

**DEPARTMENT OF
EARTH AND ENVIRONMENTAL SCIENCE
K.S.K.V. Kachchh University
Mundra Road, Bhuj-370 001, Kachchh (Gujarat State)**



Syllabus
M.Sc. (Environmental Science)
(As per the new structure of CBCS)
(Effective from June 2010)

Submitted to
The Board of University Teaching and Research (BUTR)
KSKV Kachchh University
Bhuj-Kachchh

Extended Course Structure (Semester-I and II)

Semesters Course category	Semester-I <i>(credits of each course paper are written in the brackets) - (T+Tu&P)</i>	Semester-II <i>(credits of each course paper are written in the brackets) - (T+Tu&P)</i>
Core courses	<ol style="list-style-type: none"> 1. Ens-101/C Basics of Environmental Science (3 + 2) 2. Ens-102/C Environmental Biology (Ecology) (3 + 3) 3. Ens-103/C Instrumentation and Analytical Technique (3 + 2) 4. Ens-104/C Dryland and Marine Environment – Indian Context (3 + 2) 	<ol style="list-style-type: none"> 1. Ens-205/C Environmental Pollution – I (3 + 3) 2. Ens-206/C Environmental Pollution – II (3 + 3) 3. Ens-207/C Research Methodology, Biostatistics, and Computer application (2 + 2) 4. Ens-208/C Industrial Safety and Disaster Management (3 + 2)
Elective courses	NIL	NIL
Interdisciplinary courses	<ol style="list-style-type: none"> 1. Ens-141/I Environmental Chemistry (2 + 1) 2. Ens-142/I Remote Sensing and GIS (2 + 1) 3. Ens-143/I Nanotechnology (2 + 1) <i>(Any one out of three)</i>	<ol style="list-style-type: none"> 1. Ens-244/I Environmental Geology (2 + 1) 2. Ens-245/I Environmental Economics (2 + 1) <i>(Any one out of two)</i>
Foundational courses	(One out of many suggested by BAOU) (4)	(One out of many suggested by BAOU) (4)
Total Credits	28	28

Extended Course Structure (Semester-III and VI)

Semesters Course category	Semester-III <i>(credits of each course paper are written in the brackets) - (T+Tu&P)</i>	Semester-IV <i>(credits of each course paper are written in the brackets) - (T+Tu&P)</i>
Core courses	<ol style="list-style-type: none"> 1. Ens-309/C Environmental Auditing and EIA (3 + 3) 2. Ens-310/C Current Issues in Environmental Science (Updated Every Year) (3 + 2) 3. Ens-311/C Natural Resources, Conservation and Management in India (3 + 3) 	<ol style="list-style-type: none"> 1. Ens-412/C Environmental Legislation and Guidelines (3 + 3)
Elective courses	<ol style="list-style-type: none"> 1. Ens-321/E Environmental Biotechnology (4 + 3) 2. Ens-322/E Environmental Management ISO 14001 (4 + 3) <p style="color: red; text-align: center;"><i>(Any one out of two)</i></p>	<ol style="list-style-type: none"> 1. Ens-423/E Environmental Impact Assessment (EIA), Planning & Monitoring (4 + 3) 2. Ens-424/E Environmental Toxicology (4 + 3) 3. Ens-425/E (Dissertation) EIA and Environmental Monitoring (11) 4. Ens-426/E (Dissertation) Environmental Biotechnology (11) 5. Ens-427/E (Dissertation) Environmental Toxicology (11) 6. Ens-428/E (Dissertation) Environmental Issues, Ecology, Climate Change and Conservation (11) <p style="color: red; text-align: center;"><i>(Any one out of 1 and 2)(Dissertation is equal to two elective course work) (Any one out of 3 to 6)</i></p>
Interdisciplinary courses	0	0
Total Credits	24	24

SEMESTER-1**CORE COURSES****ENS-101/C****BASICS OF ENVIRONMENTAL SCIENCE**

(3 Credits for Theory and 2 Credits for Tutorials and Practicals)

Unit-I: Basics of Environment

Understanding our Earth and its Environment: Structure of Earth, Atmosphere, Hydrosphere, Lithosphere and Biosphere. Earth's climatic zones and biomes. Climate change, Precipitation: Rain, snow, dew, mist and fog

Unit-II: Atmosphere and Hydrosphere

Atmosphere: Composition, structure and functions of atmosphere, atmospheric chemistry, classification of elements, earth's energy budget, reactions in the lower and upper atmosphere, radioactivity in the atmosphere, atmospheric stability, inversions and mixing heights, wind roses

Hydrosphere: Structure and properties of water and their environmental significance, distribution of water in earth, fresh water and its chemistry, solubility of gases in water, role of water in environment

Unit-III: Marine Chemistry and Lithosphere

Marine chemistry: seawater properties and its constituents, nutrients and salts, Metallic and non-metallic mineral resources like manganese nodules etc.

