F.H. and Snell T. W. Plankton Culture Manual. Florida Aqua Farms, Inc.

5. Environmental Science, S C Santra.

6. Environmental Biology, Sharma and Kaur.

ENS-OE303: GREEN TECHNOLOGY
(Theory: 2 credits)

Salient features of this Course:

The course content is very important to any students of any discipline to know about different concept of green and energy efficient technology to overcome the environmental pollution problems.

Pre-requisites:

This course may opt by any students from any discipline to understand the importance of green technology for protection of natural resources and sustainable development.

Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of how green technologies helpful to reduce the environmental degradation and organisations work with sustainability issues such as environmental and natural resource management and sustainability issues.
2. To know the importance of green fuel and their principle and working in different areas for pollution free environment.
3. To impart knowledge on the methods of reducing greenhouse gases level in atmosphere.
4. To consider the impacts of flows (energy, water, resources/waste) within the built, urban, agricultural and natural environments.

Course Outcomes:

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

1. To acquire the knowledge about various concepts of green technologies and Energy efficient technologies
2. It help to identify carbon credits, carbon sequestration in clean development mechanism activities
3. To know the advantages of green fuels with respect energy saving/eco-friendly techniques.

Course contents:

UNIT- I: Introduction of Green Technology

Concept of green technology, Importance – Historical background/evolution, advantages and disadvantages of green technologies, factors affecting green technologies, Role of Industry, Government and Institutions – Industrial Ecology – role of industrial ecology in green technology, Non-conventional energy resources, 3R principle- reuse, recovery, recycle for

waste minimisation, raw material substitution-Wealth from waste. Role of biotechnology and nanotechnology in energy production.

UNIT II: Clean development mechanism (CDM) project

Concept of CDM project, operations of CDM at international level, greenhouse gas reduction, green technology, green fuel, benefits and challenges, role of industries in green fuel production, innovation and research , environmental, economic and social impacts-public policies and market-driven initiatives. Biomass energy: Concept of biomass energy Wind Energy, solar energy, biodiesel, ethanol, methanol, electric vehicles, solar vehicles etc energy conversion technologies, their principles, equipment and suitability in Indian context; tidal and geothermal energy. Cleaner Production Project Development and Implementation: Technical and Environmental Feasibility analysis, Economic valuation of alternatives – Total Cost Analysis – CP Financing – Preparing a Program Plan – Measuring Progress- ISO 14000. Ecolabelling, eco-friendly products, Current issues in green technology, case studies etc.

Prescribed and Reference Books

1. 'Pollution Prevention: Fundamentals and Practice' by Paul L Bishop (2000), McGraw Hill International.
2. 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production' by World Bank Group (1998), World Bank and UNEP, Washington D.C.
3. 'Cleaner Production Audit' by Prasad Modak, C.Visvanathan and Mandar Parasnis (1995), Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok
4. 'Handbook of Organic Waste Conversion' by Bewik M.W.M.
5. 'Energy, The Solar Hydrogen Alternative' by Bokris J.O.
6. 'Non-conventional Energy Sources' by Rai G.D.
7. 'Solar Energy' by Sukhatme S.P.
8. 'Waste Energy Utilization Technology' by Kiang Y. H.
9. https://www.inspirenignite.com/jntuk/jntuk-b-tech-green-technologies-open-elective-for-r13-batch/

ENS-OE304: Fundamentals of GIS
(Theory: 2 credits)

Salient features of this Course:

The Course on Fundamentals of Geographical Information technologies will play an important role in understanding present day issues and their solutions. Presently, it is one the most important and job giving sector for both in government and private field.

Pre-requisites: Basic interest about the subject.

Course Objectives: This course aims to:

1. Introduce the students to the fundamental concepts of GIS, Remote Sensing and GPS
2. It will make them familiar with the most essential techniques
3. Students will learn about creation and organization of spatial and non spatial data.
4. Learn different GIS based techniques to identify and solve the actual natural, environmental and community problems.
5. Use GPS to collect ground points and during day to day life activities.
6. Learn application of GIS and GPS.

Course Outcomes:

After successful completion of this course, a student should know

1. The fundamental concepts of GIS, Remote Sensing and GPS
2. Identify and interpret aerial photographs
3. Differentiate between different data types in GIS.
4. Describe various GIS tools and techniques
5. Explain the fundamental principles behind GPS technology

Unit I: Basics of Remote Sensing

Introduction to Remote Sensing, Definition, Principles of Remote Sensing, Active and passive remote sensing, Reflection, Absorption, Transmission, Scattering, Process of Remote Sensing, Indian Remote Sensing Programme, Characteristics of EMR, EMR and its interaction with earth's surface and atmosphere, Types of Satellites- Sun-synchronous and Geostationary Satellites, Resolution- Spatial, Spectral, Radiometric, Temporal,

Fundamentals of Aerial Photography, History of Aerial Photographs, Types of Aerial Photographs, Flight Planning, Photogrammetry - Basic Geometric Characteristics- Scale, Overlap, Tilt, Distortion and Displacement of Aerial Photographs, Advantages and Disadvantages of Aerial Photographs, Concept of spectral Signatures- Photo recognition Elements.

Unit II: GIS and GPS

Introduction to GIS, Definition, History and Importance of GIS, Contributing disciplines, Development of GIS, Components of GIS, Hardware and Software components, GIS diversity Data models in GIS - Raster data model, Vector data model, basic entities of GIS: line, point and polygon, Geodatabase, Data: Spatial and Attribute data. Data Base Management System: Concept, types of DBMS, Hierarchical, Network and relational data models, advantages and disadvantages. Applications of GIS: Agricultural, applications, Forest Applications, Land use Land Cover mapping, Water resources, etc.

