M. Sc. ENVIRONMENTAL SCIENCE

Two Year Full Time Programme (Regular Course)

SYLLABUS

(2022-2023 ONWARDS)

A choice based credit system syllabus

P. G. DEPARTMENT OF ENVIRONMENTAL SCIENCE,

FAKIR MOHAN UNIVERSITY, VYASA VIHAR

BALASORE-756089

ODISHA

Programme Outcomes (POs) of M.Sc. Environmental Science

PO1. To prepare students to became a role player/transformer/leader/entrepreneur in multiple
aspects to address the challenges of environmental problems and finding solutions to meet the sustainable dimensions at local, regional, national and global context.

PO2. To generate resourceful degree holders enabled with professional and research oriented
knowledge and skills so as to explore and implement in diverse fields of applicability andemployability that significantly helps in the process of planning, evaluation, decision making and management of sustainable environment, sound societal development and overall nation building.

PO3. To transfer the contemporary skilful knowledge to students to address the real life issues with strong sense of ethical values, scientific intellectuality, social responsibility and national integrity.

Programme Specific Outcomes (PSOs) of M.Sc. Environmental Science

- Students will be able to critically investigate, evaluate and synthesize complex information on various problems of environmental and allied disciplines.
- Students can conduct assessment and periodic monitoring of different ecosystems of the region and its complex interactions with the local communities, thereby can address the threats and can develop conservation strategies.
- Students can investigate and analyse the wildlife and biodiversity of the region and its complex interactions with the community.
- Students can use sophisticated tools like Geo-informatics/Geospatial Technologies for monitoring, modelling and analysis to address local environmental pollutions and natural resource management.
- Students will be able to disseminate environmental knowledge and awareness among local people.
- Students will be able to pursue higher studies (Ph.D.) and can appear in various competitive examinations like CSIR-NET, UGC-NET, ICAR-NET, GATE, etc. through which they can join different scientific projects to build a promising career in the field of scientific research.

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

Paper Code	***Paper Name***	***Marks*** *(Internal + End term)*	***Credit***
Semester I			
ENS-411	Fundamentals of Ecology & Environmental Science	40 + 60	4
ENS-412	Natural Resources & their Management	40 + 60	4
ENS-413	Atmospheric Chemistry, Metrology and Climatology	40 + 60	4
ENS-414	Air & Air Pollution Management; Noise and Radiation Pollution and their Management	40 + 60	4
ENS-415	Practical	100	8
Semester II			
ENS-421	Aquatic Ecology & Water Pollution Management	40 + 60	4
ENS-422	Envirometrics, Environmental Modeling & Computer Application in Environmental Management	40 + 60	4
ENS-423	Soil & Soil Pollution Management	40 + 60	4
ENS-424	Environmental Geology and Instrumentation Techniques	40 + 60	4
ENS-425	Practical	100	8
**********	Add on course from MOOC	**Non credit Course**	
Semester III			
**********	Fakir Mohan Studies	**Non Credit Course**	
ENS-531	Environmental Biochemistry & Toxicology	40 + 60	4
ENS-532	Environmental Impact Assessment	40 + 60	4
ENS-533	Environmental Hazard, Risk & Disaster Management	40 + 60	4
ENS-534	Environmental Education for Future Sustenance *(Choice based paper)*	40 + 60	4
ENS-535	Practical	100	8
Semester IV			
Specialization – (A) Industrial Pollution Control and Management			
ENS-541-A	Industrial Pollution Control	40 + 60	4
ENS-542-A	Environmental Management Systems for Industries	40 + 60	4
ENS-543-A	Grand Viva	50	2

ENS-544-A	Practical	50	4
ENS-545-A	Dissertation Work	200	10
Specialization – (B) Environmental Biotechnology			
ENS-541-B	Biotechnological Approach for Environmental Management	40 + 60	4
ENS-542-B	Waste Management & Bioremediation	40 + 60	4
ENS-543-B	Grand Viva	50	2
ENS-544-B	Practical	50	4
ENS-545-B	Dissertation Work	200	10
Total Marks		**2000**	**96**

Note: The underlined portions in the detailed syllabus of each paper are to be self studied by the students.

MARKING/ EVALUATION PATTERN

From 2021-22 admission session, Post-Graduate degrees offered by the University will follow a continuous evaluation system as per the marks distribution mentioned below.

<table>
<tr><th></th><th>Theory papers</th><th>Practical Papers (1st, 2nd & 3rd Sem)</th><th>Practical Paper (4th Sem)</th><th>Dissertation Work (in 4th Sem)</th><th>Grand Viva (in 4th Sem)</th></tr>
<tr><td>Total marks per paper</td><td>100 Marks</td><td>100 Marks</td><td>50 Marks</td><td>200 Marks</td><td>50 Marks</td></tr>
<tr><td>Credit per paper</td><td>4</td><td>8</td><td>4</td><td>10</td><td>2</td></tr>
<tr><td rowspan="3">Internal Examination</td><td>Best of the two quizzes 10 Marks</td><td rowspan="3">----</td><td rowspan="3">----</td><td rowspan="3">---</td><td rowspan="3">----</td></tr>
<tr><td>Written (Mid Sem) 20 Marks</td></tr>
<tr><td>Presentation and Home Assignment 10 Marks</td></tr>
<tr><td rowspan="3">End Term Examination</td><td rowspan="3">60 Marks</td><td>Experiment 80 Marks</td><td>Experiment 40 Marks</td><td>Rationale and quality of project work: 100 Marks (based on the presentation)</td><td rowspan="3">50 Marks</td></tr>
<tr><td>Practical Record 10 Marks</td><td>Practical Record 5 Marks</td><td>Dissertation Report 60 Marks</td></tr>
<tr><td>Viva-Voce 10 Marks</td><td>Viva-Voce 5 Marks</td><td>Viva-Voce 40 Marks</td></tr>
<tr><td>Total no of papers in all semesters</td><td>14</td><td>3</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Total marks</td><td>1400 Marks</td><td>300 Marks</td><td>50 Marks</td><td>200 Marks</td><td>50 Marks</td></tr>
<tr><td>Grand Total</td><td colspan="5">2000 Marks</td></tr>
<tr><td>Total Credits</td><td colspan="5">96</td></tr>
</table>

Scheme of Internal Evaluation (Theory):

Each theory paper consists of five units and irrespective of the credit hours assigned, will be of 100 marks, out of which, 40 will be internal marks (continuous evaluation) and 60 will be end term examination marks. There will be three components of internal evaluation – Quiz, Mid Term Written Test and Presentation & Home Assignment as per the details below.