Lithosphere: Factors and processes of soil development, soil types and their formation, soil profiles, physical and chemical properties

ENS-102/C

ENVIRONMENTAL BIOLOGY (ECOLOGY)

(3 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit-I: Basics of Ecology, Energy and Biogeochemical cycles

Basic concepts of Ecology: Definition, Scope of Ecology. Matter and energy in the environment, Laws of thermodynamics. Principle and concept of Ecosystem: Energy in ecosystem, concept of productivity, food chain, food web and trophic levels. Biogeochemical cycles: Gaseous cycles, hydrological cycles and Sediment cycles
Role of microbes in nutrient cycles

Unit-II: Habitats, Development and Population Ecology

Habitats in the ecosystem: Fresh water, marine, estuarine, terrestrial and deserts.
Ecological pyramids; limiting factors, laws and combined concept of limiting factors,
Development and evolution of the ecosystem. Ecotone and edge effect, Ecades, ecotypes.
Population dynamics, Communities, Species interaction.

Unit-III: Biodiversity, Microbial and System Ecology

Biodiversity: Origin, speciation and extinction and ecological role of biodiversity. Types of biodiversity, alpha, beta, and gamma diversity. Rare and endangered species: IUCN, Red Data Book. Causes of Biodiversity loss. Conservation of biodiversity: Conservation theory, conservation practices, protected areas and protected species. Microbial Ecology: Natural environment of microorganism; terrestrial, aquatic and extreme environments. Microbial flora of soil; Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Azolla, etc. Structure, behaviour and growth of microorganisms as related to the environment. Interaction of microbes with plants, animals and other microbes. Role of microorganism in degradation of recalcitrant compounds.
Systems ecology: The systems approach and mathematical models in ecology with some specific examples.

ENS-103/C

INSTRUMENTATION AND ANALYTICAL TECHNIQUE

(3 Credits for Theory and 2 Credits for Tutorials and Practicals)

Unit-I: Electrochemistry and Microscopy

Electrochemistry : pH and buffers, potentiometric and conductometric titration

Microscopy: Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal microscopy Cytophotometry and flow cytometry, fixation and staining

Unit-II: Principle and application of Filtration and Chromatography

Principle and application of gel- filtration, ion-exchange and affinity chromatography; Thin layer and gas chromatography; High pressure liquid (HPLC) chromatography, FPLC,

Unit-III: Principle and application of Centrifugation and Spectroscopy

Centrifugation: Basic principle and application; Differential, density and Ultracentrifugation

Principles of biophysical method used for analysis of biopolymer structure, X ray diffraction, fluorescence, UV, visible, IR, NMR and ESR spectroscopy

ENS-104/C

DRYLAND AND MARINE ENVIRONMENT – INDIAN CONTEXT

(3 Credits for Theory and 2 Credits for Tutorials and Practicals)

Unit – I : Introduction to Marine Environment, Ecology and Its Importance

Ocean as an Ecosystem and Classification of Marine Habitats. Marine Environmental Conditions (Tides, Temperature, Wave Action, Salinity, Nutrients, Other Factors), Adaptation of Intertidal Organisms at rocky, Sandy, and Muddy Shores, Resistance to Water loss, Heat Balance, Mechanical Stress, Respiration, Feeding, Salinity Stress, Reproduction, Distribution Pattern, Feeding Biology, Community Organization and Zonation. Important Marine/Coastal Ecosystems- Mangroves, Corals, Mudflats, Estuaries, Lagoons, Back and Brackish Waters. Coastal Activities (Ports, Harbor, Aquaculture, Salt Works) and their Impact on Coastal /Marine Ecology.

Unit – II : Desertification- An Overview

Definition and UNCCD. Genesis of the Convention to Combat Desertification (CCD). Status of drylands and desertification in the world.

Climate and Desertification - Rainfall and Desertification of the Major Climatic Regions, Rainfall Distribution in the Drylands of India.

Major Factors Causing Desertification -Unsustainable Agricultural Practices, Shifting Cultivation, Unsustainable Water Management Practices, Land Use Changes, Deforestation & Loss of Vegetative Cover, Industrial and Mining Activities, Drought and Land Degradation. Processes of Desertification - Soil Erosion, Wind Erosion, Water Erosion, Salinity-Alkalinity and Waterlogging.

Unit – III : Management Strategies for Combating Desertification

Impacts of Desertification -Impact of Human Population Pressure on Forest Resources, Impact on Biodiversity, Impact of Livestock Pressures on Grazing & Forest Land Resources, Impacts of Depletion of Vegetative Cover, Impacts of Soil, Wind and Water Erosion, Impacts on Soil Fertility, Impacts of Inefficient Water Management, Impact of Desertification on Quality of Life, Impacts of Desertification on Climate Change

Measures to Combat Desertification and Mitigate the Effects of Drought – Policy, Strategy and Legislative Framework, Strategies for Environmental Conservation, Programmes and Institutional Framework, Programmes and Technologies for Combating Desertification with Special Reference to Conservation of Soil, Water & Vegetation, Programmes Specifically for Addressing Desert & Drought Prone Regions (DDP, DPAP, IGNP), Traditional/ Indigenous Technologies for Combating Desertification, Interlinking National Efforts with Regional and Global Activities in Combating Desertification.

