M. Sc. Programme in Environmental Science

COURSES OF STUDY

(Effective from Academic Session:2023-24)
(BATCH: 2023-2025)

P. G. Department of Environmental Sciences

SAMBALPUR UNIVERSITY

Jyoti Vihar-768019, Sambalpur, Odisha

COURSE AT A GLANCE

SUBJECT: **M.Sc. Environmental Science**

ACADEMIC SESSION: **2023-24 and 2024-2025 (Batch:2023-25)**

First Semester-December,2023

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS. 411C	Fundamentals of Ecology and Environmental Sciences	4	PT-20, ET-80	100
ENS. 412C	Remote Sensing and Geographical Information System	4	PT-20, ET-80	100
ENS. 413C	Instrumental Techniques : Principle and Application	4	PT-20, ET-80	100
ENS. 414C	Methods of Analysis of Environmental Samples	4	PT-20, ET-80	100
ENS. 415C	Laboratory Practical and field studies on ENS 411 C to ENS 414 C	4	ET-100	100
ESDMS 419	Environmental Field Survey	2	PT-40, ET-60	100
	TOTAL CREDIT HOUR	**22**		

Second Semester-April, 2024

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS. 421C	Fundamentals of Soil Science	4	PT-20, ET-80	100
ENS. 422C	Nonrenewable and perpetual Energy Resources	4	PT-20, ET-80	100
ENS. 423C	Data Analysis in Environmental Sciences	4	PT-20, ET-80	100
ENS. 424C	Laboratory Practical on ENS 421 C to ENS 423C including Computer application in Data Analysis	4	ET-100	100
ENS. 425C	Summer Training and Project Report/ Term Paper to be evaluated by Departmental Teachers	2	ET-100	100
ENS. 426C	Seminar (to be evaluated by Departmental Teachers)	2	ET-100	100
IDC <Code as per the course opted>	Interdisciplinary Course	3	PT-10, ET-40	50
	TOTAL CREDIT HOUR	**23**		

Third Semester-December, 2024

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS. 511C	Environmental Pollution	4	PT-20, ET-80	100
ENS. 512C	Forest and Wild Life Ecology	4	PT-20, ET-80	100
ENS. 513C	Environmental Toxicology	4	PT-20, ET-80	100
ENS. 514C	Disaster Management	4	PT-20, ET-80	100
ENS. 516C	Laboratory Practical & field studies on ENS 511 C and 514C	4	ET-100	100
EDPS 439	Entrepreneurship Development	2	PT-40, ET-60	100
MOOCs <Code as per the course opted>	MOOC Course is to be opted by the candidate <One Number>	3	ET-100	100
	TOTAL CREDIT HOUR	**25**		

Fourth Semester-April, 2025

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS 521C	Project Work	4	ET-100	100
ENS 522C	Environmental Law and Society	4	PT-20, ET-80	100
Specialisation: A student shall opt for one of the following groups				
GROUP- A: Pollution Control and Environmental Biotechnology				
ENS.523 E	Pollution Control and Management	4	PT-20, ET-80	100
ENS.524 E	Environmental Biotechnology	4	PT-20, ET-80	100
ENS 525 E	Laboratory Practical and field studies relating to ENS.523 E & 524 E	4	ET-100	100
GROUP- B: Soil Biology and Biotechnology				
ENS 5267E	Soil Biology and Ecology	4	PT-20, ET-80	100
ENS 527 E	Soil Biotechnology	4	PT-20, ET-80	100
ENS 528 E	Laboratory Practical and Field studies on ENS 526 E & 527 E	4	ET-100	100
	TOTAL CREDIT HOUR	**20**		

TOTAL CREDIT HOURS FOR THE PROGRAMME = **90**

NON-CREDIT COURSES

I. Yuva Sanskar – 1st Semester – HOD of the concerned Department will take care of this course
II. N.C.C. / N.S.S./ Sports/ Performing Arts/ Yoga (only one is to be opted) – 2nd or 3rd Semester
The course in-charge of the University will float the course at the beginning of the semester

Course	In-Charge
NCC	Officer In-Charge NCC Cell
NSS	Coordinator NSS Cell
YOGA	Coordinator School of Performing Arts
SPORTS	Physical Education Officer
PERFORMING ARTS	Coordinator School of Performing Arts

Head of the Department

COURSES OF STUDY IN M.Sc. Environmental Sciences (Effective from 2023-2024 session)

(BATCH: 2023-2025)

