

M. Sc. ENVIRONMENTAL SCIENCE

Two Year Full Time Programme (Regular Course)

SYLLABUS

(2017-2018 ONWARDS)

A choice based credit system syllabus



**P. G. DEPARTMENT OF ENVIRONMENTAL SCIENCE,
FAKIR MOHAN UNIVERSITY, VYASA VIHAR
BALASORE-756020
ODISHA**

P.G. Department of Environmental Science
M.Sc. Environmental Science
COURSE STRUCTURE

<u>Paper Code</u>	<u>Paper Name</u>	<u>Marks</u>	<u>Credit</u>
Semester I			
ENS-411	Fundamentals of Ecology & Environmental Science	40 + 10	4
ENS-412	Natural Resources & their Management	40 + 10	4
ENS-413	Atmospheric Chemistry, Metrology and Climatology	40 + 10	4
ENS-414	Air & Air Pollution Management; Noise and Radiation Pollution and their Management	40 + 10	4
ENS-415	Practical	100	8
Semester II			
ENS-421	Aquatic Ecology & Water Pollution Management	40 + 10	4
ENS-422	Envirometrics , Environmental Modeling & Computer Application in Environmental Management	40 + 10	4
ENS-423	Soil & Soil Pollution Management	40 + 10	4
ENS-424	Environmental Geology and Instrumentation Techniques	40 + 10	4
ENS-425	Practical	100	8
Semester III			
-----	Fakir Mohan Studies	Non Credit Course	
ENS-531	Environmental Biochemistry & Toxicology	40 + 10	4
ENS-532	Environmental Impact Assessment	40 + 10	4
ENS-533	Environmental Hazard, Risk & Disaster Management	40 + 10	4
ENS-534	Environmental Education For Future Sustenance (Choice based paper)	40 + 10	4
ENS-535	Practical	100	8
Semester IV			
Specialization – (A) Industrial Pollution Control and Management			
ENS-541-A	Industrial Pollution Control	40 + 10	4
ENS-542-A	Environmental Management Systems for Industries	40 + 10	4
ENS-543-A	Grand Viva (Covering the Entire Syllabus)	50	4
ENS-544-A	Practical	50	4

ENS-545-A	Dissertation Presentation	100	8
Specialization – (B) Environmental Biotechnology			
ENS-541-B	Biotechnological Approach for Environmental Management	40 + 10	4
ENS-542-B	Waste Management & Bioremediation	40 + 10	4
ENS-543-B	Grand Viva (Covering the Entire Syllabus)	50	4
ENS-544-B	Practical	50	4
ENS-545-B	Dissertation Presentation	100	8
Specialization – (C) Environmental Health and Occupational Safety			
ENS-541-C	Environmental Health and Management	40 + 10	4
ENS-542-C	Industrial Safety, Occupational Health and Management	40 + 10	4
ENS-543-C	Grand Viva (Covering the Entire Syllabus)	50	4
ENS-544-C	Practical	50	4
ENS-545-C	Dissertation Presentation	100	8
Specialization – (D) Disaster Management			
ENS-541-D	Disaster Preparedness and Mitigation	40 + 10	4
ENS-542-D	Advances in Disaster Management	40 + 10	4
ENS-543-D	Grand Viva (Covering the Entire Syllabus)	50	4
ENS-544-D	Practical	50	4
ENS-545-D	Dissertation Presentation	100	8
Total Marks		1200	96

ENS-411 FUNDAMENTALS OF ECOLOGY & ENVIRONMENTAL SCIENCE

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

Unit I– Origin of Earth and Evolution of Life

Concepts on origin of our Universe (Big bang theory) and our solar system (Nebular condensation theory); Evolution of early earth and its atmosphere; Origin of earliest life forms (Millers experiment, RNA Life, Origin of early prokaryotes, Stromatolites, Origin of early eukaryotes); Theories of biological evolution (basic outlines of Lamarkism, Darwinian theory, Mutation theory and Hardy-Weinberg principle); Geological time scale; Mass extinctions; Brief account on evolution of Human.

Unit II– Ecosystem Dynamics

Definition of Ecology and Ecosystems, Autecology, Synecology, Physico-chemical and Biological factors in the Environment (Abiotic and Biotic components); Pathways in Ecosystems (food chain, food webs, ecological pyramids, Mass and energy flow); biogeochemical (Nutrient) cycling; primary and secondary production, gross and net production, net community production; major ecosystems and biomes of the world and India.

Unit III– Population Ecology

Concept of population and population attributes, Natality and Mortality; density distribution, biotic potential and survivorship curves; population growth forms, carrying capacity and environmental resistance, r and K selection, Extrinsic and Intrinsic factors (biotic and abiotic) associated with population fluctuations, theories of population fluctuation.

Unit IV– Community Ecology

Community ecology (types, structure, qualitative and quantitative features); Ecological succession (primary and secondary processes in successions, theories of successions, climax community and types of climax); Species interactions (Competitions, Symbiosis, Commensalism, Parasitism, Prey – predator relationships); Niche concept, key stone species, ecotone, edge effect.

Books Recommended:

1. Fundamentals of Ecology by Odum and Barrett, Thompson publ.
2. Fundamentals of Ecology by MC Dash, Tata Mc Graw Hill Edu Pvt Ltd
3. Fundamentals of Ecology by EP Odum, Natraj Publ.
4. Environmental Science by SC Santra, Central Publ.
5. Environmental Science by Cunningham and Cunningham
6. Ecology: Principles and Applications by J. L. Chapman, M. J. Reiss, Cambridge University Press
7. Concepts of Ecology by EJ Kormondy, PHI
8. Sustainable Development by Kumar das, Reference Publ.
9. Ecology, Chemistry and Management of Environmental Pollution by MC Dash, Mac Millan

10. Ecology and Environmental Science by SVS Rana, PHI pvt. ltd.

11. Ecology and Environment by P D Sharma, Rastogi publication

ENS-412 NATURAL RESOURCES AND THEIR MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

Unit I– Mineral Resources

Ores and Minerals, Metal ores, Non metal minerals, Radioactive minerals, Fossil fuels (Coal and its types, Oil and Natural gas and their fractionation products), Mining (types of mining and environmental concerns), Extraction Process, Conservation of mineral resources (Reduce-Recycle and Reuse), Economic mineral deposits of Odisha and India. Basic idea on different mines and mineral acts (The Mines and Mineral act 1957, Coal mines regulation act 1957, the Mineral conservation and Development rule 1988)

Unit II– Perpetual Nonrenewable Resources

Geothermal energy (Source, nature, principle of harnessing and its operation, geothermal fields of India); Nuclear Energy (Source, fission and fusion reactions, broad idea of nuclear reactors, its operation, management and electrical power generation, safety measures); Solar energy (Devices based on solar energy: solar cookers, solar water heaters, solar cells/photovoltaic cells; their advantages and drawbacks).

Unit III– Perpetual Renewable Resources

Wind energy (aero-generators, wind energy devices, their advantages and drawbacks, wind mills of different countries); Water Energy (Hydroelectricity, waves and tidal energy, their advantages and drawbacks); Biomass energy (Sources of biomass: plants and microbes, Biomass to biofuel conversion, Types of biofuel: biogas, biodiesel and bioethanol).

Unit IV– Biodiversity

Centre of Origin hypothesis, Biodiversity hotspots, Mega-biodiversity countries; Species richness & diversity, measurement of diversity; Factors causing loss of biodiversity, Conservation of biodiversity (In-situ and Ex-situ conservation), IUCN categories, Red data book, Threatened, Vulnerable and Endangered species, Forest principles, CBD (Convention on Biological Diversity) and its goals, Man and Biosphere programme of UNESCO, Wild life protection act 1972, Project tiger, Forest conservation act 1980, Biological diversity act 2002; Biosphere reserve, National Parks and Sanctuaries of India

Books Recommended:

1. Natural Resources and Renewable Energy by MP Singh, Daya Publishing House
2. Environment Population and Resources by Sunit Gupta and Mukta Gupta, Anmol Publ. Pvt. Ltd.
3. Biodiversity by Kumar and Asija, Agrobios publ.
4. Biodiversity Assessment and Conservation by PC Trivedi, Agrobios publ.