PRACTICALS

(Ens-101/102/103/104)

- 1. GLP (Good Laboratory Practices)**
- 2. Preparation of Standards and other experimental chemicals and reagents**
- 3. Study of cleaning and sterilization of glass ware**
- 4. Study of Basic Laboratory Instruments**
 - a. pH Meter**
 - b. Spectrophotometer**
 - c. Oven**
 - d. Microscope etc.**
- 5. Staining Techniques**
 - a. Monochrome Staining**
 - b. Negative Staining**
 - c. Grams's Staining**
 - d. Endospore Staining**
- 6. Isolation techniques of micro organism from water, soil and air sample**
- 7. Microbial Diversity**
- 8. Determination of atmospheric humidity**
- 9. Physical properties of soil**
- 10. Quadrates and Species identification**
- 11. Estimation of different types of alkalinity from given samples**
- 12. Estimation of Dissolve CO₂ from given samples**
- 13. Understanding the topographic map**
- 14. Conservation of map units**
- 15. Registration of map and digitisation**
- 16. Preparation of map by using ARC GIS**
- 17. Understanding of image process by using ERDAS**
- 18. Field visit and Report preparation**

ENS-141/I**ENVIRONMENTAL CHEMISTRY**

(2 Credits for Theory and 1 Credit for Tutorials and Practicals)

Unit – I: Atmospheric Chemistry

Composition, structure and functions of atmosphere, atmospheric chemistry, classification of elements, earth's energy budget, reactions in the lower and upper atmosphere, radioactivity in the atmosphere, atmospheric stability, inversions and mixing heights, wind roses

Unit – II: Hydrosphere Chemistry

Hydrosphere: Structure and properties of water and their environmental significance, distribution of water in earth, fresh water and its chemistry, solubility of gases in water, role of water in environment

Marine chemistry: seawater properties and its constituents, nutrients and salts, Metallic and non-metallic mineral resources like manganese nodules etc.

Unit – III: Lithosphere and Analytical Tools

Lithosphere: Factors and processes of soil development, soil types and their formation, soil profiles, physical and chemical properties

Principles of analytical methods: Titrimetry, gravimetry, centrifugation, colourimetry, flame photometry, spectrophotometry, chromatography, electrophoresis, atomic absorption spectrometry

ENS-142/I

REMOTE SENSING AND GIS

(2 Credits for Theory and 1 Credit for Tutorials and Practicals)

UNIT –1 Remote Sensing and Photogeology: Fundamental concepts of remote sensing; electromagnetic energy and its interactions in the atmosphere and with terrain features; elements of photographic systems, aerial photo interpretation and geological applications, Fundamentals of photogrammetry, satellite remote sensing, multi-spectral scanners, thermal scanners, microwave remote sensing, fundamentals of image interpretation and geological applications

UNIT – 2 Introduction to GIS: Introduction to digital image processing and Geographic Information System, spatial data models and data structures, visualization and query of spatial data, overlay analysis, geological applications of GIS.

UNIT – 3 GPS: introduction, principle and working application of GPS.

LABORATORY

Laboratory exercise for remote sensing and Photogeology: Topographical map, areal photo and satellite imagery interpretation for geological and geomorphological applications, Basic photogrammetry exercises like parallax measurements for height determination, Introduction to digital image processing and GIS application packages. Tutorials for GIS softwares (Arc GIS, IRDAS, GeoMedia etc)

Texts / References (Suggested Readings)

Sabnis, F.F. Remote sensing - Principles and Interpretation, W.H. Freeman and Co., 1978.

Lillesand, T.M. and Kiefer, R.W. Remote sensing and Image Interpretation, John Wiley, 1987.

S. A. Druary, Image Interpretation in Geology,

Pandey, S.N. Principles and Applications of Photogeology, Wiley Eastern, 1987.

Bonham Carter, G.F. GIS for Geoscientists- Modelling with GIS, Elsevier, 1994.

Lattman, L.H. and Ray, R.G. Aerial photographs in field geology, McGraw Hill, 1965.

SEMESTER-2**CORE COURSES****ENS-205/C****ENVIRONMENTAL POLLUTION-I**

(3 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit-I: Basics and Air Pollution:

Definitions of Pollution and pollutant, types and origin, classification of pollutants, General concept, classification of pollutants

Air pollution: Composition of air, Major sources, Types and Properties of air pollutants, behaviour and fate of air pollutants, chlorofluoro carbons and ozone layer depletion, green house gases and concept of global warming, its origin, status and means to control

Unit-II: Air pollution: Meteorological aspects and Sampling Methods

Temperature lapse rates and stability, wind velocity and turbulence, plume behaviour and dispersion of air pollutants