Global Positioning Systems, History and developments in GPS, Trilateration process, Applications of GPS technology.

Prescribed and Reference Books

1. Ahmed, E. L. Rabbany (2002): Introduction to Global Positioning Systems, Artech House, Boston
2. Anji Reddy, M. (2008): Textbook of Remote Sensing and Geographic Information System, B.S. Publication, Hyderabad
3. Burrough, P. A. and McDonnell, R. A. (2000): Principles of Geographical Information Systems, Oxford University Press, New York
4. Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London
5. Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw-Hill, New York
6. Demers, M. N. (2000): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi
7. Heywood, I., Cornelisus, S., Carver, S. (2011): An Introduction to Geographical Information Systems, Pearson Education, New Delhi
8. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
9. Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India
10. Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore
11. Lillesand, T. M., Kiefer, R. W. and Chipman, J. W. (2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
12. Lo, C. P., Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi
13. Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester
14. Sabins, F. F. (1996): Remote Sensing: Principles and Interpretation, W. H. Freeman and Company, San Francisco

ENS-OE 305: WATER CONSERVATION
(Theory: 2 credits)

Salient features of this Course: Watershed development and management, Design, construction and maintenance of conservation structures

Pre-requisite: Basic knowledge about water resources and their use

Course Objectives: This course aims to enable the students to gain knowledge about the Watershed management, Design, construction and maintenance of conservation structures

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

1. Identifying various watershed problems and their solutions.
2. The huge scope is in planning offices, agencies, ministries and public authorities, policy advice and environmental education.

Course contents:

Unit I

Concept of watershed development and management; collection of hydrological data; watershed characteristics and hydrologic cycle; problems of land degradation; Land use capability classification and topographical characteristics of watershed; Appropriate soil and water conservation measures for agricultural and non-agricultural lands; Grassland development and management; Techniques for dry land farming based on watershed characteristics; water harvesting techniques for hilly and arid regions; Hydrological and sediment monitoring of watershed; Estimation of peak design runoff rate; Planning, management and economic evaluation of watershed development projects; case studies.

Unit II

Basic concepts of soil erosion; control of soil erosion; Mechanics of wind and water erosion; water and wind erosion control practices; concept of runoff and its estimation; Design, construction and maintenance of vegetated waterways; Planning, Design, Construction and maintenance of terraces, contours and bunds; Design of water harvesting structures and farm ponds; Flood control and routing; Design of landslide control structures; Selection of appropriate irrigation and drainage systems for efficient soil and water conservation; cost analysis.

Prescribed and Reference Books

1. Soil and WaterConservation Engineering, Fangmeier, W., Elliott, W.J., Workman, S., Huffman, R. and Schwab, G.O. , 5th Edition, Cengage Learning, Inc., Clifton Park, USA.
2. Soil and Water Conservation Engineering, 4th Edition, Frevert, R.K., Schwab, G.O.Edminster, T.W. and Barnes, K.K. , John Wiley and Sons,New York.
3. Principles of Agricultural Engineering. Volume II. 4th Edition, . Michael, A.M. and Ojha, T.P. , Jain Brothers, New Delhi.
4. Land and Water Management Engineering, Murthy, V.V.N. , 4th Edition, Kalyani Publishers, New Delhi.
5. Manual of Soil and Water Conservation Practices, Singh Gurmel, Venkataraman, C., Sastry, G. and Joshi, B.P. , Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

M.Sc. Environmental Science
II Year - IV Semester
Syllabus

M.Sc. Environmental Science, II Year, IVSemester (Total Credits 25)									
Sr. No.	**Subject**	**Code**	**Theory Paper**	**Credits**		**Sr.No.**	**Code**	**Practicals Paper**	**Credits**
1	**Core**	ENS-C401	Environmental management	2		**1**	ENS- C406	Environmental management	1
2	**Core**	ENS-C402	Solid waste management	2		**2**	ENS- C407	Solid waste management	1
3	**Core**	ENS-C403	Industrial Pollution control and Safety	2		**3**	ENS- C408	Industrial Pollution control and Safety	1
4	**Core**	ENS-C404	Disaster Management	2		**4**	ENS- C409	Disaster Management	1
5	**Core**	ENS-C405	Dissertation	4		**5**	ENS- C410	Dissertation	2
6	**Open Elective (to be selected by the School Student within the subject)**	ENS- E401	Bioresource management	3		**6**	ENS- E405	Bioresource management	1
		ENS- E402	Clean Development Mechanism				ENS- E406	Clean Development Mechanism	
		ENS- E403	Current Environmental Issues IV				ENS- E407	Current Environmental Issues IV	
		ENS- E404	Environmental Economics				ENS- E408	Environmental Economics	
7	**Open Elective For Students from other schools in University**	ENS-OE401	Industrial Safety	2		**7**	ENS- C411	Seminar	1
		ENS-OE402	Industrial waste recycling						
		ENS-OE403	Renewable Energy resources						
		ENS-OE404	Fundamentals of Organic Farming						
		ENS-OE405	Environmental Legislations						
			Total	**17**				**Total**	**8**

Department of Environmental Science
School of Earth Sciences
SRTM University
NANDED

ENS-C401: ENVIRONMENTAL MANAGEMENT
(Theory: 2 credits & Practical: 1 credit)

Salient features of this Course:

The course content is very important to any 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 etc.

Pre-requisites:

This course may opt by any students from any discipline to understand the environmental management plan/legislations for protection of natural resources.

Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of how firms and organisations work with sustainability issues such as environmental and natural resource management and sustainability issues.
2. To know the environmental legislation and their operations at national level.
3. To understand the EIA process and their role in developmental projects.
4. To apply monitoring and environmental management tools used by resource and environmental practitioners.
5. To consider the impacts of flows (energy, water, resources/waste) within the built, urban, agricultural and natural environments.