Component	Unit(s)	Marks	Remarks
Quiz – I	I	10	Best of the two quizzes of 10 marks each will be considered
Quiz – II	III		
Mid Term (Written)	I & II	20	Students are required to make presentations and home assignments on selected topics from the **self-study** section
Presentation & Home Assignment	All	10	
Total	**I – V**	**40**	

VALUE-ADDED/ ADD-ON COURSES

A student of M. Sc. in Environmental Science shall undertake one or more value-added courses of 2 – 4 credits each offered by the University and an online course of up to 4 credits under the MOOC platform, preferably during the 2nd/ 3rd semester, the performance of which may be reflected in the final grade sheet issued by the University or in a separate report card issued for the purpose by the competent authority. Fees towards enrollment and examination of such courses have to be borne by the concerned candidate.

SELF SYUDY

25% of each unit of a theory paper is earmarked for self-study by students as per UGC directives. For completion of the portion in a particular semester, the course teacher is required to take one/ two introductory classes in the beginning, one/ two summarizing classes at the end and few doubt clearing classes in between, if required. Students are required to make presentation on selected topics from the self-study section during the class in order to assess their understanding of the subject and take remedial measures, if needed. The portion earmarked for self-study has been underlined in the syllabus.

Sub. Code	Paper Name	Credit	Internal Mark	End term Mark
ENS-411	Fundamentals of Ecology & Environmental Science	4	40	60

Objectives	To expose the students about the fundamentals of ecology and environmental science
Pre-Requisites	Basic knowledge on ecology and environmental science
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
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 it's 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.	12
II	**Ecosystem Dynamics** 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;	8
III	**Biomes and Biogeographic realm** Concept of Biomes their classification and distribution; Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest, Chapparal, Savanna, Tropical rain forest, Highland Icy Alpine biome; Biogeographic realm and provinces (ecoregions) of the world (Udvardy, 1975), Global 200 list of eco-regions identified by WWF .	8
IV	**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.	10
V	**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.	10

Text Books

1. Environmental Science by SC Santra, Central Publ.
2. Ecology and Environmental Science by SVS Rana, PHI pvt. ltd.
3. Fundamentals of Ecology by EP Odum, Natraj Publ.
4. Ecology and Environment by P D Sharma, Rastogi publication

Reference Books

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. Environmental Science by Cunningham and Cunningham
4. Ecology: Principles and Applications by J. L. Chapman, M. J. Reiss, Cambridge University Press
5. Concepts of Ecology by EJ Kormondy, PHI
6. Sustainable Development by Kumar das, Reference Publ.
7. Ecology, Chemistry and Management of Environmental Pollution by MC Dash, Mac Millan

Course Outcome	At the end of the course, the students will be able to: i) Understand the origin of earth and evolution of life ii) Understand the dynamics of ecosystem iii) Understand the population and community ecology

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-412	Natural Resources and their Management	4	40	60

Objectives	To expose the students about the types of natural resources and their importance
Pre-Requisites	Basic knowledge about natural resources
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Mineral Resources** Ores and Minerals, Metal ores, Non metal minerals, Radioactive minerals, Fossil fuels (Coal: heating values grading of coal, Shale oil, Coal bed methane, Gas hydrates, Oil and Natural gas fractionation products, basic idea on Octane number, Cetane number, flash point and aniline point of liquid fuels, 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 the mines and mineral act 1957	10
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).	10
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).	10
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, Endangered and Extinct species, and their distribution in India;	14
V	**Biodiversity Conservation** CBD (Convention on Biological Diversity) and its goals, Man and Biosphere programme of UNESCO, Project tiger, Project Elephant, Crocodile conservation, GOI-UNDP Sea turtle project, indo rhino vision; Biosphere reserve, National Parks and Sanctuaries of India; Wild life protection act 1972, Forest conservation act 1980, Indian Forest Act-revised 1982, Biological diversity act 2002	

Text Books

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.

Reference Books

1. Biodiversity by Kumar and Asija, Agrobios publ.
2. Biodiversity Assessment and Conservation by PC Trivedi, Agrobios publ.

Course Outcome	At the end of the course, the students will be able to: i) Understand the significance of mineral resources and their management ii) Understand the significance of energy resources and their management iii) Understand the significance of biodiversity and their management

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-413	Atmospheric Chemistry, Meteorology and Climatology	4	40	60

Objectives	To expose the students about the chemistry and physics of atmosphere and how it controls climate
Pre-Requisites	Basic knowledge on intermediate level physics and chemistry
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
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)	10
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, Gradient wind flow, Geostrophic wind flow, Wind roses and their application	12
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, western disturbances, SW and NE Asian monsoon, Local winds); Oceanic circulation and climate (El Nino- La Nina and Southern oscillations, ENSO); Tropical cyclones;	10
IV	**World Climate and Weather Prediction** Classification of world climate- Koppen's and Thornthwaite' scheme; Agro-climatic Zones of India; Basic concepts on weather analysis and forecasting (short range predictions, long range predictions, weather radar-Doppler radar) and weather satellites -INSAT 3D	8
V	**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.	10

Text Books

1. The Atmosphere: An Introduction to Meteorology by FK Lutgen and EJ. Tarbuk, Pearson publ.
2. Environmental Meteorology by B. Padmanabha Murty, I.K. International Publishing House Pvt. Ltd.
3. Introduction to Environmental Engineering and Science by Gilbert M. Masters, Pearson Education

Reference Books

1. Meteorology Today: An Introduction to Weather, Climate, and the Environment by C. Donald Ahrens, Cengage Learning publ.
2. Physical Meteorology by H G Houghton, MIT Press
3. Basics of Atmospheric Science, by A. Chandrasekar, PHI publ.
4. The Monsoons by Dr P. K. Das, National Book Trust, New Delhi, India.