Sampling and measurement of air pollutants, control methods and equipments

Unit-III: Water Pollution: Freshwater, Marine and Thermal

Water pollution: Introduction, definition of water pollution, types and sources of water pollutants and their effects, waste water treatment. Water treatment (types, methods of waste water treatment: Preliminary, Primary, Secondary and Tertiary: Removal of suspended and dissolved solids, nitrogen and phosphorous, advanced biological system, chemical oxidation, recovery of materials from process effluents), purification of water

Pollution of Marine Environment: Sources and nature of pollutants, oil pollution, metallic pollutants, status of coastal and estuarine pollution in India, Chemicals and drugs from oceans, sea level rise, cause, effect and control

Thermal pollution: Introduction, Concept of thermal pollution, sources of thermal pollution, thermal power plant pollution, hazardous effects, long-term impact, thermal effects on marine life, effects on water quality, prevention of thermal pollution

ENS-206/C

ENVIRONMENTAL POLLUTION-II

(3 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit-I: Soil Pollution, Control and Management

Soil pollution: Introduction, importance of soil, composition of soil, soil pollution by different wastes (industrial wastes, urban wastes, radioactive pollutants, agricultural practices {chemical fertilizers and pesticides}, chemical and metallic pollutants, sewage and domestic waste)

Control of soil pollution, preventive measures, Integrated Pest management, Integrated Nutrient management, introduction of Organic Farming and Biofertilizers, restoration of degraded lands

Unit-II: Noise and Radioactive Pollution and Control

Noise Pollution: Introduction, Sources of noise, characteristics of sound, measurement of noise, types of noise, effects of noise pollution, Indian ambient noise level standards, prevention and control of noise pollution

Radiation Pollution: Introduction, types of radiation and radioactivity, source and effect

Unit-III: Solid Waste Pollution and Management

Solid waste pollution: Introduction, waste generation, Indian and International scenario; Characterization; Resources conservation and Recovery

Solid waste management: Introduction, management of municipal, agricultural, industrial, mining, hazardous (biomedical) waste, waste treatment methods (Incineration, pyrolysis) and management practices

ENS-207/C

RESEARCH METHODOLOGY, BIostatISTICS AND COMPUTER APPLICATIONS

(2 Credits for Theory and 2 Credits for Tutorials and Practicals)

Unit-I: Introduction to Research and Scientific Writing

Characteristics and Types of Scientific Research, Organizing Scientific Research: Experimental Design, Research Methodology, Sampling designs

Research proposals, Paper, Reviews, thesis, conference reports, book reviews, project reports, reference writing and scientific abbreviations

Preparation and delivery of Scientific Presentations

Unit-II: Introduction to Biometry and Parametric Tests

Statistics, Definition and scope, Sampling and sample designs, presentation of data (tabular, graphical and diagrammatic presentation), Measures of central tendency, dispersion and standard error; Probability distributions: binomial, poisson and normal distribution, Statistical significance (Hypothesis testing, types of error, level of significance)

Student's t distribution, Analysis of variance, χ^2 test and goodness of fit

Regression and Correlation Analysis

Unit-III: Computer Applications

History, development and types of computers; Computer hardware, software and peripheral devices; Basic working on DOS, Windows and Linux

General awareness and use of popular software and packages, Microsoft office, Internet-Browsing

ENS-208/C

INDUSTRIAL SAFETY AND DISASTER MANAGEMENT

(3 Credits for Theory and 2 Credits for Tutorials and Practicals)

Unit-I : Fundamentals of Industrial Safety, Health and Hygiene

Introduction to industrial safety management and its significance

Hazard identification, assessment and control techniques

Industrial hygiene and health

Legislation on safety and health in India

Introduction and concept of applied ergonomics

Unit – II: Introduction, Theoretical Concepts and Case study

Coastal development and Disaster, Rising disaster and their reversal, The politics of disaster,

The role of coordination in Disaster Management. Different approach to disaster recovery,

Debris disposal and Recycling from disaster.

Unit – III: Human, Personal, International issues; planning and prevention

Disaster Management and population with special needs, Disaster Psychology: A Dual perspective, Managing the spontaneous volunteer, First responder and workforce protection, Disaster rehabilitation: towards a new perspective

The role of training in disaster management, Disaster management and intergovernmental relations, Issues in hospital preparedness, Strategic planning for emergency manager

PRACTICALS

(Ens-205/206/207/208)

Practical: (Ens- 205/206/207/208)

1. Study the biodiversity of marine organism and identification of different species.
2. Physical characteristic of waste water (Hardness, Colour, turbidity, TDS, SS, DS, Alkainity and Acidity etc.)
3. DO (Dissolve Oxygen)
4. COD (Chemical Oxygen Demand)
5. BOD (Biological Oxygen Demand)
6. Biotransformation of Metals
 - a. Biotransformation of copper and iron
7. Bioremediation of Metals
8. Biodeterioration
9. Estimation of chloride from soil
10. Determination of total calcium and Magnesium
11. Determination of total organic carbon from the given sample
12. Determination of total phosphorus from the given sample
13. Determination of total Nitrogen from the given sample
14. Estimation of chloride from water
15. Determination phosphorus from water
16. Analysis of drinking water by MFT (Membrane Filter Technique) for the presence of coliforms
17. Ferrous Bio-oxidation (Sulphur)
18. Air quality monitoring basic
19. Air quality monitoring (SPM, aerosol, etc)
20. Industrial field visit for the study of effluent treatment plant.
21. Field visit and report preparation

ENS-244/I**ENVIRONMENTAL GEOLOGY**

(2 Credits for Theory and 1 Credit for Tutorials and Practicals)

UNIT-1 Environmental Geology: Geologic Hazards and hostile environment: Volcanism, earthquakes, mass movements, erosion and sedimentation, floods.