Course Outcomes:

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

1. Analyze and interpret the environmental problems at national and international level.
2. Students are able to compare the different roles of, and relations between, firms, governmental agencies, NGO's in relation to issues concerning environmental and natural resource management and sustainability.
3. It is important to predict the environmental impacts of developmental projects and engineered solutions in global and socio-economic context.
4. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

Course contents:

Unit I: Environmental Management:

Concept of Environmental Management Plan (EMP). Need for Environmental Management, Objectives and Components. Deforestation, Afforestation, Industrial forestry, Medicinal forestry and their significance; Pollution abatement strategies: A basis for Preventive Environmental Policy (PEP). Environmental Management System Standards (ISO 9001, ISO14000 series etc), Environmental Audit, Environmental Policies: Global Environmental Policies and National Strategies for Protection of Environmental quality International Policies. The Agenda 21 of Earth Summit, Major International Organizations and Agencies Involved in Environmental Management. Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, Copenhagen Summit, 2009. IPCC, UNEP, IGBP. Environmental Protection Efforts at National Level. National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006 etc

Unit II: Environmental Legislations:

Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Basic Concepts and Principles; History of Environmental Legislation; Environmental Acts and Policies, Scope for improvement; National Environmental Policy Act, Environmental Tribunal; Green benches - working and need for betterment of Environmental system, Role of Central Pollution Control Board and State Pollution Control Boards. The Water Act (1974); Water Act (1977); The Air Act (1981); Environmental Protection Act (1986); Conservation of Biodiversity act (1999); Salient features of this Course of Wild Life Protection Act (1972); Forest Conservation Act, 1980, Coastal Regulation Zones (CRZ) 1991 etc.

ENS-C406: Practical based on ENS-C401 (1 Credit)

Prescribed and Reference Books

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

02. **Environmental Laws of India-An Intro:** CPR Environmental Education Centre, Chennai, 2001

03. **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. **Introduction to Social Forestry :** Sitram Rao, Oxford and IBH Pub. Co. Pvt. Ltd
11. **An Introduction to Environmental Management :** Dr. Anand S. Bal, Himalaya Pub House, 2005

ENS-C402: Solid Waste Management
(Theory: 2 credits & Practical: 1 credit)

Salient features of this Course:

The course may be learned by any students of any discipline as soil pollution and solid waste problems and their associated environmental problems. Students from any discipline can understand the pathway of pollutants in environment.

Pre-requisites:

This course may opt by any students from any discipline to understand the environmental pollutants and their pathway. Students will learn how to mitigate the solid waste problems by 4 R principle and product development from waste to wealth.

Course Objectives:

1. The aim of this paper is to enhance the knowledge of soil and solid waste pollution and their sources and impacts.
2. To promote awareness among individual and societal level regarding do and don'ts of hazardous waste.
3. To undertake the role of individual/volunteer in mitigation & environmental pollution problems.
4. To understand the remedial measures/techniques for solid waste disposal.

Course Outcomes:

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

1. Analyze and interpret the solid waste pollution problems and associated risk to environment.

2. Students are able to design environmental engineering and eco-friendly systems to mitigate solid waste problems.
3. It helps to forecast and predict fate of pollutants in the environment.
4. It may help to identify best waste management practices, modern tools and techniques.
5. It is important to predict the environmental impacts of developmental projects and engineered solutions in global and socio-economic context.
6. Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability

Course contents:

Unit I: Solid waste pollution

Introduction of solid waste, Sources and characteristics; Composition, Types of solid wastes: Residential wastes, Commercial wastes, Industrial wastes. Hazardous waste Types, characteristics and health impacts. Biomedical waste, e-waste: classification, methods of handling and disposal. Fly ash: sources, composition and utilization. Plastic waste: sources, consequences and management. Solid waste collection and transportation, container systems - hauled and stationary, layout of collection routes, transfer stations.

Unit II: Solid waste management and Control techniques,

Solid waste processing and recovery– Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and Vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste. Hog feeding, open dumping, Pyrolysis, incineration, Controlled tipping, Pulverization, Hammer mills, rotating drum machines. '4R' principles of solid waste, Solid waste pollution scenario in India, The Solid Waste Management Rules, 2016, Hazardous waste management: Treatment Methods – neutralization, oxidation reduction etc, Hazardous waste management Act 1989, The Plastic Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016; The Bio-Medical Waste Management Rules, 2016.

ENS-C407: Practical based on ENS-C402 (1 Credit)

Prescribed and Reference Books

01. **Soil and Noise Pollution :** B. K. Sharma, H. Kaur, Goel Publishing House, Meerut, 1994
02. **Solid waste pollution :** Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008
03. **Principals of soil science :** M. M. Rai

04. **Soil pollution & Soil organisms :** P. C. Mishra
05. **Environmental Chemistry :** B. K. Sharma
06. **Environmental Science :** S. C. santra, New Central Book Agency, Kolkata, 2005
07. **Environmental Pollution Control Engineering,** C. S. Rao, New age International, Mumbai, 2003
08. **Fundamentals of Soil Science :** Henry D. Foth, John Wiley & Sons, New York, 1984
09. **Environmental Engineering :** Davis & Cornwell, McGraw – Hill Publications, New York, 1998
10. **Environmental Science Principles and Practices :** R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008

ENS-C403: INDUSTRIAL POLLUTION CONTROL & SAFETY
(Theory: 2 credits & Practical: 1 credit)

Salient features of this course:

This course may learn by any Science stream discipline as well as the Engineering one. The Student learns about how to minimize the pollution problems by using the update techniques with applications of various Instruments/Equipments in the present scenario.