ENS-413 ATMOSPHERIC CHEMISTRY, METEOROLOGY AND CLIMATOLOGY

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Structure Composition and Radiation Physics of the Atmosphere

Composition of the atmosphere (variable and stable components); Vertical variations in atmosphere (atmospheric layers, pressure change, temperature change, change in composition, Ionosphere); Optical phenomena of the atmosphere (Basic definitions of Reflection, Refraction, Scattering, Dispersion and Diffraction and their role in formation of Mirage, Rainbow, Halos, Sun Dogs, Solar Pillars, Corona, iridescent clouds and the Auroras); Solar radiation and earth's energy budget (solar constant, albedo, earth's effective black body temperature and actual surface temperature, net energy budget)

UNIT II Meteorology

Scales of Meteorology; Humidity Parameters (Absolute humidity, Relative humidity, Mixing Ratio, vapour pressure, dew point); Forms of condensation and precipitation; Equation of state for dry and moist air, Virtual Temperature, Potential Temperature, Pseudo- adiabatic Process, Equivalent Potential Temperature, Hydrostatic equation and its application; Atmospheric stability, inversions and mixing heights, lapse rates and smoke stack plumes; Turbulence, Geostrophic wind flow, Wind roses and their application

UNIT III Climatology

Earth-Sun relationships and seasonal variations (Solstices and equinoxes); Milankovitch Oscillations, Sun spots and effects on climate; Atmospheric circulation (Global circulation-three cell circulation model, jet stream, SW and NE Asian monsoon, Local winds); Oceanic circulation and climate (El Nino- La Nina and Southern oscillations, ENSO); Tropical cyclones; Classification of world climate- Koppen's and Thornthwaite' scheme; Basic concepts on weather analysis and forecasting (short range predictions, long range predictions, weather radar-Doppler radar) and weather satellites -INSAT 3D)

UNIT IV Atmospheric Chemistry

Stoichiometry, Chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, Laws of thermodynamics, Entropy, enthalpy, Modes of heat transfer (conduction, convection and radiation), The periodic table and geochemical classification of elements, Chemical speciation, Particles, ions and radicals in the atmosphere, radioactive and heavy isotopes and their use in paleo-dating.

Books Recommended:

1. The Atmosphere: An Introduction to Meteorology by FK Lutgen and EJ. Tarbuk, Pearson publ.
2. Meteorology Today: An Introduction to Weather, Climate, and the Environment by C. Donald Ahrens, Cengage Learning publ.
3. Physical Meteorology by H G Houghton, MIT Press

4. Environmental Meteorology by B. Padmanabha Murty, I.K. International Publishing House Pvt. Ltd.
5. Basics of Atmospheric Science, by A. Chandrasekar, PHI publ.
6. The Monsoons by Dr P. K. Das, National Book Trust, New Delhi, India.
7. Introduction to Environmental Engineering and Science by Gilbert M. Masters, Pearson Education

ENS-414 AIR & AIR POLLUTION MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Air Pollution

Air pollution and pollutants, Classification of air pollutants, Primary air pollutants (CO, CO₂, NO_x, SO_x, hydrocarbons, Particulate matter) and Secondary air pollutants (Smog, PAN, O₃, Formaldehyde), Sinks of atmospheric gases, Chemical and photochemical reactions in the atmosphere, Reactions of air in stratosphere, Mesosphere and Ionosphere, Major sources of air pollution, Acid deposition, Global climate change-green house gases and global warming, Behaviour and fate of air pollutants, Effects of air pollutants, Air pollution episodes, Air quality standards, Air pollution index.

UNIT II Air pollution control technologies

Sampling of gases and vapours, Sampling of particulate pollutants, Prevention and control techniques of gaseous pollutants (Combustion, Absorption & Adsorption), Prevention and control methods of particulates matter (Settling Chambers, Cyclone Separators, Wet Collectors (Scrubbers), Bag Filters and Electrostatic Precipitators), Stack monitoring.

UNIT III National & International Legislations, Policies for Air pollution management

Environmental policy in ancient times, The provisions for Environment in the constitution of India, Air (prevention and control of pollution) Act-1981, Various relevant legal terms salient features of Air Act, IPCC, UNFCCC, Basic objectives or salient features of different international protocols related to atmosphere (Kyoto Protocol-1997, Bali Action Plan-2007, the Copenhagen Accord-2009, the Cancún agreements-2010, the Durban Platform for Enhanced Action-2012, Vienna Convention-1985 and Montreal Protocol-1987)

UNIT IV Radiation and Noise Pollution and their Management

Radioactivity and kinds of radiation, Sources of radioactive pollution; Effects of radioactive pollution (effects of ionizing and non ionizing radiations on man and other animals, effects of radiations on plants), Prevention from exposure, Control of radioactive pollution, Disposal of radioactive wastes.

Sources of noises pollution, Characteristics of sound; Monitoring and control of noise pollution, Industrial noise and its reduction approaches; Sound level meter, Loudness measurement, Noise levels in decibel scale; Structure of human ear and hearing mechanism, Effect of noise on human health and Prevention.

Books Recommended

1. Air Pollution by VP Kudesia, Pggati Prakashan
2. Noise Pollution by VP Kudesia, Pggati Prakashan
3. Introduction to Environmental Engineering and Science by Gilbert M. Masters, Pearson Education
4. Environmental Chemistry by AK Dey, New age International (P) Ltd
5. Environmental Chemistry – Sodhi
6. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publishing House.
7. Environmental Radiation and Thermal Pollution by GR Chhatwal et al. Anmol Publications
8. Environmental Noise Pollution and its Control GR Chhatwal et al. Anmol Publications

ENS-415: LABORATORY AND FIELD TECHNIQUES/PRACTICALS

Total Marks = 100

Credit hour = 8

Based on theory papers (ENS 411 to ENS 414) a series of practical experiments/ laboratory works will be carried out.

List of practical experiments/ laboratory works

1. Determination of minimum size of a quadrat for study of a grassland study.
2. Determination of frequency, diversity and dominance of different species in grassland ecosystem.
3. Determination of Important Value Index some species in a grassland ecosystem.
4. Measurement of productivity of the pond ecosystem by Winkler's Oxygen liberation method.
5. Measuring Noise level at different work place
6. Measurement of SPM/RSPM using air sampler.
7. Measurement of SO_x, NO_x in air sample using air sampler.
8. Determination of frequency and average wind speed for a location by plotting wind rose.
9. Measurement of rainfall over a particular area.
10. To monitor the humidity of a location by using different parameters (Absolute humidity, Relative humidity, Mixing Ratio, vapour pressure, dew point).
11. To prepare phosphate buffer of different pH and strength
12. To determine the dissolved Oxygen and free CO₂ in supplied water sample.
13. Identification of mineral samples
14. Identification of monocot and dicot plants with the help of flora book

ENS-421 AQUATIC ECOLOGY & WATER POLLUTION MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Introductory Hydrology

Global distribution of water; Hydrological cycle (Evapotranspiration, Condensation, Precipitation, infiltration, runoff) and water balance; Factors affecting runoff, Graphical representation of rainfall and runoff events (Hydrographs, IDF curves, Mass rainfall curves, Hyetographs, Isochrones), Determination of peak flow rates by rational method; Ground water hydrology (Types of aquifers, Vertical distribution/zones of groundwater, Piezometric surface, artesian wells, Hydraulic gradient and Darcy's law, Basic concepts of cone of depression, Salt water intrusion in coastal areas); Urban hydrology (Changes forced to hydrological setting due to urbanization and its mitigation).