UNIT-2 Mineral and Water resource exploration and environmental impact, waste disposal, Geology and urbanization, mineral resources and future of mankind.

UNIT-3 Environmental Problems related to Geology: Indian Perspective.

LABORATORY**Texts / References (Suggested Readings)**

Bell, F.G. Fundamentals of Engineering Geology, Butterworths, 1983.

Krynine, D.P. Judd, W.P. Principles of Engineering Geology, McGraw Hill, 1957.

Ronald W. Tank, Environmental Geology

Keller, Environmental Geology

Blyth and de Freitas, A Geology for Engineers

K. S. Valdiya, Environmental Geology: Indian Context

ENS – 245/I

ENVIRONMENTAL ECONOMICS

(2 Credits for Theory and 1 Credit for Tutorials and Practicals)

Unit – I Fundamental of Environmental Economics

The economy and environment: two parts of a whole – interlinkage between the economy and environment

Micro foundation of environmental economics – theory of public goods, externalities and market failure – the problems of social cost – design of environmental policy

Unit – II Environmental policies and natural resources

Economic instruments for environmental protection: command & control versus Incentives and Subsidies – available policy options – effectiveness of these instruments, international comparisons

Economics of natural resources exploitation – renewable and non-renewable resources – methods of valuation of environmental costs and benefits

Unit – III Relationships between environmental and economics

Economic growth and environment: environmental kuznets' curve, foreign direct investment inflow and the environmental quality

Sustainable development: concept of and issues in sustainable development, strategic planning for sustainable development, economics reforms and sustainable development.

Texts / References (Suggested Readings)

Hanley, Nick, Jason F. Shrogen & Ben White: Environmental Economics in Theory and Practice, New Delhi: Macmillan – India, 1997

James, D. E., Economic Approach to environmental Problems: techniques and Results of Empirical Analysis., Elsevier Scientific Publishing C., 1978

Nash, R.F., The right of Nature: A History of Environmental Ethics, University of Wisconsin, 1989

Whyte, A. V., and Ian Burton (eds), Environmental Risk Assessment, John Wiley and sons, 1980

Arrow, K.J. and Scitovsky, T., Reading in Welfare Economics Part III, 1969

Coase, R.H., The problem of Social cost in Reading in micro Economics by Breit and Hochman, 1951

Allen V. And James S., eds. Handbook of natural resources and Energy Economics, Cha. 2, 12, 14, 17, North Holland, 1985

SUGGESTED BOOKS

1. Ecology - E.P. Odum, 1983, holt- saunders international edition
2. Environmental chemistry - A.K.De, new Age int. Pub. Co., new delhi, 1990
3. A Text book of environmental - C.S. Rao, wiley eastern limited, 1993 pollution and control
4. Water supply and sanitary engg – g.s. birdie & j.s. birdie, dhanpath raj & sons publishers, 6th edition, 1993
5. Waste water treatment – Metcalf & eddy
6. Remote sensing and GIS – m. anji reddy
7. Environmental Remote sensing – f. mark damson
8. Principles of GIS for land - burrough p.a. resources assessment
9. Microbiology - pelczar reid & chan, tata mc graw hill publishing company ltd., 1996
10. Text book of air pollution and control technologies, - y. anjaneyulu , allied publishers, 2002
11. Environmental pollution control – c.s. rao, wiley estern ltd., 1993
12. Air pollution - m.n. rao mc graw hill 1993
13. Air pollution control and engineering - de nevers, mc graw hills, 1993
14. Fundamental of air pollution - Samuel, j.w. 1971 addison Wesley publishing
15. Fundamental of environmental pollution – Krishnan khannan s. chand & company ltd., 1994
16. Environmental air analysis,- trivedi & kudesia, akashdeep pub. 1992
17. Noise pollution - vandana pandey, meerut publishrrs, 1995
18. Air pollution – by t. shivaji rao , lavanya lata pub., 1988
19. Concepts of ecology - E.J. kormonday, 1984, Indian reprint 1991 prentice hall of india .
20. Ecology & environment – P.D. Sharma, ashish publication, 1994
21. Environmental chemistry – by B.K.sharma S.H.kaur , goel publishing house meerut, 1992
22. Environmental chemistry – A.K.de., new age intl. pub co, new delhi, 1990
23. Chemistry for Environmental engineering,- C.N.sawyer and P.L.mc carty, mc kogakusha ltd., 1990
24. Introduction to ecology – paul colinvaux, 1973. Wiley international edition.
25. Fundamental of ecology – E.P. odum 1971. W.B. saunders & co.
26. Introduction to environmental toxicology -wayne G.landi ming-ho yu
27. Metod of toxicology- paget G.E.
28. Patty's industrial hygiene and toxicology – ed.by. lewis J. cralley, lester V. cralley, james S. bus
29. Text book of preventive and soil medicine - K.park
30. Renewable energy environment and development – maheswar dayal konark publishers pvt. Ltd.