Pre–requisites: This course can prefer by any students of Science discipline to understand the environmental pollutants and their pathways. Students will learn how to mitigate the industrial pollution and its impact on environment.

Course Objectives:

1. To bring about all round improvement in the quality of the Environment in and around by effective implementation in pollution control measures.
2. To Identifications of sites and development of procedures and methods for the max reuse, recycle and then disposal of hazardous wastes.
3. Using different Environmental cleaning devices can create a healthy and natural Environment.

4. Minimal expenditure with cost effective benefits and the course one can easily understand and apply everywhere.
5. To promote new developed / developing technologies in the area of air pollution control.
6. To minimize the hazardous emissions disperse into the environment.
7. Identification of agencies / groups / individual involved in field of industrial air pollution control.
8. To work out a suggestive action plan for implementation of suitable / feasible technologies / measures for air pollution abatement.

Course Outcomes:

After completion of the course the students will be able to

1. By completion of this course, student can control pollution, methods with cost effective.
2. The course indeed Industrial impact on Soil, Air, Water as well as Environment.
3. To evaluate solutions to reduce the different kinds of pollution sources.
4. It may be helpful to distinguish between various industrial pollutants.
5. Organic and inorganic wastes are released at large amount of the most eco-toxic materials.
6. The system should be able to degrade, pollutant by microbes, fungi, as it will destroy toxicants.

Course contents:

Unit- I

Introduction: Industrial pollution, Different types of wastes generated in an industry, Various water pollutants, Air pollutants and Solid wastes from industry, Their effects on living and non-living things, Environmental regulatory legislations and standards, Importance of industrial pollution abatement, Air Pollution Control: Sources and classification of air pollutants, Nature and characteristics of gaseous pollutants and particulate matter, pollutants from automobiles. Control of gaseous emissions by absorption, adsorption. Recycle and Reuse of waste, Energy recovery and waste utilization. Water use minimization, fugitive emission/effluents and leakages and maintenance, Fertilizer, Glass, Rubber, Sugar Industries and Thermal power plants etc.

Unit- II

Water Pollution: Identification, Classification of different treatment methods into physico-chemical and biochemical techniques, General concept of primary treatment, Liquid-solid separation, Biogas plant usage, Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and Textiles, Dyes Drugs, Paints, Oil Refineries. Wet gas scrubbing, gaseous emission control by absorption and adsorption,

Design of cyclones, ESP, fabric filters and absorbers. Industrial pollution control, safety equipments, safety act, safety training and requirements.

ENS-C408: Practical based on ENS-C403 (1 Credit)

Prescribed and Reference Books

1. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, 4th edn., Tata McGraw Hill, New Delhi, 2003.
2. Modi, P. N., Sewage Treatment and Disposal and Waste Water Engg, Vol. II, Std Book House, Delhi.

3. Peavy, H. S., Rowe, D. R, Tchobanoglous, G, Environmental Engineering; McGraw Hill, 1995.

4. De Nevers, N, Air Pollution Control Engineering, 2nd edn., McGraw-Hill, 2000.

5. Bhatia S C, Environmental Pollution and Control in Chemical Process Industries, Khanna Pub, Delhi.

6. Mahajan, S. P, Pollution Control in Process Industries, Tata McGraw-Hill, New Delhi, 1998.

7. Masters, G. M, Introduction to Environmental Engineering and Science, Prentice Hall off India, (2008).
8. Rao C S, Environmental Pollution Control Engineering, Wiley Eastern (2010).
9. S C Santra, Environmental Science.

ENS-C404: DISASTER MANAGEMENT
(Theory: 2 credits & Practical: 1 credit)

Salient features of this Course:

The course may be learned by any students of any discipline as Disaster Management (DM) is multi disciplinary and draws its knowledge base from a range of disciplines. The overall aim of this is to provide broad understanding about the basic concepts of Disaster and its management.

Pre-requisites:

This course may offer specializations in areas like threat response, disaster management, disaster preparedness or public administration. These specialization degrees will require specific prerequisites. It also requires prerequisites in leadership, organizational behavior, emergency services, public administration, strategic planning, and occupational safety and health. Students will learn how to plan for disasters and emergencies while applying the common concepts of disaster management. Students will explore documented case studies in order to understand how real disaster situations interrupt operational efficiency and effectiveness.

Course Objectives:

1. The aim of Approaches to Disaster Risk Reduction is to enhance the knowledge by providing existing models in risk reduction strategies to prevent major causalities during disaster.
2. To promote Prevention and Preparedness plan for disaster mitigation
3. To undertake the role of individual/volunteer in mitigation & Risk Reduction steps
4. To prioritize Rescue and Relief operation during disaster.
5. To understand the causes, effects and remedial measures for disaster.

Course Outcomes:

1. It helps to learn the concept of Disaster Management and its application during on site and off site emergency.
2. The project/field work is meant for students to understand vulnerabilities and to work on reducing disaster risk, project/case studies are conceived creatively based on the geographic location and hazard profile of given region etc.
3. It may help to individual to create the ability for mitigate the disaster risk.
4. It is important to learn the Preparedness plans for disaster response.
5. It creates the ability monitoring and evaluation plan for disaster response and its functioning at national/state/district level.
6. It may helps to learners to create hazard/risk profile maps of any geographical area.

Course contents:

Unit I: Introduction of Disaster

Introduction of Disaster, Types/Classification of Disasters, Natural and Manmade disasters, Flood, Landslide, Earthquake, Volcanism, Cyclones, Drought, Fire, Tsunami, mining, Wind storms, Nuclear/Biological/Chemical disasters, Environmental pollution, Global warming, Road/Rail accidents, endemic/pandemic disasters etc., Disaster potential in India. Disaster Impacts: Disaster loss, Social and economic impacts, Environmental Impacts, Reconstruction and Rehabilitation problems, Damage assessment, Hazard identification, Disaster Risk and Vulnerability, Disaster risk reduction, Risk analysis techniques, Primary and secondary impacts of disasters etc.