Course Outcome	At the end of the course, the students will be able to: i) Understand the structure composition and radiation physics of the atmosphere ii) Understand how temperature, pressure and humidity play their role in controlling the climate and other meteorological phenomena iii) Understand the chemical processes involved in the atmospheric phenomena.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-414	Air & Air Pollution Management	4	40	60

Objectives	To identify the pollutants of the atmosphere and address their management
Pre-Requisites	Basic knowledge on atmospheric composition and air quality
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Air Pollution** Air pollution and pollutants, Classification of air pollutants, Primary air pollutants (CO, CO_2, NOx, SOx, hydrocarbons, Particulate matter) and Secondary air pollutants (Smog, PAN, O_3, Formaldehyde), Sinks of atmospheric gases, Fate of air pollutants, 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, Air pollution episodes, Impact of air pollution on human health, plants and materials.	12
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; Air quality standards, Indian National Ambient Air quality standards, Air pollution index.	10
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, Motor Vehicle Act-2019, Noise Pollution rules 2000, UNFCCC, IPCC, Basic objectives or salient features of different international protocols related to atmosphere (Kyoto Protocol-1997, Paris Agreement-2015; Vienna Convention-1985 and Montreal Protocol-1987)	10
IV	**Radiation 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.	8
V	**Noise Pollution and their Management** Sources of noises pollution, Characteristics of sound; Monitoring and control of noise pollution, measurement of noise indices (L_{eq}, L_{10}, L_{90}, L_{50}, L_{DN}, TNI); Sound level meter, Loudness measurement, Noise levels in decibel scale; Industrial noise & vibrations and its reduction approaches and Prevention; Structure of human ear and hearing mechanism, Effect of noise & vibrations on human health,	8

Text Books

1. Introduction to Environmental Engineering and Science by Gilbert M. Masters, Pearson Education
2. Environmental Chemistry by AK Dey, New age International (P) Ltd
3. Environmental Chemistry – Sodhi
4. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publishing House.

Reference Books

1. Air Pollution by VP Kudesia, Pgagati Prakashan
2. Noise Pollution by VP Kudesia, Pgagati Prakashan
3. Environmental Radiation and Thermal Pollution by GR Chhatwal et al. Anmol Publications
4. Environmental Noise Pollution and its Control GR Chhatwal et al. Anmol Publications

Course Outcome	At the end of the course, the students will be able to: I) Understand the nature of air pollutants and their management options Ii) Understand the radiation and noise pollution and their management options Iii) Understand the national & international legislations, policies for air pollution management

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-415	Laboratory and Field Techniques/Practical	8	00	100 Experiment : 80 Marks, Practical Record: 10 Marks Viva-Voce: 10 Marks

Objectives	To expose the students about the practical methods related to the theory papers ENS 411 to ENS 414
Pre-Requisites	Basic knowledge on the theory papers (ENS 411 to ENS 414)
Teaching Scheme	Laboratory based practical experiments and field works will be carried out.

Detailed Syllabus

List of practical experiments/ laboratory works	**Hours**
1. Determination of minimum size of a quadrate 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 SOx, NOx 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 CO_2 in supplied water sample. 13. Identification of mineral samples 14. Identification of monocot and dicot plants with the help of flora book	

Course Outcome	At the end of the course, the students will be able to: i) Determine the characteristics of a community of an ecosystem ii) Measure the presence of some of the air pollutants in the atmosphere iii) Monitor some of the meteorological parameters such as rainfall, temperature, humidity, wind pattern etc.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-421	Aquatic Ecology & Water Pollution Management	4	40	60

Objectives	To understand the aquatic habitats, pollution of the water bodies and their management.
Pre-Requisites	Basic knowledge on chemistry and physics of water, ecosystem components etc.
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
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 Dracy's law, Basic concepts of cone of depression, Ghyben-Herzberg relation between fresh-saline water, Salt water intrusion in coastal areas); Urban hydrology (Changes forced to hydrological setting due to urbanization and its mitigation) Major basins and ground water provinces of India.	12
II	**Aquatic ecosystems I** 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;	8
III	**Aquatic ecosystems II** 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.	8
IV	**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, IS:10500,2012); Basics of water sampling.	10
V	**Waste water treatment process and Water Pollution and Resource 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 Act 1974, Water conservation methods-Rain water harvesting and ground water recharge; National river conservation plan- Namami Gange and Yamuna Action Plan.	10

Text Books

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

Reference Books

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

Course Outcome	At the end of the course, the students will be able to: i) Understand the hydrological settings in the environment ii) Understand the characteristics of various aquatic ecosystems iii) Understand the water pollution and its management options

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-422	Envirometrics, Environmental Modeling & Computer Applications	4	40	60

Objectives	To enable students to analyze environmental data using statistical tools and computer applications
Pre-Requisites	Basic knowledge of statistics and computer applications
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Basics Envirometrics** Basic elements and tools for analysis in envirometrics; Concept of population, Sample, Sample designing; Measures of Central Tendency (Arithmatic mean, mode and median); Dispersion of Data; Standard Deviation, Coefficient of Variation; Confidence interval of mean;	8
II	**Advanced Envirometrics** 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, Test of Hypothesis, Test of Significance, Type I and Type II errors.	8
III	**Theoretical Distributions** Moments-measures of skewness and kurtosis, 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);	10
IV	**Environmental Modeling** Introduction to Environmental modeling; Approaches for Development of Models, Simple and Multiple Regression Models, Model validation and forecasting; Models of population Growth and interaction, Lotka-Voltera pray-predator Model, Leslie's matrix model; Point source pollution model, line source model, Box dispersion model.	10
V	**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.	10