Semester/ Course No	Title of the Course	Credit Hr.	Total CH
First Semester			
ENS. 411C	Fundamentals of Ecology and Environmental Sciences	4	
ENS. 412C	Remote Sensing and Geographical Information System	4	
ENS. 413C	Instrumental Techniques : Principle and Application	4	
ENS. 414C	Methods of Analysis of Environmental Samples	4	
ENS. 415C	Laboratory Practical and field studies on ENS 411 C to ENS 414 C	4	**20**
ESDMS 419	Environmental Field Survey	2	**22**
Second Semester			
ENS.421C	Fundamentals of Soil Science	4	
ENS.422C	Nonrenewable and perpetual Energy Resources	4	
ENS.423C	Data Analysis in Environmental Sciences	4	
ENS.424C	Laboratory Practical on ENS 421 C to ENS 423C including Computer application in Data Analysis	4	
ENS 425 C	Summer Training and Project Report/ Term Paper to be evaluated by Departmental Teachers	2	
ENS.426C	Seminar (to be evaluated by Departmental Teachers)	2	**20**
IDC <Code as per the course opted>	Interdisciplinary Course	3	**23**
Third Semester			
ENS.511C	Environmental Pollution	4	
ENS.512C	Forest and Wild Life Ecology	4	
ENS.513C	Environmental Toxicology	4	
ENS.514C	Disaster Management	4	
ENS.516C	Laboratory Practical & field studies on ENS 511 C and 514C	4	**20**
EDPS 439	Entrepreneurship Development	2	
MOOCs <Code as per the course opted>	MOOC Course is to be opted by the candidate <One Number>	3	**25**
Fourth Semester			
ENS 521C	Project Work	4	
ENS 522C	Environmental Law and Society	4	
Specialisation	A student shall opt for one of the following groups		
GROUP- A	**Pollution Control and Environmental Biotechnology**		
ENS.523 E	Pollution Control and Management	4	
ENS.524 E	Environmental Biotechnology	4	
ENS 525 E	Laboratory Practical and field studies relating to ENS.524 E & 525 E	4	
GROUP- B	**Soil Biology and Biotechnology**		
ENS 5267 E	Soil Biology and Ecology	4	
ENS 527 E	Soil Biotechnology	4	
ENS 528 E	Laboratory Practical and Field studies on ENS 526 E & 527 E	4	**20**
	TOTAL CREDIT HOURS		**90**

Questions will be asked from each unit with 50% choice for the students from each unit. The students shall be asked to answer four questions. A maximum of 50% of the questions should be of objective and short answer type. Full mark in each theory paper shall be 100 to be finally scaled down to Grade Point and the examination will be of 3 hrs duration. Practical Experiments and Fields projects will be designed by the concerned course teachers.

COURSES OF STUDY IN M.Sc. Environmental Sciences (2023-2025 Batch)
Total Credit Hour-90

DETAILS OF THE COURSE CONTENT (Theory papers)

Ist Semester

ENS 411 C Fundamentals of Ecology and Environmental Sciences 4CH

Objectives: Understanding on the Environment and Ecology is important to make the human society sustainable on earth. The course aims to provide the students with an understanding on i) Environment and Ecology and their roles ii) System concept in ecology, iii) Production and Energy flow in the ecosystem, iii) concepts on population, its growth and control mechanisms, iv) Community structure, feature and dynamics.

Outcome: On completion of the course, the candidate will be able to understand a) Spheres of environment, b) the concept of ecosystem and ecological processes, c) Bio-geochemical cycling, d) Primary and secondary production and energy flow concept and models, e) concept of population and population attributes and f) concept of community structure, features and dynamics.

Unit-I: System Concept in Ecology: Component parts of an ecosystem, Classification of ecosystems, Ecological factors; temperature, light, water, *Bio-geo-chemical cycles* : Carbon cycle, nitrogen cycle, sulphur cycle, phosphorous cycle, *Functional attributes of an Ecosystem :*Biological Diversity and stability: Biodiversity, Index of diversity and dominance, Biological indices, Relationship between species diversity, dominance and stability. *Food chain, Trophic levels & Ecological pyramid concept :*Types of food chain & Significance of food chains, method for studying food chains, pyramid of number, biomass & energy. Physical relationship in natural water bodies: The radiation in water body. Heat balance of water bodies, water movement and exchange.

Unit-II: Primary and secondary production and Ecosystem Energy Flow : Concept of Primary Production, Factors affecting primary production (light, carbon supply, water movement, nutrient demand etc), method for measuring primary production., Relationship between GNP, NPP and atmospheric respiration, primary productivity of different world sites. **.***Secondary Production :* Concept of secondary production and secondary productivity, maintenance cost, production-assimilation efficiency and secondary productivity. Relationship of secondary production to net primary production, *Energy flow in Ecosystems :*Concept of Energy, Energy source in Ecosystem, Laws governing energy transformation, concept of free energy, Enthalpy and Entropy, Energy flow in producers and consumers, Lindeman's Trophic-Dynamic concept, Ecological efficiencies, Energy flow models..