Unit II: Disaster management and Legislation

Disaster management Act- 2005, National/State/District level disaster management, Disaster prediction, Disaster mitigation strategies, Disaster management cycle, Disaster prevention, Disaster preparedness, disaster preparedness plan for people and infrastructure, community based disaster preparedness plan, Early warning system model in disaster preparedness, basic components of disaster relief (Water, Food, Sanitation, Shelter, Health, Waste management etc). Disaster mitigation, Role of International agencies, NGO's, Community based Organisations (CBO's), Role of individual, voluntary organization, Disaster monitoring and evaluation, Disaster relief fund, Disaster related case studies, The project/field work is meant for students to understand vulnerabilities and to work on reducing disaster risk, project/case studies are conceived creatively based on the geographic location and hazard profile of given region etc

ENS-C409: Practical based on ENS-C404 (1 Credit)

Prescribed and Reference Books

01. Natural Disaster Reduction : Girish K.M. and G.C.Mathur, Reliance Publishing House, New Delhi. (1993)
02. Disaster Management : Shailendra K.Singh , Subhash. C, Kundu and Shobhue Singh , Mittal Publications, New Delhi. (1998)
03. Disaster Preparedness in India:Narendra Kumar Jain, Adhyatma Sadhana Kendra, New Delhi.(1996)
04. Disaster Management : Dr. S. R. Singh, A. P. H. Publishing Carporation, New Delhi, (2008)
05. Environmental Science : S. C. Santra, New Central Book Agency, Kolkata, 2005.
06. Bryant Edwards (2005), Natural hazard, Cambridge University press, UK.
07. Roy, P S. (2000): Space technology for disaster management: A remote sensing and GIS perspective, Indian institute of Remote sensing (NRSA), Dehradhun.
08. Sharma R. K. and Sharma G. (2005) (ed): Natural Disaster, APH Publishing corporation, New Delhi.

ENS-E401: BIO-RESOURCE MANAGEMENT
(Theory: 3 credits & Practical: 1 credit)

Salient features of this course: It is post graduate course offers consulting, managing and marketing services to the forestry, agriculture, biomass energy and organic residual management fields, useful in sustainable development .

Pre-requisites:

This course useful in any discipline of science would manage the resources at some extent level and refurbish them again.

Course Objectives:

1. To identify and discuss various issues, which can affect conservation attempts and apply knowledge of these issues in order to recommend conservation strategies for real or hypothetical situations;
2. To identify the importance of healthy ecosystems and biological resources in the wider field of resource management.
3. Calculate and manage the resources available and regenerate it.

Course Outcomes: Students completing this course should be able to:

1. Integrate basic environmental science concepts with traditional and modern resource management practices in recommending environmental management decisions.
2. Exhibit best management practices when extracting and utilizing natural resources.
3. Design and implement an environmental study.
4. Effectively use laboratory and field instrumentation to collect data.
5. Analyze and interpret environmental data.
6. Write an objective technical report involving the presentation and analysis of environmental data.

Course contents:

UNIT-I

Earth and environmental resources: Atmosphere, lithosphere, hydrosphere Interior of Earth, environmental work of wind and water, underground water, igneous, sedimentary and metamorphic rocks, mineral types, mineral resources of India, erosion and weathering, soil

formation, soil profiles, types of erosion, estimation of soil degradation, land use and land use planning, earth resource mapping and the use of remote sensing and GIS.

UNIT-II

Water resources: hydrology, the hydrological cycle and its components, drainage systems, classification of water resources, characteristics of water resources. Surface run-off, stream flow estimation, problems of water and ground water resource depletion, watershed types and functions, water conservation, wetland culture and resource management, microbial organism species utilization and management, significance of aquatic resources and its supplementation, planning and peoples participation in natural resource conservation.

UNIT-III

Applications for management: Soil and water conservation measures, erosion control, case studies in water resource conservation and management, flood management and control, landslide control and mitigation measures, coastal zone management, watershed management and case studies, earthquake mitigation for buildings and dams, forest fire mitigation and management, biodiversity conservation, agriculture practices and its gene culture preservation, plant species, gene pool, germ plasm banks, forest fire mapping.

ENS-E405: Practical based on ENS-E401 (1 Credit)

Prescribed and Reference Books

1. Roy, A.B. 2010.Fundamentals of Geology. Narosa.
2. Singh, Rajvir. 2000. Watershed Planning and Management. Yash.
3. Wallace, John M., and Peter V. Hobbs. 1997. Atmospheric Science: An Introductory Survey, Academic Press.
4. Bocker, Egbort, and Rienk Van Grondille, 1999.Environmental Physics. John Wiley & Sons.
5. Murthy, V.V.N. 2009. Land and Water Management, 5 edition. Kalyani Publishers.
6. Heathcote, I.W. 1988. Integrated Watershed Management: Principles and Practice.John Wiley.
7. Raganuth, H.M. 2007. Hydrology: Principles, Analysis and Design, 3rd edition. New Age Int.
8. Dennen, William H., and Bruce R. Moore. Geology and Engineering. Wm C Brown Publisher.
9. S C Santra, Environmental Science.

ENS-E402: CLEAN DEVELOPMENT MECHANISM
(Theory: 3 credits & Practical: 1 credit)

Pre-requisites: knowledge about Climate Change & Carbon Management

Course Objectives:

The elective course on Clean Development mechanism will introduce the students to various aspects of the CDM market and flexibility mechanisms.