Text Books

1. Statistical methods by S.P. Gupta. S. Chand Publications
2. Fundamentals of Biostatistics, by Khan and Khanun, Ukaaz Publications/bsp Books Pvt. Ltd.
3. Methods in Biostatistics for Medical Students and Research Workers by BK Mahajan

Reference Books

1. Programming in ANSI C by E. Balaguruswami Tata, Mgraw Hill publisher.
2. Basic Statistics by Gun, Gupta & Dasgupta, World press
3. Introduction to Biostatistics by Robert R. Sokal, F. James Rohlf, W.H. Freeman & Company
4. Statistics for Environmental Biology and Toxicology by WW Piegorsh and AJ Bailer

Course Outcome	At the end of the course, the students will be able to: i) Understand the application of statistics in analyzing environmental data ii) Understand the concept of environmental modeling. iii) Understand the application of computers in handling large data

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-423	Soil & Soil Pollution Management	4	40	60

Objectives	To understand the ecology of soil, pollution of the soil environments and their management.
Pre-Requisites	Basic knowledge on soil properties
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
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; Chemical properties of soil: Mineral (inorganic) constituents of soil, Clay minerals, Cation exchange capacity, Soil pH (acidity, alkalinity, salinity and sodicity), Soil organic matter; Physical properties of soil (colour, textural classes, structure, particle density, bulk density, porosity); Soil water; Soil aeration and temperature; Soil classification, Soil types of India.	10
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.	10
III	**Biogeochemical cycles** Concept of soil quality and soil health; Carbon Cycle and the Role of Soil Microbes; Nitrogen Cycle and the Role of Soil Microbes: Nitrification and Denitrification, Biological Nitrogen fixation; Sulfur Cycle and the Role of Microbes; Role of Sulphur Phosphorus and Potassium in plant nutrition and soil fertility; Soil nutrient management;	8
IV	**Soil Health, Degradation, Pollution and Soil restoration** 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.	8
V	**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.	10

Text Books

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

Reference Books

1. Soil Pollution and Organisms by PC Mishra, Ashish publishing House
2. Soil Microbiology by NS Subba Rao, Oxford & IBH publ.
3. Soil Fertility by CE Miller, Biotech publ.
4. Soil Biology by Brady Burges and Raw, Academic Press

Course Outcome	At the end of the course, the students will be able to: i) Understand the physio-chemical and biological properties of soil. ii) Understand the pollution of the soil environments and their management. iii) Understand the solid waste management options

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-424	Environmental Geology and Instrumentation Techniques	4	40	60

Objectives	To have basic understanding about the geological features of earth
Pre-Requisites	Basic understanding about environment and its components
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Introductory Environmental Geology** Structure and composition of earth's interior, Seismicity and earth's interior; Plate tectonics- sea floor spreading- plate boundaries, Paleomagnetism; Continental drift and evolution of continents, Crustal deformation (Faults and Folds) and Mountain building; Basic features of different landforms: Fluvial landforms, Karst topography, Glacial Landforms and Aeolian landforms.	10
II	**Rocks and Minerals** 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;	**8**
III	**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; Sources and impact of Marine pollution, methods of abatement of Marine pollution.	15
IV	**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); Digital image processing and ground truthing, Advantages and applications of remote sensing and GIS in environmental management.	10
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, FTIR); High volume air sampler, Respirable dust sampler, Electrostatic precipitator.	12

Text Books

1. Understanding Earth by Grotzinger, Jordan, Press & Siever; WH Freeman and Company
2. Physical Geography by Sabinder Singh, Pryag Publ.
3. The Earth's dynamic surface by K Siddhartha, Kishalaya Publications
4. Oceanography-an introduction to marine science by Tom Garrison, Brooks/Cole-Thomson Learning
5. Remote Sensing by Meenakshi Kumar, NCERT
6. Text book of Remote Sensing and Geographical Information System, M Anji Reddy, BS Publications
7. Handbook of Analytical Instruments by RS Khandpur, Tata Mc Graw Hill Edu Pvt Ltd

Reference Books

1. Text book of Physical Geology by G B Mohapatra, CBS Publ.
2. Earth's Dynamic System by Hamblin & Christiansen, Prentice Hall
3. Introduction to Geochemistry by Mason & Moore
4. Environmental Geology by C W Montgomery, Mc. Graw Hill International
5. Remote Sensing by BC Panda, Viva Books pvt. Ltd.
6. Remote Sensing: Principles and Applications by FF Sabbins, Freeman
7. Fundamental of molecules spectroscopy by CN Banwell McGraw Hill
8. Modern Methods of chemical analysis RL Recsok & LD Shields, John Willey & sons, Inc

Course Outcome	At the end of the course, the students will be able to: i) Understand the geological (geochemical and geo-morphological) features of earth ii) Understand the role of oceans in our envoronment iii) Understand the use of remote-sensing, GIS and other analytical tools to study the geological features of earth.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-425	Laboratory and Field Techniques/Practical	8	00	100 Experiment : 80 Marks, Practical Record: 10 Marks Viva-Voce: 10 Marks

Objectives	To expose the students about the practical methods related to the theory papers ENS 421 to ENS 424.
Pre-Requisites	Basic knowledge on the theory papers (ENS 421 to ENS 424)
Teaching Scheme	Laboratory based practical experiments and field works will be carried out.

Detailed Syllabus

List of practical experiments/ laboratory works	**Hours**
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.	