UNIT II Aquatic ecosystems

Lentic and Lotic ecosystems; Ecological factors operating in the aquatic ecosystem (Temperature, Light, Turbidity, Wind and Current, Concentration of inorganic salts, Concentration of respiratory gases); Classification of aquatic biota (Planktons, Nektons, Neustons, Benthos, Periphyton, Macrophytes); Primary productivity of aquatic ecosystems; Lake ecosystems (Classification of lakes based on their formation, Stages of productivity, Eutrophication); Wetlands and their environmental significance, Ramsar convention and wetland management (with special reference to India); Estuaries (Types: based on origins and salinity stratification, Ecological and environmental significance); Mangroves, Coral reefs and their environmental importance.

UNIT III Water Pollution

Physicochemical properties of water; Sources of pollution (for surface water, ground water and marine water); Effects of water pollution on aquatic organisms and human health; Basic concepts on water quality analytical parameters (Physical: temperature, turbidity, colour, odor; Chemical: pH, DO, BOD, COD, TOC, O&G, conductivity, TS, TDS, TSS, hardness, alkalinity, mineral nutrients such as N, P, K, Ca, Mg, trace metals, pesticides; Bacteriological: fecal coliform, total coliform); Standards of water quality (US-EPA, CPCB and BIS guidelines); Basics of water sampling.

UNIT IV Waste water treatment process and Policies for Water Pollution Management

Waste water treatment processes (Characteristics of domestic, industrial and municipal waste water, primary, secondary and tertiary treatment methods); Sludge digestion processes; Drinking water treatment processes (Ion exchange, Reverse Osmosis, Ozonisation, Carbon Adsorption, Membrane Processes, UV treatment and other advanced treatment methods); Genesis, powers and functions of Central and State pollution control boards; the Water (Prevention and control of pollution) Act 1974, The Ganga Action Plan.

Books Recommended:

1. Groundwater Hydrology by DK Todd, John Wiley
2. Introduction to Environmental Engineering and Science by Gilbert M. Masters, Pearson Education
3. Environmental Engineering by Gerard Kiely, Tata Mc Graw-Hill Education
4. Ecology and Environment by P D Sharma, Rastogi publication

5. Fundamentals of Aquatic Ecology by RSK Barnes and KH Mann, Wiley
6. Freshwater Algae of Eastern India by SK Das and SP Adhikary, Daya Publishing House
7. Oceanography-an introduction to marine science by Tom Garrison, Brooks/Cole-Thomson Learning
8. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publishing House.

ENS-422 ENVIROMETRICS, ENVIRONMENTAL MODELING & COMPUTER APPLICATIONS IN ENVIRONMENTAL MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Basics and Applied Envirometrics

Basic elements and tools for analysis in envirometrics; Concept of population, Sample, Sample designing; Measures of Central Tendency (Arithmetic mean, mode and median); Dispersion of Data; Standard Deviation, Coefficient of Variation; Confidence interval of mean; Concept of Probability; Student 't' Distribution, Properties and applications, 't'-Test for random samples, Independent and Dependent samples; χ^2 Test; Correlation and Regression analysis; Analysis of Variance.

UNIT II Theoretical Distributions in Envirometrics

Normal Distribution (Properties, area under normal curve, Significance); Binomial Distribution (Coefficient, Properties, Importance and fitting, Pascal's triangle); Poisson distribution (Constant, fitting, Poisson distribution as an approximation of binomial distribution); Test of Hypothesis, Test of Significance, Type I and Type II errors.

UNIT III System Analysis and Environmental Modeling

Introduction to Environmental System Analysis; Approaches for Development of Models, Simple and Multiple Regression Models-its validation and forecasting; Models of population Growth; Lotka-Voltera pray-predator Model; Point source pollution model, Thermal plumes, Box and dispersion model.

UNIT IV Computer Applications

Scope of computer and information technology in environmental management; basic ideas on computer (input and output devices, CPU, Software and Hardware); Data processing using MS Excel (Preparation of graphs, tables, pie charts, histograms, and regression curves); Basic idea on Sigma Plot statistical package.

Books Recommended

1. Statistical methods by S.P. Gupta. S. Chand Publications
2. Programming in ANSI C by E. Balaguruswami Tata, Mgraw Hill publisher.
3. Fundamentals of Biostatistics, by Khan and Khanun, Ukaaz Publications/bsp Books Pvt. Ltd.

4. Introduction to Biostatistics by Robert R. Sokal, F. James Rohlf, W.H. Freeman & Company
5. Statistics for Environmental Biology and Toxicology by WW Piegorsch and AJ Bailer
6. Methods in Biostatistics for Medical Students and Research Workers by BK Mahajan
7. Basic Statistics by Gun, Gupta & Dasgupta, World press

ENS-423 SOIL & SOIL POLLUTION MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Soil Structure and composition

Soil as environmental interface; Weathering (physical, chemical and biological) of rocks and formation of soil; Soil profile or soil horizons; Mineral (inorganic) constituents of soil; Physical properties of soil (colour, textural classes, structure, particle density, bulk density, porosity); Soil water; Soil aeration and temperature; Soil organic matter; Soil pH (acidity, alkalinity, salinity and sodicity); Soil classification, Soil types of India.

UNIT II Soil Organisms and Ecology

Dynamics and diversity of soil organisms, Earthworms and soil arthropods, Soil microbes (algae, fungi, bacteria, actinomycetes), beneficial effects of soil organisms; Decomposition of organic matter by microbes, Soil Enzymes, Soil respiration; Primary and secondary decomposers, effect of C/N ratio on organic matter decomposition; Lignin and polyphenol content of organic matter; Humus – genesis and nature, Composts and composting; Bio-fertilizers and Bio-pesticides; Soil pathogenic organisms and damage to plants.

UNIT III Soil Health, Degradation, Pollution and Soil restoration

Concept of soil quality and soil health; Nitrogen cycle – Nitrification and Denitrification, Biological Nitrogen fixation; Role of Sulphur Phosphorus and Potassium in plant nutrition and soil fertility; Soil nutrient management. Soil erosion and land degradation; Effects of intensified agro-ecosystems on soil health; Effects of chemical residues on soil (pesticides, fertilizers, heavy metals); Soil Solarization; Soil pollution by industrial and urban wastes, Soil pollution control measures, Soil erosion control measures and Restoration of degraded land.

UNIT IV Solid Waste Management

Definition, sources, classification & composition of solid wastes; Concepts of 4Rs (refuse, reduction, recycling and reuse); Segregation of solid wastes; Solid waste processing technologies: Recycling and Resource recovery, Composting, Mechanical and thermal volume reduction, Incineration, Pyrolysis, Sanitary land filling (design and operation of sanitary landfills, leachate and landfill gas management, landfill closure); Fly ash generation & utilization; Bio-medical and hazardous waste management; Hazardous Waste Management & Handling rules-1989.

Books Recommended

1. The nature and Properties of Soils by N C Brady and R R Weil, Pearson Education
2. Introductory Soil Science by DK Das, Kalyani Publishers
3. Soil Pollution and Organisms by PC Mishra, Ashish publishing House
4. Soil Microbiology by NS SubbaRao, Oxford & IBH publ.
5. Soil Fertility by CE Miller, Biotech publ.
6. Soil Biology by Brady Burges and Raw, Academic Press

ENS-424 ENVIRONMENTAL GEOLOGY AND INSTRUMENTATION TECHNIQUES

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Environmental Geology

Structure and composition of earth's interior, Seismicity and earth's interior; Plate tectonics- sea floor spreading, Paleomagnetism; Continental drift and evolution of continents, Crustal deformation (Faults and Folds) and Mountain building; Formation and types of igneous, metamorphic and sedimentary rocks, rock cycle; Compositions of minerals and their formation (Bowen's reaction series); Rock forming minerals; Chemical classes of minerals; Introduction to silicate structures; Physical properties of minerals, Mohs scale of hardness, Specific gravity and Density; Basic features of different landforms: Fluvial landforms, Karst topography, Glacial Landforms and Aeolian landforms.