Course Outcomes: On successfully completing this course, the students will be able to:

1. Critically assess various national and international Climate Change agreements;
2. Demonstrate an understanding of the bodies like UNFCCC, Kyoto Protocol and its mechanisms – ET, JI and CDM;
3. Illustrate the basics of Clean Development Mechanism

Course contents:

UNIT I

Introduction to carbon market, Compliance and voluntary market; Kyoto Flexibility Mechanisms, CDM, Joint Implementation and Emissions trading; UNFCCC, CDM Executive boards and its requirements; Methodologies for CDM and Voluntary carbon projects

UNIT II

Introduction to CDM, Project Cycle; Concepts of Baseline, Leakage, additionality, project emissions; Project Idea Note (PIN), Project Design Document (PDD) –application of baseline methodology & plan, estimation of the net GHG removal by sinks,

UNIT III

environment impacts of CDM project activities, socio-economic impact of CDM/JI project activities, stakeholder analysis, role of DOE & DNA in CDM/JI, Accredited Independent Entities under JI, review of CDM/JI projects, emission reduction units etc. Validation mechanisms

ENS-E406: Practical based on ENS-E402 (1 Credit)

Prescribed and Reference Books

1. Understanding Carbon Credits by Gurmit Singh
2. IPCC Fourth and Fifth Assessment Report
3. www.unfccc.int
4. www.cdmrulebook.org
5. www.carbonyatra.com
6. www.earthscan.co.uk

ENS-E403: Current Environmental ISSUES-IV (Theory: 3 credits & Practical: 1 credit)

Salient features of this Course:

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

Pre-requisites:

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

Course Objectives:

1. To make students aware with present issues obstructing the sustainable environmental development.
2. To enhance the knowledge about environmental concerns.

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

Course Outcomes:

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

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

Course contents:

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

ENS-E407: Practical based on ENS-E403 (1 Credit)

ENS-E404: ENVIRONMENTAL ECONOMICS
(Theory: 3 credits & Practical: 1 credit)

Salient features of this Course: Environmental Economics, Sustainable Development, Cost Benefit Analysis

Pre-requisite: Basic knowledge about Environmental Resources and problems

Course Objectives: This course aims to enable the students to gain knowledge about how the Natural resources drive the economy

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

1. Analyze the cost and benefits
2. Identifying the benefits to achieve sustainable development

Course contents:

Unit I:
Introduction to Environmental Economics, the Law of Diminishing Returns, Carrying Capacity, Sustainable Development

Unit II:
Markets – Supply and Demand Externalities, Net Present Valuation, Ecosystem Valuation, Trade-offs and opportunity cost

Unit III:
Marginal Costs and Benefits, Cost Benefit Analysis, Environmental Impact Analysis, Environmental Regulations & Economic Incentives

ENS-E408: Practical based on ENS-E404 (1 Credit)

Prescribed and Reference Books

1. Environmental Economics by Charles D Kolstad
2. Natural Resources and Environmental Economics by Roger Perman and others
3. Environmental and Natural Resources Economics by Steven C Hackett
4. Economics of the Environment by Berck
5. Economics of Environment by Shubhashini Muthukrishnan
6. Environmental Economics: An Indian Perspective by Bhattacharya Rabindranath

ENS-OE401: INDUSTRIAL SAFETY
(Theory: 2 credits)

Salient features of this Course:

The course content is very important to any students to develop highly qualified professional manpower in the industries. Thus, this syllabus is designed to train and provide expert human resource to safety management and expected to bring direct benefits to industry and society.

Pre-requisites:

This course may opt by any students from any discipline to understand the personal/occupational safety and avail better placement opportunity in the industries.

Course Objectives:

1. The aim of this paper is to provide skills and an improved understanding of how industries work with health issues.
2. To know the occupational and health safety in industrial environment and their operations.
3. Students are able to acquire sound knowledge about personal/occupational health, industrial hygiene, and accidental prevention methods.

Course Outcomes:

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

1. Analyse and interpret the occupational health safety and importance personal health during industrial work
2. It is help to develop an expert manpower to handle the complex environment in the industrial process.
3. It is important to predict the environmental impacts of developmental projects and engineered solutions in global and socio-economic context.
4. Students are able to think critically and contribute to research in solving contemporary health problems of workers with professional and ethical accountability

Course contents:

UNIT- I Industrial Safety :

Personal/ Occupational Safety, Health and Environmental Safety, Industrial safety management – principles & practices, Management role in Industrial Safety, Organization

role towards workers. Protective equipment, planning for Safety, Health and Management, Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records. WHO/ILO/ EPA guidelines for personal health

Unit II: Monitoring for Safety, Health & Environment:

Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures. Chemical Hazard: Introduction to chemical hazards, dangerous properties of Chemical, Dust, Gases, Fumes, Mist, Vapors, Smoke and Aerosols. Route of entry to human system, recognition, evaluation and control of basic hazards, concepts of dose response relationship, bio-chemical action of toxic substances. Concept of threshold limits values. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Importance of Industrial safety, role of safety department, Safety committee and function.

Prescribed and Reference Books

1. R. K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York.
3. Jeanne Mager Stellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication. IL

ENS-OE402: INDUSTRIAL WASTE RECYCLING

(Theory: 2 credits)

Salient features of this course:

This course may learn by any Science stream discipline as well as the Engineering one. The Student learns about how to minimize the pollution problems by using the update techniques with applications of various Instruments/Equipments in the present scenario.

Pre-requisites: This course can prefer by any students of Science discipline to understand the environmental pollutants and their pathways. Students will learn how to mitigate the industrial pollution and its impact on environment.