Course Outcome	At the end of the course, the students will be able to: i) Determine the some physiochemical and biological properties of soil ii) Determine the some physiochemical and biological properties of water and waste water iii) Determine the some of the statistical parameters of large samples

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-531	Environmental Biochemistry & Toxicology	4	40	60

Objectives	To understand the biochemical and toxicological processes in organisms those are influenced by the environment.
Pre-Requisites	Preliminary knowledge on biochemistry.
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Basic Environmental Biochemistry** Enzymology (Classification and properties of enzymes, active sites, mechanism of enzyme catalysis, Michaelis –Menten Equation, Km, Vmax, Linewever and Burk plot, Eddy-Hoffstee plot, enzyme inhibition, allostoric enzymes, multi enzyme complex); Biochemistry of stress (Altered membrane permeability, free radical formation, lipid peroxidation, lysosomal degradation, superoxide dismutase).	10
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; Therapeutic index, Factors that influence toxicity (biological, chemical, ecological); Bio-transformation, Bio-accumulation, Bio-magnification.	12
III	**Toxic Action of Pollutants** Toxic action of Insecticides (Organochlorine, organophospahate, carbamate and pyrethroids), Toxic action of herbicides, Toxic action of heavy metals and Metalloids (Lead, Mercury, Cadmium, Chromium, Arsenic, Selenium), Toxic action of CO, O_3, PAN, VOC, POPs (PCB, PAH, Dioxins), Fluoride and Iodine related diseases, 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)	14
IV	**Chromatographic techniques** Basic concepts of chromatography and associated , Size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, paper chromatography, Thin layer chromatography, Gas-chromatography, Liquid chromatography, HPLC	8
V	**Microscopy and Molecular biology techniques** Elementary idea on Advanced microscopic techniques (SEM, TEM, Fluorescence microscopy, Confocal microscopy), Electrophoresis and Blotting (Basic concepts, Agarose gel electrophoresis, Native PAGE, SDS-PAGE, 2D-GE, Southern, Northern, Western blots); DNA isolation, Polymerase Chain Reaction.	8

Text Books

1. Lehninger Principles of Biochemistry by DL. Nelson & MM. Cox, WH Freeman
2. Principles and techniques of Practical Biochemistry by Wilson and Walker, Cambridge Univ. Press
3. Environmental Biology and Toxicology by P.D. Sharma, Rastogi Pupl.
4. Concepts of Toxicology by Omkar, Vishal Publ.

Reference Books

1. Toxicology - principles & applications - Niesink & Jon devries
2. Environmental Toxicology by W.G. Lendis, Lewis Publ.
3. Physiology of abiotic stress in plants by Dwivedi and Dwivedi, Agrobios (India)

Course Outcome	At the end of the course, the students will be able to: i) Understand the basic concepts of enzymology and stress biology. ii) Understand the basic concepts toxicology and toxic actions of environmental pollutants. iii) Understand the analytical techniques frequently used in environmental biology.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-532	Environmental Impact Assessment	4	40	60

Objectives	To understand the concepts of Sustainable Development and Environmental Impact Assessment.
Pre-Requisites	Basic idea on the components of environment, natural resources and environmental pollution
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Environmental Legislations in India** Environmental laws of India: Article 48A and 51A of Indian constitution, National environmental policy-2006, National Water Policy-2002, National Forest Policy-1988; India's National Action Plan on Climate Change (including eight national missions), Environmental Protection Act and Rules 1986; Latest EIA Notification (2006), and statutory requirements of EIA, CRZ notification 1991 and its amendments;	10
II	**EIA analysis and Methodologies** Origin and development of EIA: relationship of EIA to sustainable development; Objectives of EIA, 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); Preparation of Environmental Impact statement (EIS).	12
III	**Environmental Planning** Designing of Environmental Management Plan (EMP), Project planning, Risk assessment of projects, Rural and urban planning, Land use pattern and policies; Environmental Management System standards (ISO14000 series).	8
IV	**Environmental Auditing** 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,	8
V	**Environmental Conventions and Agreements on Sustainable Development** Environment and economic resources, ecosystem services; Concepts of carrying capacity and global commons; 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; United Nations Millennium Development Goals and Sustainable Development Goals; Environmental priorities of India and Odisha.	10

Text Books

1. Sustainable Development by Kumar Das, Reference Publ.
2. Environmental and Social Impact Assessment by CJ Barrow
3. Environmental Impact Assessment by RR Barthwal, New Age International Pvt. Ltd
4. Environmental Impact Assessment by PR Trivedi, APH Publishing Corporation
5. Environment and Pollution Law manual by SK Mohanty, Universal Law Publisher Ltd.

Reference Books

1. Sustainable Development of the Biosphere by WC Clark and RE Munn, Cambridge University Press
2. The Hand Book of Environmental Economics by W Daniel, Black well

Course Outcome	At the end of the course, the students will be able to: i) Know important international Conventions and Agreements on Environment and Environmental Legislations in India ii) Understand the procedure of getting Environmental Clearance in India iii) Understand the concepts of Environmental Impact Analysis, Environmental Planning and Auditing

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-533	Environmental Hazard, Risk & Disaster Management	4	40	60

Objectives	To understand basic concepts of Environmental Hazards, Risks & Disaster Management
Pre-Requisites	Basic knowledge on geological processes, environmental pollutions etc.
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
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.	10
II	**Geological Hazards** ***Earthquake:*** Global distribution pattern, causes and consequences, Pacific ring of fire, Richter scale, Seismic Zonation of India, preparedness and management, ***Volcanic activity:*** Global distribution pattern, causes and consequences, type of volcano and volcanic ejecta, preparedness and management, ***Tsunami:*** Causes and consequences, preparedness and management, tsunami warning system, ***Landslide:*** Causes and consequences, Types of landslide, preparedness and management,	8
III	**Weather Disasters** ***Tropical Cyclone:*** Causes and consequences, Naming of tropical cyclones, preparedness and management, ***Cloudburst and Thunderstorm:*** Causes and consequences, preparedness and management, ***Flood and Drought:*** Causes and consequences, preparedness and management, ***Cold and heat hazards:*** Causes and consequences, preparedness and management, ***Forest fire***: Causes and consequences, preparedness and management,	8
IV	**Technological Disasters** 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), Love Canal Disaster, Minamata Disaster, Fukusima Daiichi nuclear disaster (2011).	10
V	**Environmental and Occupational Health Hazards** 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.	12