31. Environmental impact assessment center- L.W 1977 mc graw hills newyork .
32. Energy resource by - j.J mc mullan, R. morgan and R.B. murray 1983
33. Energy resource resources and option – M.N satri Himalaya publishing house ,1992
34. Energy for a sustainable world – J.goldenbery, T.B.johanson, amulya K. reddy & Robert Williams, wiley eastern ltd., 1983
35. Environmental audits, govt. industries – cahll L.B.
36. Handbook of variables of Environmental impact assessment ann arbor science 1979
37. Energy education – beena shah 1990
38. Element of biotechnology, - 1995 P.K. gupta rastogi co.
39. Industrial microbiology, -casida, wiley eastern punlishers, 1994

40. Industrial microbiology – Prescott and dunn
41. Biochemical engineering fundamental 2nd ed. By – J.E. bailey and D.F. ollis, mc graw hills 1986
42. Biotechnology – a new industrial revolution prentis S. orbis publishing ltd.,London
43. Introduction to Biotechnology – K.S. bilgram and pandey A.K. 1992 CBS pub. & distributors, delhi.
44. Environmental chemistry – moor, W.A. and moore E.A
45. Introduction to Environmental engineering and science – gilbert m. masters, prentice hall of india, 1992
46. Chemistry and the Environmental – Johnson , D.O.netterville, J.T. wood, J.C. and james, M., 1973 W.B. saunders company, Philadelphia.
47. Toxic chemical, health and the environmental, -- lave L.B. and upton, A.C. 1987. The Hopkins press ltd., London.
48. Chemistry for Environmental engineering – C.N sawyer and p l mc carty mc graw hill kogakusha ltd., 1990
49. The microbial world 1990 , stanier, p.r ingraham., wheelis, M.L. and painter, P.R. prentice-hall of india private ltd., newdelhi.
50. Microbiology – pelzar, reid and chan. Tata- mc graw hills pub., co., lit., 1996
51. Microbial physiology- metabolism - Caldwell, D.R. 1995wm c. brown publishers, inc.
52. Microbiology, davis, b.d. bulbecco , R., eisen, H.N. and ginsberg, H.S. harper and row pub.singapor 1992
53. Environmental microbiology,-- maier, R.M. pepper, I.L. and gerba, C.P. academic press,2000

SEMESTER-3**CORE COURSES****ENS-309/C****ENVIRONMENTAL AUDITING AND EIA**

(3 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit – I Fundamental of Environmental Auditing:

Fundamental, Scope, Needs and Aim of Environmental Audit; Environmental accounting, its standards Definitions, Element and quality control of audit; Domains and Benefits of Environmental audit , Fundamentals of ISO 14000

Unit-II Fundamental of Environmental Impact Assessment

The concept, principles, types of EIAs, Introduction aspects of EIA in Asia, Methods for undertaking EIAs, Data requirement, Methodologies for data collection (water quality impact assessment, Ecology, fisheries impact assessment, Construction noise, waste management), and data acquisition, Approach to predict the Impact.

Risk and uncertainty in Impact Assessment, Economic Analysis,

Unit – III Social aspect and public participation

Social Assessment, Application of expert systems, Public concerns on EIA, strategies for undertaking EIAs, Steps in EIA, Environmental Impact Statement (EIS) and Environmental management Plan (EMP), Environmental monitoring and Audit

Preparation of EIA report; Reviewing and evaluating and EIA report

Ens-310/C

Current issues in Environmental Science (Updated Every Year) (3 +2)
(3 Credits for Theory and 2 Credits for Tutorials and Practicals)

Unit-I Environmental crisis, Population and global Environmental Issues

Environmental crisis: Problems their causes and sustainability, Population growth and environment
Global environment problems: O₃ depletion, Global Warming, Ice-cap melting, Sea-level rise, Shore erosion, Major climatic changes, Storms
Radioactive leakages and environment
Carbon emission, Earth Carbon Reservoirs, Carbon Cycling, Carbon credits, Carbon footprints

Unit-II Nuclear winter and Indian Environment

Atmospheric turbidity and nuclear winter
State of Indian Environment: Dams and canal network and their impact, rain water harvesting and water shade management

Unit-III Current Environmental Issues

Current environmental problems in India and their management (**Must be updated every year**)
Urban waste and health: recycle of water and use; role of garden, park and reservoirs in environmental protection
Sustainable development: an international perspective
Retrospect and prospects of sustainable environmental development

Ens-311/C

Natural Resources, Conservation and Management in India (3 + 3)

(3 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit – I : Basis of Natural Resources

Introduction to Natural Resources (Land, Water Resources, Forests, Grassland, Biodiversity, Agriculture, Human & Livestock) and Common Property Resources (CPRs).