Course Objectives:

1. To bring about all round improvement in the quality of the Environment in and around by effective implementation in pollution control measures.
2. To Identifications of sites and development of procedures and methods for the max reuse, recycle and then disposal of hazardous wastes.
3. Using different Environmental cleaning devices can create a healthy and natural Environment.
4. Minimal expenditure with cost effective benefits and the course one can easily understand and apply everywhere.
5. To promote new developed / developing technologies in the area of air pollution control.
6. To minimize the hazardous emissions disperse into the environment.
7. Identification of agencies / groups / individual involved in field of industrial air pollution control.
8. To work out a suggestive action plan for implementation of suitable / feasible technologies / measures for air pollution abatement.

Course Outcomes:

After completion of the course the students will be able to

1. By completion of this course, student can control pollution, methods with cost effective.
2. The course indeed Industrial impact on Soil, Air, Water as well as Environment.
3. To evaluate solutions to reduce the different kinds of pollution sources.
4. It may be helpful to distinguish between various industrial pollutants.
5. Organic and inorganic wastes are released at large amount of the most eco-toxic materials.

6. The system should be able to degrade, pollutant by microbes, fungi, as it will destroy toxicants.

Course contents:

Unit- I

Introduction: Industrial pollution, Different types of industrial wastes generated from industry, Types of industrial wastes, waste composition, constituents of industrial wastes, analysis of industrial waste, biological waste composition, role of microbes in waste recycling, various microbes involved in degradation of organic and industrial wastes, natural composting, environmental regulatory legislations and standards, importance of industrial pollution abatement, environmental laws, standards for ambient of Air, Noise emission and effects.

Unit- II

Sources and classification of air pollutants, gaseous pollutants and particulate matter, recycle and reuse of industrial waste, energy recovery and waste utilization, water use minimization, forest fires, General concept of primary treatment, Liquid-solid separation, settling tank, biogas generation process, organic waste recycling, anaerobic microbes utilization in energy production, use of waste in land filling, fertilizer, micro and macronutrient supplementation, solid waste utilization and disposal methods, hazardous and non-hazardous wastes, treatment and disposal of solid wastes, incineration, environmental impact assessment, its concept and applications, environmental audit and industrial record maintenance.

Prescribed and Reference Books

1. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, 4th edn., Tata McGraw Hill, New Delhi, 2003.

2. De Nevers, N, Air Pollution Control Engineering, 2nd edn., McGraw-Hill, 2000.

3. Bhatia S C, Environmental Pollution and Control in Chemical Process Industries, Khanna Pub, Delhi.

4. Mahajan, S. P, Pollution Control in Process Industries, Tata McGraw-Hill, New Delhi, 1998.

5. Rao C S, Environmental Pollution Control Engineering, Wiley Eastern (2010).

6. S C Santra, Environmental Science.

7. Masters, G. M, Introduction to Environmental Engineering and Science, Prentice Hall off India, (2008).

ENS-OE403: RENWEABLE ENERGY RESOURCES
(Theory: 2 credits)

Salient features of this Course:

The course will provide a solid foundation about renewable energy systems in society. It will help the students in preparing for the successful career in the renewable energy sector. It will provides the detailed information about renewable energy resources including Solar energy, wind energy, geothermal energy, tidal energy, hydroelectric, biomass energy etc. with emphasis on the alternate energy, their technology and application. The students will be able to understand society's present requirements and future energy demands. They will also learn about the methods of energy conservation in detail.

Pre-requisites:

Basic understanding and interest about energy resources.

Course Objectives:

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

Course Outcomes:

After successful completion of this course, a student should know

1. The fundamental knowledge about renewable energy resources and technologies used to harness it.
2. Depict the challenges associated with the use of renewable energy resources 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 in relation to environment.

Course contents:

Unit I : Renewable Energy :

Introduction to Energy, energy requirement, Impact on the environment, Alternate sources of energy; Sun as source of energy: Solar energy: Solar electricity generation, Construction and working of Solar heaters, Solar dryers, Solar cookers; Wind energy: Wind Power plants, Harnessing of wind energy, Wind power potential in India; Geothermal energy: Sources of geothermal energy, power generation from geothermal energy, Hydroelectric energy: micro hydropower, Hydropower and the environment; Tidal and wave energy

Unit II : Bio-Energy :

Bio Fuel: Classes of bio fuel, Sources of bio fuel, Production of bio fuel, Ethanol. Biodiesel: Introduction, Production of bio diesel: Manufacturing process for bio diesel, Biogas – production and uses, anaerobic digestion; Biomass energy: Wood and wood waste, Waste to Energy Conversion, Biomass and the Environment.

Prescribed and Reference Books

1. Alternative Fuels, Sunggyu Lee, Applied Energy Technology Series, CRC Press
2. Environmental resource Conservation: S. K. Shukla, P. R. Shrivastava, Commonwealth Publishers, New Delhi, 1992.
3. Fuels and Bio-fuels: Vijayalaxmi, Meena Devi, Nagendra Prasad, Agrobios (India), Jodhpur, 2007.
4. Fundamentals of Environmental Science: G. S. Dahliwal, G. S. Sangha, P. K. ralhan, Kalyani Publishers, New Delhi.
5. Fundamentals of Renewable Energy Sources, G.N. Tiwari, M.K. Ghosal, Alpha Science Intnl. Ltd., 2007
6. Handbook of Alternative Fuel Technologies, Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka, CRC Press
7. Non Conventional Energy Sources: S. N. Kaul, A. R. Bhalerao, R. K. Trivedy, Current Publications, Agra, 2007.
8. Non-Conventional Energy: Ashok Desai V, Wiley Eastern Ltd, 1990.
9. Non-Conventional Energy Systems, Mittal K.M, Wheeler Publishing Co. Ltd, 1997
10. Non-Conventional Energy Resources, Sobh Nath Singh, Pearson Education