UNIT II Physical Oceanography

Ocean Floor Topography; Ice ages and record of global sea level changes, paleo-thermometry; Variation of environmental factors (light, temp, density, salinity, pH and dissolved gases) with depth; Sediments of deep ocean basin, Calcium carbonate compensation depth; Oceanic circulations (Surface currents, Geostrophic gyres, upwelling and downwelling, Thermohaline circulations); Coasts (Erosional and Depositional coasts); Basic concepts on ocean waves and tides.

UNIT III Remote sensing & GIS

Defining remote sensing & GIS, History and development; Fundamental principles, Platform and Sensors; Basic principles of thermal, multispectral and microwave sensors; Spectral characteristics of environmental components (vegetation, water, soil); Remote sensing satellites (Geostationary and polar orbiting satellites, resolution, sensors, LANDSAT, SPOT and IRS satellites); Advantages and applications of remote sensing and GIS in environmental management.

UNIT V Geo-Analytical techniques

Principles and techniques of Titrimetry, Gravimetry, Colorimetry; Basic principles, types and applications of Spectroscopy (UV-Vis light spectroscopy, Spectrofluorimetry, Flame photometry, Atomic Absorption Spectrophotometry, X-Ray Fluorescence, X-Ray Diffraction, NMR); High volume air sampler, Respirable dust sampler, Electrostatic precipitator.

Books Recommended

1. Environmental Geology by C W Montgomery, Mc. Graw Hill International
2. Understanding Earth by Grotzinger, Jordan, Press & Siever; WH Freeman and Company
3. Earth's Dynamic System by Hamblin & Christiansen, Prentice Hall
4. Text book of Physical Geology by G B Mohapatra, CBS Publ.
5. Physical Geography by Sabinder Singh, Pryag Publ.
6. The Earth's dynamic surface by K Siddhartha, Kishalaya Publications
7. Introduction to Geochemistry by Mason & Moore
8. Oceanography-an introduction to marine science by Tom Garrison, Brooks/Cole-Thomson Learning
9. Remote Sensing: Principles and Applications by FF Sabbins, Freeman
10. Remote Sensing by Meenakshi Kumar, NCERT
11. Remote Sensing by BC Panda, Viva Books pvt. Ltd.
12. Text book of Remote Sensing and Geographical Information System, M Anji Reddy, BS Publications
13. Handbook of Analytical Instruments by RS Khandpur, Tata Mc Graw Hill Edu Pvt Ltd
14. Fundamental of molecules spectroscopy by CN Banwell McGraw Hill
15. Modern Methods of chemical analysis RL Recsok & LD Shields, John Willey & sons, Inc

ENS-425: LABORATORY AND FIELD TECHNIQUES/PRACTICALS

Total Marks = 100

Credit hour = 8

Based on theory papers (ENS 421 to ENS 424) a series of practical experiments/ laboratory works will be carried out.

List of Practical Experiments

1. To assay the cellulose activity of different soil sample
2. To determine the bulk density, particle density, porosity, moisture content and degree of saturation of different soil sample.
3. To determine the pH and conductivity of soil and water samples
4. To determine the total organic matter present in the soil sample.
5. To verify Darcy's law and to determine the hydraulic conductivity of supplied soil sample.
6. To determine soil respiration by alkali absorption method
7. To determine the BOD of supplied water samples
8. To determine the total hardness of water sample
9. To determine the alkalinity of water sample
10. To determine the Phosphate/ Nitrates/ Nitrites in given water sample
11. To determine residual chlorine content in water sample
12. To determine the TS, TDS, TSS, in given water sample
13. To determine the mean and standard deviation of supplied biological sample
14. To determine the co-efficient of correlation of length and weight of supplied fish sample.
15. To verify null hypothesis by χ^2 Test

16. Comparison of means of samples using t test.
17. Identification of different rock samples.

ENS-531 ENVIRONMENTAL BIOCHEMISTRY & TOXICOLOGY

Total Marks = 50 (End Term-40 + Internal-10)
Credit hour =4

UNIT I Basic Environmental Biochemistry

Enzymology (Classification and properties of enzymes, active sites, mechanism of enzyme catalysis, Michaelis –Menten Equation, Km, Vmax, Lineweaver and Burk plot, Eddy-Hoffstee plot, enzyme inhibition, allosteric enzymes, multi enzyme complex); Biochemistry of stress (Altered membrane permeability, free radical formation, lipid peroxidation, lysosomal degradation, superoxide dismutase).

UNIT II Environmental Toxicology

Definition and basic concept of toxicology; Definition of toxins, xenobiotics; LADME or ADME scheme of toxicokinetics (Liberation-routes of exposure, absorption, distribution, metabolism, and excretion), Duration and frequency of exposure (Acute, Sub-acute, Chronic); Statistical concept of LC50, LD50; Dose response relationships and curves; Factors that influence toxicity (biological, chemical, ecological); Bio-transformation, Bio-accumulation, Bio-magnification.

UNIT III Toxic Action of Pollutants

Toxic action of Insecticides (Organochlorine, organophosphahate, carbamate and pyrethroids), Toxic action of herbicides, Toxic action of heavy metals (Lead, Mercury, Arsenic, Chromium), Toxic action of POPs (PCB, PAH, Dioxins), Basic concept of carcinogenesis (Types of cancer, properties of cancer cells, Stages and progression of cancer, role of cell cycle check points in carcinogenesis), Carcinogens (Types: genotoxic, epigenetic, unknown; Types: physical, chemical, biological)

UNIT IV Bio-analytical techniques

Chromatography (Basic concepts of chromatography, Size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, paper chromatography, Thin layer chromatography, Gas-chromatography, Liquid chromatography, HPLC), Electrophoresis and Blotting (Basic concepts, Agarose gel electrophoresis, Native PAGE, SDS-PAGE, 2D-GE, Southern, Northern, Western blots); DNA isolation, Polymerase Chain Reaction.

Books Recommended

1. Lehninger Principles of Biochemistry by DL. Nelson & MM. Cox, WH Freeman
2. Environmental Toxicology by W.G. Lendis, Lewis Publ.
3. Environmental Biology and Toxicology by P.D. Sharma, Rastogi Pupl.
4. Toxicology - principles & applications - Niesink & Jon devries
5. Concepts of Toxicology by Omkar, Vishal Publ.

6. Principles and techniques of Practical Biochemistry by Wilson and Walker, Cambridge Univ. Press
7. Brock Biology of Microorganisms, by MT. Madigan et. al. Prentice Hall publication.
8. Microbiology by Lansing M Prescott, John P. Harley and Donald A. Klein, Mc Graw Hill publication.
9. Physiology of abiotic stress in plants by Dwivedi and Dwivedi, Agrobios (India)

ENS-532 ENVIRONMENTAL IMPACT ASSESSMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Concept and Basic Principles of EIA

Concepts of carrying capacity and global commons; Origin and development of EIA: relationship of EIA to sustainable development; National environmental policy and statutory requirements of EIA; Objectives of EIA, Preparation of EIA statement, EIA notification; EIA Notification 1989 (amended 1994), Notification 1997; Public hearing, EIA in project planning and implementation; Review of EIS, Examples of Project EIS.