Text Books

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. Occupational health: A manual for primary health care workers, by World Health Organization

Reference Books

1. Environmental Geology by C W Montgomery, Mc. Graw Hill International
2. The Atmosphere: An Introduction to Meteorology by FK Lutgen and EJ. Tarbuk, Pearson
3. Oceanography-an introduction to marine science by Tom Garrison, Brooks/Cole-Thomson Learning
4. Understanding Earth by Grotzinger, Jordan, Press & Siever; WH Freeman and Company
5. Industrial safety and health, David L. Goetsch, Macmillan Publishing Company.
6. Handbook of environmental health and safety, Vol I & II, H Kooren & M Bisesi, Jaico Publ. House.

Course Outcome	At the end of the course, the students will be able to: i) Understand causes consequences and management of natural disasters ii) Understand causes consequences and management of technological or industrial disasters iii) Understand causes consequences and management of environmental and occupational health hazards

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-534	Environmental Education for Future Sustenance	4	40	60

Objectives	To aware students other than the M. Sc. Environmental Science course about the importance of environment and how to preserve it.
Pre-Requisites	Choice based paper for the students other than the M. Sc. Environmental Science course
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Environment and Ecosystem** Introduction to Environmental Science, Scope, Components of Environment (Biosphere, Hydrosphere, Lithosphere, Atmosphere), Concepts of Ecosystem, Food Chain, Food Web, Ecosystem Services, Ecological Foot Prints;	8
II	**Natural Resources:** Concept of Resources, Renewable and Non-renewable Resources, Conventional and alternative energy resources, Biodiversity - its importance and conservation.	8
III	**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.	8
IV	**Environmental Policies, legislations and International Agreements on Environment** Environmental Protection Act and Rules 1986, 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.	10
V	**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	8

Text Books

1. A text book on Environmental Engineering by HD Kumar and SP Adhikari, India Tech publ.
2. Environmental Science by SC Santra, Central Publ.
3. Ecology and Environmental Science by SVS Rana, PHI pvt. ltd.
4. Ecology and Environment by P D Sharma, Rastogi publication
5. Environmental Awareness and Education by D DasGupta, Agrobios

Reference Books

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. Environmental Science by Cunningham and Cunningham
4. Ecology: Principles and Applications by J. L. Chapman, M. J. Reiss, Cambridge University Press
5. Sustainable Development by Kumar Das, Reference Publ.
6. Ecology, Chemistry and Management of Environmental Pollution by MC Dash, Mac Millan.

Course Outcome	At the end of the course, the students will be able to: i) Understand the components of environment and how the ecosystem functions ii) Understand the global environmental issues and how human activities are involved iii) Understand the concept of Sustainable Development and how Environmental Policies, legislations and International Agreements work to achieve sustainable development.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-435	Laboratory and Field Techniques/Practical	8	00	100 Experiment : 80 Marks, Practical Record: 10 Marks Viva-Voce: 10 Marks

Objectives	To expose the students about the practical methods related to the theory papers ENS 531 to ENS 533.
Pre-Requisites	Basic knowledge on the theory papers (ENS 531 to ENS 533)
Teaching Scheme	Laboratory based practical experiments and field works will be carried out.

Detailed Syllabus

List of practical experiments/ laboratory works	**Hours**
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 CO_2 evolution from soil with respect to pesticides. 7. Determination of CO_2 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	

Course Outcome	At the end of the course, the students will be able to: i) Use some of the basic tools of biological science research such as chromatography, spectrophotometry etc. ii) Carryout preliminary toxicological assays such as determination of LD50 values of toxic chemicals iii) Prepare an EIA report

Specialization – (A) Industrial Pollution Control and Management

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-541-A	Industrial Pollution Control	4	40	60

Objectives	To understand the industrial pollution control approaches
Pre-Requisites	Basic knowledge on different classes of environmental pollutants
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Waste Management Rules and Regulations I** 17 categories of most polluting industries(CPCB), Categories of industries that require environmental clearance as per impact assessment notification 2006, Environmental protection Act 1986; The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991; Coal mines regulations 1957.	8
II	**Waste Management Rules and Regulations II** Hazardous and other Waste (Management & trans boundary movement) rules-2016; Elementary idea on Plastic waste Management rules-2016, The Solid waste management rules 2016, The bio-medical waste management rules 2016, E waste management rules 2016, The construction and demolition waste management rules 2016,	8
III	**Industrial water pollution control** 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;	12
IV	**Industrial air pollution control** Permissible limit of ambient air quality and emission standards, Monitoring technique of particulate and gaseous pollutants (SPM, RSPM, SO_2, 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 pants, Textile and Generator;	10
V	**Industrial solid wastes pollution control** 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; Recycle and Reuse of waste such as peletilisation, energy recovery, vermicomposting, and its benefits.	10

Text Books

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. Pollution Control and Management in Industries by Trivedi
5. Environment and Pollution Law manual by SK Mohanty, Universal Law Publisher Ltd.

Reference Books

1. Process Engineering for Pollution Control and Waste Minimization by DL Wise
2. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ House
3. Environmental Protection and Laws by CS Mehta
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.