Unit-III: Concept of population and population attributes: Biotic potentiality and natality, mortality, survivorship curves, life table, age structure, population growth forms, concept of carrying capacity and environmental resistance, Life history strategies, r and k selection. *Population fluctuation and population interaction*: Extrinsic and intrinsic factors associated with population fluctuation, abiotic, biotic, density dependent and independent factors, parasitism, predation, competition, social behaviour in animals. *Human Population* : Factors affecting change in size of human population: death rate and net population change, migration, fertility, age structure, Human population control; economic development and demography transition, family planning method of birth control, socio-economic methods of controlling population growth.

Unit-IV: Community: Concept of habitat and niche, types of niches; spatial, trophic and hypervolume niche; ecological equivalents, community organization, types of communities, community structure (analytical and synthetic), qualitative features of community (Composition, stratification, Physiognomy, dispersion, sociability, vitality etc), quantitative characteristics of community(frequency, density, cover dominance and diversity, important value index), Ecotone and edge effect. *Community dynamics and succession*: Ecological succession and kind of

succession, succession process, concept of climax, monoclimax, and polyclimax theories, Examples of succession (hydrosere, lithosere and xerosere). Classification of Lakes: Association of living organisms in natural water in standing and flowing water, Zonation and community stratification.

Selected References:

1. Botkin, D. B. and E. A. Keller. Environmental Studies: The Earth as a Living Planet. Charles E. Merrill Publishing Co., Columbus, Ohio, 506 p.
2. Miller G.T. (1992). Living in the Environment: An Introduction to Environmental Science. 768p. International Thomson Publishing; 7th Ed edition.
3. Dash, M.C. and Dash, S.P. (2009). Fundamentals of Ecology. (2009). McGraw-Hill Education (India) Pvt Limited. p. 370.
4. Kormondy, E.J. (1969). Concepts of Ecology. Prentice-Hall, Englewood-Cliffs, New Jersey.
5. Odum, E.P. (2017). Ecology. Oxford and IBH Publishing Co. Pvt. Ltd.
6. Ramade, F. (1984). Ecology of Natural Resources. John Wiley & Sons, New York.

ENS 412 C Remote Sensing and Geographical Information System 4CH

Objectives: Remote Sensing and GIS techniques are versatile tools to handle, manipulate and interpret the spatial and temporal data. The environmental attributes are interpreted in both the spatial and temporal domain. Therefore a student opting for Environmental Science and Engineering should be trained to understand and use the tools of remote sensing and GIS.The course aims to provide the students with an understanding on i) Electromagnetic radiation and its use in remote sensing, ii) principles and data acquisition mechanism of Remote sensing satellites, iii) digital image processing, iv) GIS to handle spatial data.

Outcome: On completion of the course, the candidate will be able to understand the principles and applications of Remote Sensing and GIS techniques in the Environmental monitoring, forecasting and management. The student will develop skill to work in the programmes in industrial and government sectors that involve the study on spatial and temporal data on different entities of the environment.

Unit-I: **Introduction to Remote sensing Science & Technology :** Principles of Remote sensing, Physical basis of Remote sensing. The nature and generation of Electromagnetic radiation (EMR). Interaction of EMR with the atmosphere and earth's surface features. Spectral signatures and characteristic spectral reflectance curves for rocks, soil, vegetation and water. Spectral quantities. Far and Near Infrared and Microwave remote sensing.

Unit-II: **Geographic Information System:** Introduction, Definition and Terminology, Map Protection and Coordinate system, GIS system hardware, software and infrastructures. Basic Components of GIS software. Data structures. Data models, Data acquisition, Data input and Data processing and management including topology, TIN model, DEM/DTM generation, overlying and Integration and final data product and report generation. Integration of Remote Sensing and GIS techniques and their applications in Environmental studies including Impact Assessment and management with case studies.

Unit-III: Remote Sensing Observation and Platforms: Air borne and space borne platforms, their relative importance and applications, Orbital geometry. Remote Sensing Satellites. Sensors, Aerial cameras and type of aerial photography, Photo scale and photo elements, Single and multi band scanners MSS sensor and other type of sensors. Aerial Stereo coverage and. Details of sensors on board. Latest Earth resources Satellites viz. LANDSAT 6/7/8, SPOT, IKONOS, IRS, ERS, MODIS, RESOURCESAT, CARTOSAT, GOES, OCEANSAT. Hyperspectral imaging, RADAR and LIDAR techniques.