UNIT II EIA analysis and Methodologies

The process of getting Environmental Clearance (EC) for a project (Screening, Scoping, Public consultation and Appraisal); The process of EIA (base line study, Evaluation of proposed actions, identification and prediction of impacts, mitigation measures, comparison of alternatives, social and environmental compensatory actions); Methodologies to identify Impacts (Adhoc method, Checklist method, Matrix method, Network method, Overlay method); Case studies (River valley projects, thermal power plants, mining projects, oil refineries and petrochemicals).

UNIT III Environmental Planning and Auditing

Designing of environmental plan, project planning, Risk assessment of projects, Clearing of projects (River valley project, Dam sites, Highway, Mining, Refineries and Industrial projects), Rural and urban planning, Land use pattern and policies; Environmental auditing, Cost-benefit analysis and simulation modeling, Environmental audit statement notification, Environmental accounting, Life cycle assessment, Elements of waste minimization strategy, Waste reduction techniques, Case studies (Paint manufacturing industries).

UNIT IV Social Issues and Sustainable Development

Environment and economic resources, ecosystem services; Stockholm Conference (1972) and its declaration, WCED (1983) and Brundtland Report (1987), Concept and strategies of sustainable development, Environmental ethics; Rio Earth Summit-UNCED (1992) and its declaration, Agenda 21, Polluter pays principle, Human centered environmental problems, Environmental education and awareness; environmental justice; The environmental protection Act (India) 1986, Environmental priorities of India and Odisha.

Books Recommended

1. Sustainable Development by Kumar Das, Reference Publ.
2. Sustainable Development of the Biosphere by WC Clark and RE Munn, Cambridge University Press
3. The Hand Book of Environmental Economics by W Daniel, Black well
4. Environmental and Social Impact Assessment by CJ Barrow
5. Environmental Impact Assessment by RR Barthwal, New Age International Pvt. Ltd
6. Environmental Impact Assessment by PR Trivedi, APH Publishing Corporation
7. Environment and Pollution Law manual by SK Mohanty, Universal Law Publisher Ltd.

ENS-533 ENVIRONMENTAL HAZARD, RISK & DISASTER MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

UNIT I Disaster and Hazard Management

Disaster introduction; Disaster Management Capability: Vulnerability and risk, Hazard zonation and mapping- Risk Reduction Measures; Disaster preparedness: Community based training and education, Engineered structure /structural strengthening techniques; Disaster management cycle, Rescue and relief camps, Post disaster restoration; Disaster management of coastal zones; Role of local institutions, NGOs, ODRAF and NDRF team in disaster management.

UNIT II Natural Hazards

Geological Hazards: Global distribution pattern, causes, consequences and mitigation of Earthquake, Tsunami, Volcanoes, Landslide; Forecasting of geological disasters (tsunami warning system); Earthquake zones, ring of fire, Richter scale; Case studies: 2011-Japan Earthquake and tsunami, 2004-Indian Ocean tsunami.

Weather Disaster: Global distribution pattern, causes, consequences and mitigation of Cyclone, Cloudburst, Thunderstorm, Flood, Drought, cold and heat hazards, forest fire; Forecasting of weather disasters; Case studies: Study of Orissa super cyclone 1999 and Pheilin 2013.

UNIT III Technological Disasters

Technological Disaster: Causes (Faulty design, Negligence in handling and operation, Negligence in periodic maintenance, natural disaster); Specific causes, consequences and mitigation of nuclear disasters, coal mine disasters, industrial disasters (due to fly ash and poisonous gases); Case studies: Bhopal gas tragedy (1984), Chernobyl nuclear disaster (1986), Sevaso disaster (1976).

UNIT IV Environmental and Occupational Health Hazards

Health hazard: Causes of disease outbreak (personal hygiene, environmental hygiene, occupational factors); Specific causes, consequences and mitigation of occupational diseases

(Asbestosis, Silicosis), vector borne and infectious diseases (Dengue, Chikungunya, Plague, Swine flu, Bird flu, AIDS, Ebola), Antibiotics resistant microbes; Role of WHO in disease control.

Books Recommended

1. Coping with Natural Hazards; Indian context by KS Valdiya, Orient Longman
2. Environmental Changes and Natural Disasters by Baber, New India Publishing agency
3. All you want to know about Disasters by BK Khanna, New India Publishing agency
4. Disaster Management, Concept, People and Perception by Acharya et. al. Agrobios
5. Environmental Geology by C W Montgomery, Mc. Graw Hill International
6. The Atmosphere: An Introduction to Meteorology by FK Lutgen and EJ. Tarbuk, Pearson
7. Oceanography-an introduction to marine science by Tom Garrison, Brooks/Cole-Thomson Learning
8. Understanding Earth by Grotzinger, Jordan, Press & Siever; WH Freeman and Company
9. Industrial safety and health, David L. Goetsch, Macmillan Publishing Company.
10. Handbook of environmental health and safety, Vol I & II, H Kooren & M Bisesi, Jaico Publ. House.
11. Occupational health: A manual for primary health care workers, by World Health Organization

ENS-534 ENVIRONMENTAL EDUCATION FOR FUTURE SUSTENANCE

(Choice based paper for the students other than the M. Sc. Environmental Science course)

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

Unit I- Understanding our Environment

Introduction to Environmental Science, Scope, Components of Environment (Biosphere, Hydrosphere, Lithosphere, Atmosphere), Concepts of Ecosystem, Food Chain, Food Web, Ecosystem Services, Ecological Foot Prints; Natural Resources: Concept of Resources, Renewable and Non-renewable Resources, Biodiversity - its importance and conservation.

Unit II- Environmental Degradation and Consequences

Man and Environment relationships, Causes of environmental degradation, Control measures of air, water, soil and noise pollution, Green House Effect and Global Warming, Ozone layer depletion and its consequences.

Unit III- Environmental Policies, legislations and International Agreements on Environment

National Environmental Policy -2006, Air Pollution (Prevention and Control) Act-1981, Water Pollution (Prevention and Control) Act-1974, Ramsar Convention- 1971, First World Conference on Human Environment (1972), Montreal Protocol - 1987, Basel Convention (1989), Earth Summit (1992), Kyoto Protocol- 1997.

Unit IV- Sustainable Development and Environmental Education

Concept of Sustainable Development, WCED (1983) and Brundtland Report (1987), Ecological Economics, Tragedy of Commons, WTO and Environment, Green Business, Corporate Social Responsibility, Environmental awareness and Education

Books Recommended

1. Fundamentals of Ecology by Odum and Barrett, Thompson publ.
2. Fundamentals of Ecology by MC Dash, Tata Mc Graw Hill Edu Pvt Ltd
3. A text book on Environmental Engineering by HD Kumar and SP Adhikari, India Tech publ.
4. Environmental Science by SC Santra, Central Publ.
5. Environmental Science by Cunningham and Cunningham
6. Ecology: Principles and Applications by J. L. Chapman, M. J. Reiss, Cambridge University Press
7. Sustainable Development by Kumar Das, Reference Publ.
8. Ecology, Chemistry and Management of Environmental Pollution by MC Dash, Mac Millan
9. Ecology and Environmental Science by SVS Rana, PHI pvt. ltd.
10. Ecology and Environment by P D Sharma, Rastogi publication
11. Environmental Awareness and Education by D DasGupta, Agrobios

ENS-535: LABORATORY AND FIELD TECHNIQUES/PRACTICALS

Total Marks = 100

Credit hour = 8

Based on theory papers (ENS 531 to ENS 533) a series of practical experiments/ laboratory works will be carried out.