11. Principles of Solar Engineering, D. Y. Goswami, F. Kreith and J. F. Kreider, Taylor and Francis, Philadelphia, 2000.
12. Renewable Energy Resources, J W Twidell & A D Weir, ELBS, 2006
13. Renewable energy sources and emerging technologies by D.P.Kothari,K.C.Singhal, PHI
14. Renewable Energy Technologies, Ramesh R, Kurnar K.U, Narosa Publishing House, New Delhi, 1997
15. Solar Energy - Principles of thermal collection and storage, S. P. Sukhatme and J K Nayak, 3rd Ed Tata McGraw-Hill, New Delhi.
16. Understanding Clean Energy and Fuels from Biomass, H S Mukunda, Wiley India

ENS-OE404: FUNDAMENTALS OF ORGANIC FARMING
(Theory: 2 credits)

Salient features of this Course:

Organic farming has numerous advantages over conventional/traditional farming practices. Due to ever increasing environmental problems and issues like pollution, soil and water quality degradation, the value of organic farming is increasing. Organic farming is beneficial, and it has high demand from consumers as the awareness about food safety, security and health effects is increasing. In this view, the course is intended to provide fundamental knowledge about organic farming and related concepts to the interested students.

Pre-requisites: None

Course Objectives:

1. This course will be useful for students to understand the need and significance of organic farming in the present scenario
2. It will provide an overview about tools and techniques essential for it.
3. It will develop their interest towards sustainable agriculture and for the betterment of environment.
4. It will encourage the growth of organic practices in surrounding areas.

Course Outcomes:

After successful completion of this course, a student should know

1. The fundamental concept of organic farming
2. The need of organic agriculture
3. Describe the challenges advantages, disadvantages, conditions and limitations associated with organic farming

Course contents:

Unit I:

Organic Farming: Concepts and principles of organic farming, Scope and Present state of organic farming; Conventional farming v/s organic farming, Sustainable agriculture, Types of organic farming, Benefits of organic farming Vermi-composting- principles, Green labels, Green manuring, organic manures, Fertilizers, Bio-fertilizers-types, Bio-fertilizers-methods of application, techniques involved in organic farming, organic farming and climate change.

Unit II:

Requirements for organic farming, Farm components for an organic farm, Water management: water storage, drip irrigation system, National and international status of organic farming, Agencies related to organic agriculture, Standards for organic products, Organic Food Quality and Human Health, Integrated Nutrient Management (INM) and Integrated Plant Nutrient Supply System (IPNS).

Prescribed and Reference Books

1. Kristensen, P., Taji, A. and Reganold, J. (2006). Organic Agriculture: A Global Perspective.CSIRO Press, Victoria, Australia.
2. Bavec, F. and Bavec, M. (2007). Organic Production and Use of Alternative Crops.CRC Press, Boca Raton, FL.
3. Joshi, M., Setty, T.K.P. and Prabhakarasetty (2006). Sustainability through Organic farming.1st Edition.Kalyani Publishers, Ludhiana, India.
4. Altieri Miguel**.** 1987. **Agroecology: The Scientific Basis of Alternative Agriculture**. Westview Press. Boulder, CO.
5. Soule, Judith D. and Piper, Jon K. 1992.**Farming in Nature's Image: An Ecological Approach to Agriculture**. Island Press, Washington, D. C.

ENS-OE405 ENVIRONMENTAL LEGISLATIONS (Theory: 2 credits)

Salient features of this Course: National and International laws and policies

Pre-requisite: Basic knowledge about environment problems

Course Objectives: This course aims to enable the students to gain knowledge about National and International laws, strategies and policies about environment

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

1. Identifying laws, strategies and policies about various environment problems.
2. The huge scope is in planning offices, agencies, ministries and public authorities, management of medium-sized enterprises, policy advice and environmental education.

Course contents:

Unit I

International laws and policy:
Stockholm Conference 1972;
United Nations Conference on Environment and Development 1992;
Rio de Janeiro (Rio Declaration, Agenda 21);
Montreal Protocol 1987;
Kyoto Protocol 1997;
Copenhagen and Paris summits;
Ramsar convention.

Unit II

Environment Protection Act 1986
Amendments, Notifications
The Forest (Conservation) Act, 1980,
The Wildlife Protection Act 1972,
Rules 1973 and Amendment 1991,
The Wild Life (Protection) Amendment Act, 2006,
The Indian Forest Act, 1927,
National Forest Policy, 1988 and State Forest Policies,
Forest Dwellers Act 2008,
PESA, 1996,
National Green Tribunal (NGT),

The Water (Prevention and Control of Pollution) Act 1974;
The Forests (Conservation) Act 1980;
The Air (Prevention and Control of Pollution) Act 1981;
Noise Pollution (Regulation and Control) Rules 2000,
Land Acquisition Act 1894, 2007, 2011, 2012;
Land Acquisition Rehabilitation and Resettlement Act 2013,
The Biological Diversity Act 2002;
scheme and labelling of environment friendly products, Ecomarks, etc.

Prescribed and Reference Books

1. Environmental Law, (3rd Edn.), S.C. Shastri, Eastern Book Company, Lucknow, 2008.
2. Environmental Law, (2nd Edn.), I.A. Khan, Central Law Agency, Allahabad, 2002.
3. Environmental Law, (1st Edn.), Amod S. Tilak, Snow White Publication, Mumbai.
4. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, Oxford University Press, New Delhi, 2005.
5. Textbook on Environmental Law, (2nd Edn.), Maheshwara Swamy, Asia Law House, Hyderabad, 2008.
6. Environmental Law in India, (2nd Edn.), P Leelakrishnan, Lexis Nexis, New Delhi, 2005.