Unit-IV: **Digital Image Processing :** Introduction to digital structure and data recording format sets. Visual Photo-Interpretation Techniques based on Photo elements and Terrain elements, Image Restoration, Enhancement and classifications, Significance of Ground Truths and Training Sets in Image Processing and in automated processing.

Selected References:

1. Angi Reddy, M. (2008). Text Book of Remote Sensing and Geographical Information system. BS Publications, Hyderabad. p 447.
2. Chang, Kang-tsung (2007). Geographical Information System. Tata McGraw-Hill Education Pvt. Ltd.
3. Bhatta, B. (2011). Remote Sensing and GIS. Oxford University Press. p 752.
4. Jensen, J. R. (2009). Remote Sensing of the Environment: An earth resource Perspective. Dorling Kindersley India Pvt. Ltd. (Indian edition).
5. Lillesand, Thomas M., Kiefer, Ralph W. and Chipman, Jonathan W. (2007). Remote sensing and image interpretation. Wiley. p 804.
6. Panigrahi, N. (2009). Geographical Information Science. CRC Press. p 292.

ENS 413 C Instrumental Techniques: Principle and Application 4CH

Objectives: Identification of the presence of chemical species in the different entities of the environment and estimation of their concentration in those entities are necessary for assessment and management of the environmental quality. Thus, there has been the need to generate trained manpower to analyse different chemical species using sophisticated analytical instruments and techniques. The course aims to provide the students with an understanding on i) the spectrophotometry, ii) electrochemical methods and iv) chromatographic techniques for the identification and concentration estimation of different chemical species in environmental samples.

Outcome: On completion of the course, the candidate will be able to understand the principles and techniques of a) spectrophotometry b) Electrochemical methods, c) Chromatography and d) Fluorimetry, Nephlometry . The student will develop skill to i) work in the NABL recognized state and national and laboratories where environmental samples are analysed and to ii) use these techniques in research.

Unit-I: pH metry: Idea of pH and buffer, Buffer capacity and Ionic strength, pH measurements by method of pH indicators and potentiometric methods. Application.*Centrifugation Techniques:* Principle and application of High speed centrifuges, Continuous flow centrifuge, Density gradient centrifuge, Analytical ultracentrifugation.

Unit-II: Spectroscopic methods: The principle, instrumentation (basic lay-out)and application of the ultraviolet and visible spectrometry, Fluorescence Photometry, Infra-red-spectroscopy, Nuclear Magnetic Resonance Spectrometry. *Atomic Absorption Spectroscopy:* The principle, differences, instrumentation and application of Flame emission spectroscopy and Absorption spectroscopy. *Bomb Calorimetry:* Principle, experimental arrangement and its application

Unit-III: Chromatography Techniques: The principle, experimental techniques, qualitative and quantitative analysis, applications of Adsorption Chromatography, Ion exchange chromatography, Paper chromatography, Thin layer chromatography, Gas liquid chromatography (Instrumentation),High performance liquid chromatography

Unit-IV: ***Electrophoresis Techniques:*** Principle, methods of measurement and applications of paper and cellulose Acetate electrophoresis, Thin layer Electrophoresis, Gel electrophoresis, Immuno-electrophoresis.

Selected References:

1. Willard H.H. & Dean L.L. (1976). Instrumental Methods of Analysis, John Wiley.
2. Recsok R.L. & Shields L.D. (1990). Modern Methods of Chemical Analysis -, John Wiley & Sons, Inc,
3. Ewing, G.W. (1975). Instrumental Methods of Chemical Analysis -, McGraw Hill Book Company, Inc.
4. Pecsok, R.L. & Shields, LD (1986). Modern Methods of Chemical Analysis - John Wiley & Sons, Inc.
5. Banwell, C.N. (1990). Fundamentals of Molecular Spectroscopy -, McGraw Hill, NY,
6. Sharma, Y.R. (2009). Analytical Methods in Chemistry, Kalyani Publishers, New Delhi, p.309.

ENS 414 C Methods of Analysis of Environmental samples 4CH

Objectives: A student trained in Environmental science must understand the physic-chemical analysis of different endowments of the environment. The course aims to provide the students with an understanding on different analysis of water, soil, air, biological sajmples and i) Community analysis.

Outcome: On completion of the course, the candidate will be able to understand a)Physicochemical and Biological Parameters of water, ii) Physico-Chemical and Biochemical parameters of Soil, iii) Air and Noise Intensity Analysis, iv) Biological Sample and Community Analysis**.**

Unit I: Physico-chemical and Biological parameters of Water : **p**H, Conductivity, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Chloride, Alkalinity, Free CO_2, Nitrate, Phosphate, Sodium, Potassium, Primary productivity, Phyto Plankton, Zooplankton, Heterotrophic bacteria, Total coliform and faecal coloform.