List of Practical Experiments

1. Verification of Beer Lambert's law using spectrophotometer.
2. Determination of absorption maxima and Molar extinction coefficient of methyl orange and bromophenol blue
3. Determination of peroxidase activity in plant tissues of different ages.
4. Determination of effect of different factors on membrane permeability.
5. Determination of LC50/LD50 in animals (cockroach, earthworm, fish, insects) in response to different toxic chemicals.
6. Determination of CO₂ evolution from soil with respect to pesticides.
7. Determination of CO₂ evolution from soil with respect to Heavy metals.
8. Effect of heavy metals on seed germination
9. Effect of heavy metals on physiological parameters (total chlorophyll/ peroxidase activity/ soluble protein content/ reducing sugar content) in growing seedlings
10. To prepare paper chromatograms of Phenol Red and Methyl orange and to determine *rf* values.
11. To prepare an EIA report on the waste dumping of a nearby Industry.

Specialization – (A) Industrial Pollution Control and Management
ENS-541-A INDUSTRIAL POLLUTION CONTROL

Total Marks = 50 (End Term-40 + Internal-10)
Credit hour =4

Unit I- Industries setting and Guideline for Environmental clearance

Industrial scenario, Categories of industries that require environmental clearance as per impact assessment notification 1994, Public hearing preparation of EIA and EMP, Industrial setting clearance from SPCB and MOEF, Govt. of India. Sources, types and uses of industrial waste, Preventing and minimizing wastes at the source, Industrial waste disposal and environmental impacts; Environmental protection Act 1986, EIA Notification 1989 (amended 1994), Notification 1997; National Environmental Policy -2006, Coastal Regulatory Zone.

Unit II- Industrial water pollution control and management

Sources and characteristics of industrial wastewater, Effluent generation rates, Standards related to industrial wastewater, Waste volume and strength reduction, Primary, Secondary and Tertiary treatment of industrial wastewater. Advanced technology for removal of toxic ions from industrial effluents such as Ion exchange, Electro dialysis, Reverse osmosis, Membrane technology, Ozonation, Wet air oxidation; Wastewater characteristics and waste treatment flow sheet for Textiles , Tanneries , Pulp and paper, Sugar & Distilleries and fertilizers; Water Pollution (Prevention and Control) Act-1974.

Unit III- Industrial air pollution control and management

Permissible limit of ambient air quality and emission standards, Monitoring technique of particulate and gaseous pollutants (SPM, RSPM, SO₂, NO_x, Ozone etc), Principles and operations of gravity settling chamber, cyclones, scrubbers, filters, ESP; Control gaseous pollutants through adsorption, absorption, mass transfer, condensation, and combustion; Control of motor vehicle emissions, Stack monitoring; Air pollution treatment flow sheet for Thermal power plant, Steel plants, Textile and Generator; Air Pollution (Prevention and Control) Act-1981.

Unit IV- Industrial solid wastes pollution control and management

Characteristics of solid wastes from food; fish processing unit; sugar industry; pulp and paper industries; coal based Thermal power plants, Aluminum industries; Hospital solid waste and Municipal solid waste collection; treatment; disposal and management of industrial Solid waste and related problems; Hazardous Waste Management & Handling rules-1989,

ENS-542-A ENVIRONMENTAL MANAGEMENT SYSTEMS FOR INDUSTRIES

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

Unit I- Environmental Management

Resource allocation, Responsibility and Accountability, Environmental Management cell, Skill and Training development, Record and Documentation, Report writing and submission of Report, Environmental Management System, Managerial System (Accounting and Auditing) EMS certification, Environmental Management Principle of Industries and Mines; Continuous performance evaluation, Top management commitment and leadership: Corporate Environmental Policy and targets including pollution prevention; Corporate Social Responsibility (CSR); Development of ISO 14000 series, green rating project and Green Marketing.

Unit II- Environmental and Industrial Safety Management

What is safety, Principles of Industrial Safety management, Accident, Causes of Accidents, Types of Accident, Industrial hazards (Chemical, Mechanical, Biological, Fire and Electrical hazards); Hazards Control and Management in Industries (Petrochemicals, Refinery, LPG bottling); Safety analysis, Safety handling and storage of hazardous materials, Safety management for Industries

Unit III- Sanitary Engineering for Industries

Environmental Hazard due to improper sanitation and impart on workers health, comfort and productivity; Sanitary disposal of liquid, gaseous and solid wastes in industry and mines; Biomedical waste, Municipal solid waste; Waste minimization techniques, strategies and programmes; Recycle and Reuse such as peletilisation, Energy recovery, vermicomposting, and its benefits

Unit IV- Environmental Health and Occupational Health Hazards

Definition of Environmental Health, Heavy metal and Trace elements in human health and hazard; Occupational health hazard of workers in industry and mines and its management; Air borne bio allergies and their effects, Water borne diseases and community health hazards, Epidemiological issues like fluorosis, Arsenic, Goiter

ENS-543-A GRAND VIVA (COVERING THE ENTIRE SYLLABUS)

Total Marks = 50

Credit hour =4

In this paper, the student has to appear before a Board of Examiners constituting the Departmental Teachers and at least one External Examiner, where he/she will be asked questions covering the entire syllabus and basing on the performance the Board will award the mark to the student.

ENS-544-A LABORATORY AND FIELD TECHNIQUES/PRACTICALS

Total Marks = 50

Credit hour = 4

Based on theory papers (ENS 541-A to ENS 542-A) a series of practical experiments/laboratory works will be carried out.

List of Practical Experiments

1. Determination of total Chromium in supplied water sample.
2. Determination of iron content in supplied water sample.
3. Determination of Nickel content in supplied water sample.
4. Determination of Fluoride content in supplied water sample.
5. Determination of COD of supplied water sample by open reflux method.
6. Use of separatory funnel for extraction of oil and grease from waste water sample.
7. Use of Soxhlet extractor for extraction of organic compounds present in sediment sample.
8. Recording and interpretation of noise and noise Leq determination.
9. Measurement of temperature, Humidity, Rainfall, Wind direction in an industrial area during a specific time period.
10. Land use pattern survey of an area

ENS-545-A DISSERTATION PRESENTATION

Total Marks = 100

Credit hour = 8

At the beginning of the fourth semester, the student will select a topic for project work in consultation with teacher assigned to him/her by the department. The student will carry out the project work, and will compile the findings in the form of a project report which will be submitted to the Department. For evaluation, the student will present and defend his/her findings before a Board of Examiners constituting the respective Teacher Supervisor and one External Examiner. Basing on the project report and performance in the presentation, the Board will award the mark.

Books Recommended for ENS 541A & ENS 542A

1. Industrial Effluents by Mani Vasakam, Shakti publ.
2. Industrial Pollution by VP Kudesia & RK Kudesia, Himalaya Publishing House
3. Introduction to Environmental Engineering and Science by Gilbert M. Masters, Pearson Education
4. Environmental Engineering and Safety by BK Nanda & T Biswal, BK publications
5. Environmental Engineering by SK Garg, Khanna Publ.
6. Mining Environment in India by SC Joshi et. al. Himalaya Research Publ.
7. Pollution Control and Management in Industries by Trivedi
8. Process Engineering for Pollution Control and Waste Minimization by DL Wise
9. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ House
10. Environmental Protection and Laws by CS Mehta
11. Environment and Pollution Law manual by SK Mohanty, Universal Law Publisher Ltd.

Specialization – (B) Environmental Biotechnology
ENS-541-B BIOTECHNOLOGICAL APPROACH FOR ENVIRONMENTAL MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)
Credit hour =4

Unit I- Environmental Biotechnology

Environmental biotechnology (Definition, Scopes and Issues); Basic resources for environmental biotechnology (Microorganisms, plants, animals and/or their produce); Recombinant DNA technology, genetically engineered organisms their environmental risk and importance; Biotechnology for biodiversity conservation (DNA-based taxonomy, Ex-situ and In-vitro conservation methods); Intellectual Property Rights (IPR) and patenting

Unit II- Bio-indicators and Biosensors in Environmental Monitoring

Definition of Bioindicators, Types (Plant indicators: Air Pollution Tolerance Index, Animal indicators, Microbial indicators: Microbial Prospecting for Oil and Gas); Definition of Biosensors, Types (immunochemical, enzymatic, non-enzymatic receptor, whole-cell, and DNA biosensors); Reporter genes and their application in environmental monitoring.