Course Outcome	At the end of the course, the students will be able to: i) Understand the Guidelines for Environmental clearance and Industrial waste management ii) Understand the Industrial water and air pollution control techniques iii) Understand the solid waste control techniques.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-542-A	Environmental Management Systems for Industries	4	40	60

Objectives	To understand the Environmental Management Systems for Industries
Pre-Requisites	Basic knowledge on Environmental Impact assessment, environmental auditing etc.
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
I	**Environmental Management in Industries** Development of ISO 14000 series, EMS Accreditation and certification process; Elements of Environmental Management System (EMS) [Environmental Policy, Environmental planning, Implementation and operation, Checking and corrective action, Continuous performance evaluation];	10
II	**Corporate Environmental Policy** Corporate Social Responsibility (CSR) with specific reference to Environmental Responsibility; Section 135 of India's Companies Act, Green rating project and Green Marketing, Green Building-GRIHA rating norms.	
III	**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	10
IV	**Sanitation and Health Management** Health hazards due to improper sanitation and impart on workers, comfort and productivity; Water borne diseases (Etiology of Bacillary dysentery, Amoebic dysentery, Cholera, Hepatitis) their transmission and prevention, Vector borne diseases (Etiology of Dengue, Chikungunya, Japanese encephalitis) their transmission and prevention.	10
V	**Occupational Health Hazards and Management in Industries** Definition of Occupational Health, Potential Occupational health hazards; Example of Occupational diseases (Pulmonary dust diseases-Asbestosis, Silicosis, Black Lungs disease(CWP); locomotors disorders- carpal tunnel syndrome, back pain; AIDS, Hypertension and coronary heart disease); Exposure (to pollutants) measurement techniques, of workers in industry and mines and its management;	12

Text Books

6. Industrial Effluents by Mani Vasakam, Shakti publ.
7. Industrial Pollution by VP Kudesia & RK Kudesia, Himalaya Publishing House
8. Introduction to Environmental Engineering and Science by Gilbert M. Masters, Pearson Education
9. Pollution Control and Management in Industries by Trivedi
10. Environment and Pollution Law manual by SK Mohanty, Universal Law Publisher Ltd.

Reference Books

7. Process Engineering for Pollution Control and Waste Minimization by DL Wise
8. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ House
9. Environmental Protection and Laws by CS Mehta
10. Environmental Engineering and Safety by BK Nanda & T Biswal, BK publications
11. Environmental Engineering by SK Garg, Khanna Publ.
12. Mining Environment in India by SC Joshi et. al. Himalaya Research Publ.

Course Outcome	At the end of the course, the students will be able to: i) Understand work environment management in Industries. ii) Understand occupational health hazards and their management in industries iii) Understand the sanitation and safety management in industries.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-543-A	Grand Viva	2	00	50

Objectives	To evaluate the overall knowledge retained by the candidate at the end of the two year M. Sc. Course.
Pre-Requisites	Basic knowledge on all the theory and practical papers taught during the two year course duration.
Teaching Scheme	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.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-544-A	Laboratory and Field Techniques/Practical	4	00	50 Experiment : 40 Marks, Practical Record: 5 Marks Viva-Voce: 5 Marks

Objectives	To expose the students about the practical methods related to the theory papers ENS 541-A and ENS 542-A.
Pre-Requisites	Basic knowledge on the theory papers (ENS 541-A and ENS 542-A)
Teaching Scheme	Laboratory based practical experiments and field works will be carried out.

Detailed Syllabus

List of practical experiments/ laboratory works	**Hours**
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	

Course Outcome	At the end of the course, the students will be able to: i) Determine concentration of different pollutants in water and wastewater sample. ii) Determine organic pollutant load in the soil sample. iii) Determine noise level, meteorological parameters, land use pattern of a study area

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-545-A	Dissertation Work	10	00	200 Rationale and quality of project work:100 Marks (based on the presentation) Dissertation Report : 60 Marks Viva-Voce : 40 Marks

Objectives	To enable to the students design and execute a small research project.
Pre-Requisites	Through understanding about the laboratory and field techniques taught during all the semesters of the course.
Teaching Scheme	At the beginning of the Third 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 rationale and quality of project work done, project report and performance in the presentation (Viva-Voce), the Board will award the mark.

Specialization – (B) Environmental Biotechnology

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-541-B	Biotechnological Approach for Environmental Management	4	40	60

Objectives	To understand different Biotechnological Approach for Environmental Management
Pre-Requisites	Basic knowledge on Biotechnology
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
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	10
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.	10
III	**Microbial Interactions with Organic 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;	8
IV	**Microbial Interactions with Inorganic 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.	8
V	**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 biobutanols): types of feedstock and fermentation of feedstock into bioalcohols; Biodiesel (fatty acid methyl ester): types of feedstock and transesterification of feedstock into biodisel; Sources and processing of Biogas (Biomethane) and Biohydrogen; Basic concepts on microbial fuel cells.	12

Text Books

1. Textbook of Environmental Biotechnology by PK Mohapatra, IK International
2. Elements of Biotechnology by P.K.Gupta, Rastogi publication.
3. Environmental Biotechnology: Basic Concepts and Applications by I S Thakur, IK International
4. Introduction to Environmental Biotechnology by KC Chatterji, PHI Pvt. Ltd.

Reference Books

1. Microbial Biotechnology by Glazer,A.N. and Nikaido; Freeman and company.
2. Microbial degradation of Xenobiotics by T Leisinger, Academic Press
3. Vermitechnology by PK Gupta, Agrobios
4. A handbook of Bioenergy crops by V.N Meena Devi et. al., Agrobios (India).
5. Advanced Environmental Biotechnology by SK Agrawal, APH publishing Corporation
6. Bioremediation by H Baker and DS Herson, Mc Graw Hill
7. Environmental Biotechnology: Theory and Application by GM. Evans, JC. Furlong, IK International

Course Outcome	At the end of the course, the students will be able to: i) Understand the basic concepts of Environmental biotechnology, Intellectual Property Rights (IPR) and patenting etc. ii) Understand the application of Bio-indicators and Biosensors in Environmental Monitoring iii) Understand the application of microbes in environmental remediation iv) Understand the need and scope of eco-friendly biofuels and bioenergy.