Basics of Environmental Economics and Valuation Methods for Natural Resources.

Land Use Classification - Agro-Climatic Regions, Agro-Ecological Regions, Bio-Climatic Regions, Agro-Meteorological Regions

Unit – II : Natural Resource Conservation and Management

Programmes for Natural Resource Conservation -Integrated Afforestation and Eco-development Project Scheme (IAEPS), Integrated Wastelands Development Programme (IWDP), Eco-Task Forces and Scheme for Reclamation of Alkali Soils


Management of Natural Resources of the Country -Land, Water Resources, Meeting Water Requirements of the Country, Use of Cost-Effective Water Harvesting Systems, Environmental Issues, Unsustainable Agricultural Practices and Land Use Planning

Unit – III : Energy Resources

Energy Resources-Introduction, Energy Resources, Basic Concept, Types, Origin, Conventional, Non-Conventional and Perpetual Sources of Energy.

Various Energy Resources- Solar Energy, Wind Energy, Tidal Energy, Biogas Energy, Geo-thermal Energy, Environmental Implications, Fuel Cells, and Hydrogen Cells.

Practical (Ens-309/310/311)

1. Secondary data collection for a EIA report
 2. Biostatistics practical basic
 3. Biostatistics practical X^2 , Student t test, Manvitny U test etc
 4. Non parametric statistics and it application in EIA and SEA studies
 5. Parametric statistics and it application in EIA and SEA studies
 6. EIA report preparation techniques
 7. Environmental auditing – a case study
 8. Environmental education material preparation – models a case study
 9. Prepare a case study report in current environmental issue
 10. Natural resource mapping using GIS –RS techniques
 11. Biogas production and quantification
 12. Noise pollution
 13. Industrial field visit for the study of effluent treatment plant.
 14. Field visit and report preparation
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ENS- 321/E Environmental Biotechnology (4+3)

(4 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit-I: Biotechnology Essentials

Role of Biotechnology in environmental Protection; Microbiology and Biochemistry of waste water treatment (Biological treatment, impact of pollutants on biotreatment, important microorganisms, role of enzymes, principles of growth, Bioaugmentation)

Environmental Sampling, Processing, and Screening of Indicator Microorganisms

Unit-II: Ecofriendly Bioprocesses

Biofertilizers, Biocontrol of pathogens, and Biosurfactants

Biofuel: concept, characteristics and current status, production of Biofuel (Transesterification - Industrial Practice – Lurgi Process), the Indian and International Experiences, Commercial Production: Indian Efforts, Biofuel Usage - Field Trials, Advantages, and Socioeconomic implications; Production of Bioenergy

Unit-III: Cleaner Bioprocesses

Bioremediation: need and scope, principles and mechanisms, types and environmental applications

Specific Processes: Bioleaching, Bio-hydrometallurgy, Vermitechnology, Biodeterioration

Biodegradable and Ecofriendly Products: Biodegradable Plastics, Biosurfactants, Trickling filters, bioscrubbers and Biobeds.

ENS – 322/E Environmental Management ISO 14001 (4+3)

(4 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit – I: Fundamentals of Environmental Management systems

Introduction to environmental management, The global perspective, Brief history of environmental standards

Introduction to ISO 14001

Unit – II: The concept and Implementation of ISO 14001

The spirit of ISO 14001

Implementation of ISO 14001

The assessment process

Planning the project, Policy and planning; Implementation and operation

Unit – III: Reviewing the management plan, Case study and Auditing standards

Integration of environmental management systems with other management systems; Checking, corrective action and management review

The environmental Management Manual and Launch

Internal environmental auditing and assessment

Case studies

SEMESTER-4**CORE COURSES****Ens-412/C Environmental Legislation and Guidelines (3 + 3)**

(3 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit – I: Basics and Significance of Environmental Law

Role of court and appellate authorities, need for special environmental protection court, importance of consent, NOC and NA (Non-Agriculture) application proforma, role of voluntary agencies as campaigners and crusaders.

Factory Act, 1948; Atomic Energy Act, 1962; Insecticides and Pesticides Act.,1960 with their limitation.