Unit III- Microbial Interactions with Pollutants

Biodegradable and Persistent Organic Pollutants, Determination of biodegradability, Factors affecting the process of biodegradation; Degradation of Lignocelluloses, Degradation of aliphatic, aromatic and chlorinated compounds with examples; Degradation of petroleum wastes; Co-metabolic degradation of organic pollutants; Metal-mobilizing micro-organisms (Bioleaching: Heterotrophic leaching, Autotrophic leaching; Siderophores; Biomethylation); Metal-immobilizing micro-organisms (Biosorption and Bioaccumulation); Chemistry and biology of acid mine drainage.

Unit IV- Biofuels and Bioenergy

Definition of Biofuels and bioenergy; Generations of biofuels (first, second, third and fourth generation of biofuels and their significance); Bioalcohols (bioethanol and biobutanol): types of feedstock and fermentation of feedstock into bioalcohols; Biodiesel (fatty acid methyl ester): types of feedstock and transesterification of feedstock into biodiesel; Sources and processing of Biogas (Biomethane) and Biohydrogen; Basic concepts on microbial fuel cells.

ENS-542-B WASTE MANAGEMENT & BIOREMEDIATION

Total Marks = 50 (End Term-40 + Internal-10)
Credit hour =4

Unit I- Bioremediation

Concept of bioremediation, Types of bioremediation, Constraints and priorities of bioremediation, In-situ bioremediation (Bioventing, Biostimulation, Bioaugmentation, Natural attenuation); Ex-situ bioremediation (Land farming, solid phase treatment, slurry phase treatment); factors influencing bioremediation, Phytoremediation (types and basic mechanisms)

Unit II- Biotechnology for Solid Waste and Air Pollution Management

Aerobic treatment of solid wastes: Composting, Vermicomposting (Design of vermiculture unit, Selection and mass multiplication of worms, Vermitechnology and modern agriculture, Environmental benefits of vermicomposting, Vermifilter for waste water treatment, Vermiwash); Anaerobic treatment of solid wastes: Biogas generation; Comparison of aerobic and anaerobic solid waste treatment. Bio-scrubbers, bio-filters and bio-trickling filters for air pollutants and particulate matter control; Microbial desulfurization of coal;

Unit III- Biotechnology for Water Pollution Abatement

Aerobic biological treatment of waste water (Oxidation ditch, Trickling filters, Rotating Biological Contactors, Biological Aerated Filters, Activated sludge process); Anaerobic biological treatment of waste water (UASB reactors, Anaerobic fluidized bed reactors, Anaerobic baffled reactors); Biological methods for removal of nutrients (Nitrogen and Phosphorous) from waste water; Biofilms and their role in waste water treatment.

Unit IV- Cleaner Technology for Industry and Agriculture

Cleaner Technology for: Pulp and Paper Industries (Bio-pulping, Bio-bleaching), Distillery Industry (treatment of distillery spent wash), Leather industry (Enzymatic degreasing of skins), Electroplating Industry (recovery of metals from effluent); Cleaner Technology for Agriculture: Development and utilization of Bio-fertilizers, Bio-pesticides; Bio-mobilization of silicon, phosphorous, nitrates and development of waste lands; Biotechnological approach for carbon sequestration (Biocalcification, CO₂ sequestration by microalgae and cyanobacteria)

ENS-543-B GRAND VIVA (COVERING THE ENTIRE SYLLABUS)

Total Marks = 50

Credit hour = 4

In this paper, the student has to appear before a Board of Examiners constituting the Departmental Teachers and at least one External Examiner, where he/she will be asked questions covering the entire syllabus and basing on the performance the Board will award the mark to the student.

ENS-544-B LABORATORY AND FIELD TECHNIQUES/PRACTICALS

Total Marks = 50

Credit hour = 4

Based on theory papers (ENS 541-B to ENS 542-B) a series of practical experiments/laboratory works will be carried.

List of Practical Experiments

1. Microbial analysis of water by MPN method
2. Enumeration of bacteria in Industrial effluent by Viable Plate Count Method
3. Morphological characterization of bacterial colonies isolated from waste water sample on nutrient agar plates.
4. Identification of bacterial samples following differential staining technique.
5. Separation of Amino acids from Mixtures using paper chromatographic techniques.
6. Estimation of reducing sugars.
7. Estimation of soluble proteins.
8. Estimation of amino acids
9. Determination of microbial quality of milk.
10. Estimation of Hemoglobin content in blood sample

ENS-545-B DISSERTATION PRESENTATION

Total Marks = 100

Credit hour = 8

At the beginning of the fourth semester, the student will select a topic for project work in consultation with teacher assigned to him/her by the department. The student will carry out the project work, and will compile the findings in the form of a project report which will be submitted to the Department. For evaluation, the student will present and defend his/her findings before a Board of Examiners constituting the respective Teacher Supervisor and one External Examiner. Basing on the project report and performance in the presentation, the Board will award the mark.

Books Recommended for ENS 541B & ENS 542B

1. Textbook of Environmental Biotechnology by PK Mohapatra, IK International
2. Elements of Biotechnology by P.K.Gupta, Rastogi publication.
3. Microbial Biotechnology by Glazer, A.N. and Nikaido; Freeman and company.
4. Microbial degradation of Xenobiotics by T Leisinger, Academic Press
5. Environmental Biotechnology: Theory and Application by GM. Evans, JC. Furlong, IK International
6. Environmental Biotechnology: Basic Concepts and Applications by I S Thakur, IK International
7. Advanced Environmental Biotechnology by SK Agrawal, APH publishing Corporation
8. Bioremediation by H Baker and DS Herson, Mc Graw Hill
9. Introduction to Environmental Biotechnology by KC Chatterji, PHI Pvt. Ltd.
10. A handbook of Bioenergy crops by V.N Meena Devi et. al., Agrobios (India).
11. Vermitechnology by PK Gupta, Agrobios

Specialization – (C) Environmental Health and Occupational Safety

ENS-541-C ENVIRONMENTAL HEALTH AND MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

Unit I- Environmental Health

Dimension and definitions of environmental health; The man-environment-health relationship; Potential health hazard factors in the environment (physical, chemical, biological); Concepts of infection, incubation period, symptom, syndrome, host, pathogen, parasite and pathogenicity; Human adaptations at extreme environments (high altitude and extreme temperatures); Climate change and possible outcomes on human health; Major agencies, programs, and organizations involved in environmental and occupational health protection;

Unit II- Health Risk Assessment

Human exposure to toxins (sources, pathways, and routes of exposure to the disease causing agents); Exposure assessment/quantification methods (Direct and Indirect methods); Linking Exposure to Health Effects (Risk assessment); Modeling of health effects from exposure estimates and derivation of risk estimates.

Unit III- Environmental Epidemiology

Environmental epidemiology: definition and scope; Epidemics and Pandemics; Mortality and Morbidity; Sensitive or susceptible populations; Basic approaches for epidemiological study (Disease etiology, transmission, outbreak investigation; disease surveillance and comparisons of treatment effects such as in-clinical trials, Bradford Hill criteria for assessing causality); Control of communicable diseases and prevention of epidemics; Vaccination and immunization programmes; Environmental and occupational health professions and their roles.

Unit IV- Diseases and Case studies

Epidemiological study of selective diseases of recent times (Diseases involving chemical pollutants or nutritional deficiency: fluorosis, Arsenicosis, Goiter, Cancer; Diseases involving biological pathogens: Dengue, Chikungunya, Viral Hepatitis B and C, SARS, Swine flu, bird flu, Ebola; Lifestyle and stress related diseases: Diabetes, Heart disorders, Obesity).