Specialization – (B) Environmental Biotechnology

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-542-B	Waste Management & Bioremediation	4	40	60

Objectives	To understand the basic concepts and applications of bioremediation and waste management techniques
Pre-Requisites	Basic knowledge on biotechnology
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Unit	Topics	Hours
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)	10
II	**Biotechnology for Solid Waste 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.	10
III	**Biotechnology for Industry and Air Pollution Management** Bio-scrubbers, bio-filters and bio-trickling filters for air pollutants and particulate matter control; Microbial desulfurization of coal; 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);	10
IV	**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.	10
V	**Cleaner Technology 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, CO_2 sequestration by microalgae and cyanobacteria)	10

Text Books

1. Textbook of Environmental Biotechnology by PK Mohapatra, IK International
2. Elements of Biotechnology by P.K.Gupta, Rastogi publication.
3. Environmental Biotechnology: Basic Concepts and Applications by I S Thakur, IK International
4. Introduction to Environmental Biotechnology by KC Chatterji, PHI Pvt. Ltd.

Reference Books

1. Microbial Biotechnology by Glazer,A.N. and Nikaido; Freeman and company.
2. Microbial degradation of Xenobiotics by T Leisinger, Academic Press
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4. A handbook of Bioenergy crops by V.N Meena Devi et. al., Agrobios (India).
5. Advanced Environmental Biotechnology by SK Agrawal, APH publishing Corporation
6. Bioremediation by H Baker and DS Herson, Mc Graw Hill
7. Environmental Biotechnology: Theory and Application by GM. Evans, JC. Furlong, IK International

Course Outcome	At the end of the course, the students will be able to: i) Understand the basic concepts and applications of bioremediation ii) Understand the basic methods to manage waste iii) Understand the application of Cleaner Technology for Industry and Agriculture

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-543-B	Grand Viva	2	00	50

Objectives	To evaluate the overall knowledge retained by the candidate at the end of the two year M. Sc. Course.
Pre-Requisites	Basic knowledge on all the theory and practical papers taught during the two year course duration.
Teaching Scheme	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.

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-544-B	Laboratory and Field Techniques/Practical	4	00	50 Experiment : 40 Marks, Practical Record: 5 Marks Viva-Voce: 5 Marks

Objectives	To expose the students about the practical methods related to the theory papers ENS 541-B and ENS 542-B.
Pre-Requisites	Basic knowledge on the theory papers (ENS 541-B and ENS 542-B)
Teaching Scheme	Laboratory based practical experiments and field works will be carried out.

Detailed Syllabus

List of practical experiments/ laboratory works	**Hours**
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	

Course Outcome	At the end of the course, the students will be able to: i) Analyse the microbial load in water, soil, air and milk sample. ii) Estimate reducing sugars, and soluble proteins in biological samples iii) Estimate Hemoglobin content in blood sample

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-545-B	Dissertation Work	10	00	200 Rationale and quality of project work:100 Marks (based on the presentation) Dissertation Report : 60 Marks Viva-Voce : 40 Marks

Objectives	To enable to the students design and execute a small research project.
Pre-Requisites	Through understanding about the laboratory and field techniques taught during all the semesters of the course.
Teaching Scheme	At the beginning of the Third 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 rationale and quality of project work done, project report and performance in the presentation (Viva-Voce), the Board will award the mark.

Industrial Safety Management

Sub. Code	Paper Name	Credit	Internal Mark	End Term Mark
ENS-VAC-401	Industrial Safety Management	2	50	50

Objectives	To understand the significance of Industrial safety and get an elementary idea on the prevention and control of Accidents in Industries
Pre-Requisites	Preliminary knowledge on Environmental Pollution.
Teaching Scheme	Regular class room lectures with use of ICT tools as and when required.

Detailed Syllabus

Module 1: Safety Laws

The basic Purpose and Provisions of: Factories Act and Rules, Employees State Insurance Act, The Public Liability Insurance Act 1991 and Rules, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules 2000, The Batteries (Management and Handling) Rules, Mines Act 1952 Mine Rules – 1955, Coal Mine Regulation-1957, Chemical Accidents (Emergency Preparedness, Planning and Response) Rules 1996, Environmental protection Act 1986. Hazardous and other Waste (Management & trans boundary movement) rules-2016.

Module 2: Industrial Hazards, Risks, Accidents and their Assessment

Concepts of Hazards, Risks and Safety; Hazard and Risk Assessment Techniques; Accident Causative Factors; Principles of Accident Prevention, Behaviour Based Safety (BBS); Safety Management: Management Information System (MIS) for Safety; Accident Investigation, Analysis and Reporting;

Module 3: Measures of Safety in Industry

Ventilation and Heat Control, Electrical Safety, Noise and Vibration control, Fire and Explosion safety, Requirements of Machine Guarding, Types of Chemical Hazards & Controls, Air Pollutant control; Water Pollutant control; Radiation pollution Control

Module 4: Industrial Hygiene and Health

Industrial Hygiene and pollution, Health hazards due to improper sanitation and pollution; Physiology of Work, Definition of Occupational Health, Ergonomics and other potential Occupational Health Hazards in Industries; Example of common occupational diseases in Industry;

Module 5: Personal Protective Equipment and First Aid

Non Respiratory Personal Protective Equipments; Respiratory Personal Protective Equipments; Need of the First Aid, General Principles for Rendering First Aid, Electrical Injuries, Artificial Respiration, Burns and Scalds, Poisoning - First Aid and Antidotes

Reference Book:

1. Fundamentals of Industrial safety & health by K.U. Mistry.

Course Outcome	At the end of the course, the students will be able to get an idea about i) Different legislations related to environmental safety ii) iii) Estimate Hemoglobin content in blood sample