Unit-I: Environmental Legislations and Guidelines - I

Environmental Protection Act (EPA), 1986; EIA notification (1994, 2006); Air pollution and prevention Act, 1981; The Water (prevention and pollution) Act, 1974; Central and State Pollution Control Boards for prevention and control of air and water pollution: roles and responsibilities; GPCB & CPCB Norms

Unit – II: Environmental Legislations and Guidelines - II

Forest Conservation Act, 1980 and 1982 (revised); Wildlife (protection) Act, 1972, Coastal Regulation Zone Notification, 1991; Biodiversity Conservation Act, The Mines Act, 1952, The Hazardous Waste (Management and Handling) Rules, 1980

Ens-423/E**Environmental Impact Assessment (EIA), Planning & Monitoring (4 + 3)***(4 Credits for Theory and 3 Credits for Tutorials and Practicals)***Unit-I: Fundamental of Environmental Impact Assessment**

The concept, principles, types of EIAs, Introduction aspects of EIA in Asia, Methods for undertaking EIAs, Data requirement, Methodologies for data collection (water quality impact assessment, Ecology, fisheries impact assessment, Construction noise, waste management), and data acquisition, Approach to predict the Impact. Strategic Environmental Impact Assessment.

Risk and uncertainty in Impact Assessment, Economic Analysis,

Unit – II: Social aspect and public participation

Social Assessment, Application of expert systems, Public concerns on EIA, strategies for undertaking EIAs, Steps in EIA, Environmental Impact Statement (EIS) and Environmental management Plan (EMP), Environmental monitoring and Audit

Preparation of EIA report; Reviewing and evaluating and EIA report

Unit-III: Recent Advances in EIA

Recent Concepts and Advances in Impact Assessment, Strategic Impact Assessment (SEA), difference between SIA and EIA, Public Involvement in SEA, EA, differences from EIA, Methods and their usage in SEA: Guidance and Good Practices

Ens-424/E Environmental Toxicology (4 + 3)

(4 Credits for Theory and 3 Credits for Tutorials and Practicals)

Unit-I: Basic Concepts, Definitions, and Heavy metal toxicity

Definition of toxicology, LC₅₀ and LD₅₀, toxic chemicals and xenobiotic, Routes and rates of administration, environmental/behavioural factors, effect and response Types of Toxicity studies: Acute, sub-acute and chronic toxicity

Chemical Interactions: Dose response relationship, statistical concept of toxicity, translocation of toxicants. Systemic toxicology (Hepatotoxicity, Genotoxicity, Reproductive toxicity, Respiratory toxicity)

Definition and sources of heavy metals, heavy metals in the environment (marine, fresh water and terrestrial ecosystems), bioavailability and bioaccessibility

Metal uptake by organisms and the mechanism, metal uptake from solution and food, availability of metals from sediments, factors affecting the metal uptake

Unit-II: Mechanisms and Principles

Mechanism of toxicity: Biotransformation of toxicants (conjugation and hydrolysis), Free-radical toxicity, the concept of bioequivalence and bioavailability, bioaccumulation of pollutants/xenobiotics, antidotes, case studies

Bioaccumulation and detoxification: the concept, hyperaccumulation, bioconcentration, biomagnification of toxicants, biomarkers and bioindicators

Unit-III: Chemical Speciation

Definition of terms related to speciation, speciation analysis, speciation study in water and soil or sediments

Speciation approaches - direct and combined speciation methods quality control in speciation, role of chemical models, bioreporters and biosensors in chemical speciation studies

Ens-425/E (Dissertation):	EIA and Environmental Monitoring (11)
Ens-426/E (Dissertation):	Environmental Biotechnology (11)
Ens-427/E (Dissertation):	Environmental Toxicology (11)
Ens-428/E (Dissertation):	Environmental issues, ecology, climate change and conservation (11)

Masters' Thesis (Dissertation)

(Dissertation / Project work/ Industrial Training Report Environmental Issue/Survey Project Report)

The purpose of this exercise is to become familiar with research methods, computer application, literacy and the presentation skills. Moreover, to think about how to approach, communicate and assess an environmental issue from various viewpoints (economic, environmental, legislative, societal, etc.). All viewpoints must be addressed in your outline and project. The student has the freedom to select any research problem related to the environmental science; they can also work for their masters' thesis in the department or research institutes or industry with prior communication and approval from both the side.

1. Select an Environmental issue / Research Problem consult faculty for guidance
2. Learn what resources are available and how to access them
3. Collect references, secondary information on the topic and prepare bibliography
4. Set the methodology, approve it from faculty/supervisor and run the experiments
5. Collect findings and draw your conclusion and prepare a detailed report/thesis
6. Record Results (statistics w/data tables)
7. Interpret and explain results (using charts)
8. Use outline and related research to develop a PowerPoint presentation of your topic
9. Present topic and survey to class (summarize the research and results) and explain what your results mean.

The outline must include the following:

- For guidelines and format go to www.evc.edu/library then click on Internet Directory. Find Student Survival Guide, Developing an Outline, online Writing Lab (OWL), sample outline.
- Literature Review section should include citations and or references from previous studies of the topic
- References must be taken from a book, magazine, newspaper and Internet (one from each).
- Make certain that your cited sources are in APA Citation Style.

A 10-minute formal oral presentation during the final examination must include the following:

- A PC PowerPoint Slide Presentation showing your objectives, methodology, findings, conclusion and message to convey.

In the final examination the evaluation shall be made by an external examiner and an internal examiner.