ENS-542-C INDUSTRIAL SAFETY, OCCUPATIONAL HEALTH AND MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)

Credit hour =4

Unit I- Work Environment and Recognition of Health Hazard Factors

Occupational health: Definition; Interrelationship between health, workplace, economy and sustainable development; Recognition of potential health hazards factors in work environment (Physical, Chemical, Biological, Ergonomical, Psychological and Accidental); Techniques used in recognizing occupational health hazards (Material inventory, Process inventory, Hygiene survey, Air sampling programmes).

Unit II- Occupational Diseases

Characteristics of occupational diseases; Diseases caused due to physical factors (Cold/heat stress, Noise induced hearing loss, and effects of ionizing and non-ionizing radiations); Diseases caused due to chemical agents (Asphyxia, Acute Respiratory Diseases-ARD, Respiratory Irritation, Silicosis and Asbestosis, Allergic-asthma); Diseases caused due to biological agents (Pulmonary tuberculosis, Anthrax, AIDS,); Locomotor disorders (Carpel tunnel's syndrome, low-back pain syndrome, shoulder-neck pain syndrome)

Unit III- Control and Prevention of Occupational Health Hazards

Recommended exposure limits (TLV for chemical and physical agents and BEI for biological agents as issued by ACGIH); Prevention and control of occupational diseases (Primary prevention: engineering, work practice and administrative controls; Secondary prevention: disease surveillance and monitoring; Tertiary control: medications); Prevention of Heat stress, Noise, Radiation exposure; Prevention of gases and dusts; Environmental ventilation.

Unit IV- Industrial and Occupational Safety

Classification and Causes of occupational accidents, Prevention and control of occupational accidents, control of electrical and fire hazards; Importance of first aid, First aid for external injuries, fracture, thermal injuries, poisoning, hemorrhage, shock and impaired breathing; Recognition, evaluation and control of harmful factors in mines and small scale industries; Occupational health safety for working woman and children; Identification of potential risks at workplace during pregnancy, pregnancy related disorders and birth defects due to work place exposure

ENS-543-C GRAND VIVA (COVERING THE ENTIRE SYLLABUS)

Total Marks = 50
Credit hour =4

In this paper, the student has to appear before a Board of Examiners constituting the Departmental Teachers and at least one External Examiner, where he/she will be asked questions covering the entire syllabus and basing on the performance the Board will award the mark to the student.

ENS-544-C LABORATORY AND FIELD TECHNIQUES/PRACTICALS

Total Marks = 50
Credit hour = 4

Based on theory papers (ENS 541-C to ENS 542-C) a series of practical experiments/laboratory works will be carried out.

ENS-545-C DISSERTATION PRESENTATION

Total Marks = 100
Credit hour = 8

At the beginning of the fourth semester, the student will select a topic for project work in consultation with teacher assigned to him/her by the department. The student will carry out the project work, and will compile the findings in the form of a project report which will be submitted to the Department. For evaluation, the student will present and defend his/her findings before a Board of Examiners constituting the respective Teacher Supervisor and one External Examiner.

Basing on the project report and performance in the presentation, the Board will award the mark.

Books Recommended for ENS 541C & ENS 542C

1. Industrial safety and health, David L. Goetsch, Macmillan Publishing Company.
2. Handbook of environmental health and safety, Vol I & II, Herman Kooren, Michael Bisesi, Jaico Publishing House.
3. Occupational health: A manual for primary health care workers, by World Health Organization

Specialization – (D) Disaster Management ENS-541-D DISASTER PREPAREDNESS AND MITIGATION

Total Marks = 50 (End Term-40 + Internal-10)
Credit hour =4

Unit I- Disaster Prevention, Mitigation and Community Based Disaster Preparedness

Basic principles and elements of disaster mitigation; Protection measures during disaster; Action plan for Drought, Cyclone, and Earthquake mitigation; Flood mitigation practices in India; Disaster vulnerability; Community perception in disaster management; Community Based Disaster Preparedness programme; cost benefit analysis for disaster mitigation.

Unit II- Emergency Disaster Preparedness and Disaster Assistance

Management of emergencies in chemical Industries; Pre-Disaster phase, Actual disaster phase, and Post disaster phase case study; Technological assistance; National and International organizations for emergency services.

Unit III- Rescue, Relief and Rehabilitation Operation System

Disaster rescues, casualty management; security; Relief camps, financing relief operations and provision of human and livestock needs; Epidemiological aspects of post disaster public health impact and sanitization; Role of Army, Govt. agencies, NGOs in relief operations.

Unit IV- Shelter/Housing, Structural Mitigation Techniques

Clearing, Preparation of shelters; Deployable structures for sheltering, Diagnosis, Sheltering of Damaged structures; Housing and structural mitigation for earthquakes, flood, cyclone and tsunami

ENS-542-D ADVANCES IN DISASTER MANAGEMENT

Total Marks = 50 (End Term-40 + Internal-10)
Credit hour =4

Unit I- Industrial Disasters and Accidents

Man made chemical and Industrial Accidents; Technological Disasters; Case study of Bhopal disaster; Industrial disasters in odisha; Chernobyl nuclear disaster; Accidental Explosions.

Unit II- Natural Disasters and their Reduction

Natural calamities like Earthquake, Flood, Drought, Landslide, Tornado, Cyclone, Forest fire and Tsunami, their causes, intensity and magnitude. International decade for natural disaster reduction; Training operations and building of National and organizational capabilities in disaster mitigation and reduction.

Unit III- Disaster management Plan and Training

Concept of natural disaster management plan, Pre-disaster planning, ViSP (Visual Settlement Planning), Toning of disaster prone areas; Mitigation Strategies; Disaster education and training needs; Target groups-Local conditions

Unit IV- Disaster Management Information System

Natural disaster forecasting and warning systems; Animals in predictions of natural disaster occurrence; Earthquake intensity measurement instrument; Ham-Radio system; Information and Administration during disaster mitigation.

ENS-543-D GRAND VIVA (COVERING THE ENTIRE SYLLABUS)

Total Marks = 50

Credit hour =4

In this paper, the student has to appear before a Board of Examiners constituting the Departmental Teachers and at least one External Examiner, where he/she will be asked questions covering the entire syllabus and basing on the performance the Board will award the mark to the student.

ENS-544-D LABORATORY AND FIELD TECHNIQUES/PRACTICALS

Total Marks = 50

Credit hour = 4

Based on theory papers (ENS 541-D to ENS 542-D) a series of practical experiments/ laboratory works will be carried out.

ENS-545-D DISSERTATION PRESENTATION

Total Marks = 100

Credit hour = 8

At the beginning of the fourth semester, the student will select a topic for project work in consultation with teacher assigned to him/her by the department. The student will carry out the project work, and will compile the findings in the form of a project report which will be submitted to the Department. For evaluation, the student will present and defend his/her findings before a Board of Examiners constituting the respective Teacher Supervisor and one External Examiner. Basing on the project report and performance in the presentation, the Board will award the mark.

Books Recommended for ENS 541D & ENS 542D

1. Coping with Natural Hazards; Indian context by KS Valdiya, Orient Longman
2. Environmental Changes and Natural Disasters by Baber, New India Publishing agency
3. All you want to know about Disasters by BK Khanna, New India Publishing agency
4. Disaster Management, Concept, People and Perception by Acharya et. al. Agrobios
5. Natural Hazards by E Bryant, Cambridge University press
6. Environmental Geology by C W Montgomery, Mc. Graw Hill International
7. The Atmosphere: An Introduction to Meteorology by F K Lutgen and EJ. Tarbuk, Pearson publ.
8. Oceanography-an introduction to marine science by Tom Garrison, Brooks/Cole-Thomson Learning
9. Understanding Earth by Grotzinger, Jordan, Press & Siever; WH Freeman and Company