Unit II: Physico-Chemical and Biochemical parameters of Soil : Nitrogen, Organic matter, Humus, Phosphate, Nitrate, CO_2 Evolution, Amylase, Invertase, Protease, Dehydrogenase, Bacteria and Fungi.Respiration and excretion study in animals .Extraction of soil mesofauna

Unit III: Air and Noise Intensity Analysis: Sampling of SOx, NOx and Suspended particulate matters from ambient air.Analysis of SOx, NO_X and Suspended particulate matters collected through High Volume Samplers

Unit IV: Biological Sample and Community Analysis: Aminoacid, Protein, Carbohydrate and Lipid Content in Plant and Animal samples, plant Pigment Content, Energy Content through Oxycalorific value, Density, Dominance, Abundance, Diversity and Population structure in grass land and forest community

Selected References:

1. Williams, B.L. and Wilson, K. (1981). A Biologist's Guide to Principles and Techniques of Practical Biochemistry (Second Edition). Edward Arnold, London. p 318.
2. Robyt, J.F. and White, B.J. (1990). Biochemical techniques: theory and practice. Prospect Heights, III. : Waveland Press.
3. Benton, A.H and Werner, W.E. (1976). Field Biology and Ecology. Mc Graw Hill, Inc., New York.
4. Michael, P. (1984). Ecological methods for field laboratory investigation. Tata McGraw-Hill, New Delhi & London.
5. Mishra, R. (1968). Ecology Work Book. Oxford & IBH Publishing Company. p242.
6. Trivedy, R.K., Goel, P.K. and Trisal, T.L. (1987). Practical methods in Ecology and Environmental Science. Environ Media Publications. p 340.

ENS 415 C Laboratory Practical and Field Studies on ENS 411C- ENS414C 4CH

ESDMS 419 Environmental Field Survey 2CH

Objectives:

Survey of different components of the environment are necessary for assessment and management of the environmental quality. Thus, there has been the need to generate trained manpower to ably survey the different components of the environment. The course aims to provide the students with an understanding on survey techniques relating to Biodiversity, Soil, Water, Air, demography and impact assessment methodologies

Outcome: On completion of the course, the candidate will be able to understand the principles and techniques of survey relating to a) Biological entity b) Physical Entity, c) Sociological Entity and d) Environmental Impacts

Unit-I: Biological Entity: Flora :General vegetation patterns, Plant species, Tree species, Rare plant species in entire area, Others Fauna :Amphibians, Reptiles, Mammals, Birds, Rare faunal species. Biodiversity: surface, below ground

Unit-II: Physical Entity: Water Quality, Air Quality, Noise Level, Traffic Density, Wind Velocity and Direction, Soil Quality

Unit-III: Sociological Entity: Socio-economic survey procedures, Likert Scale, Bogardus Social, Thurstone Scale, Semantic Differential Scale

Unit-IV: Environmental Impact Assessment Matrices: Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods

1. Kothari, C.R. (2016). Research Mehoodology: Methods and Techniques. New age international, New Delhi, p. 403
2. Hill, D., Fasham, M. Tucker, G., Shewry, M. and Shaw, P. (2005). Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring , Cambridge University Press, 573 p.
3. Anjaneyulu, Y. and Minickam, V (2007) Environmental Impact Assessment Methodologies:., BS Publications, Hyderabad, p.437 p.
4. CPCB (2011) Guide Manual: water and Wastewater Analysis. p.183
5. CPCB (2011). Guidelines for the measurement of Ambient air pollutants, p. 243
6. USDA (1993). Soil Survey Manual

IInd Semester

ENS 421 C Fundamental of Soil Science 4CH

Objectives: Soil provides nutrients to the living organisms. Bulk of the below-ground biodiversity remains within the pedosphere. Plant growth is controlled by different soil properties. Therefore, students need to understand different processes operative within the pedosphere. The course aims to provide the students with an understanding on i) soil forming processes and soil reactions and ii) soil aeration, soil temperature, soil water and soil organic matter and their role for plant growth.

Outcome: On completion of the course, the candidate will be able to understand a) genesis of different soils b) roles of soil water and air on crop management and c) influence of soil organic matter on plant growth. The student will develop skill to understand the soil types and their basic parameters governing plant growth.

Unit-I: Soil genesis: Different types of soil forming rocks, Weathering processes-physical, chemical, biological weathering, soil forming process and factors affecting soil formation, chief soil types of India. *Soil texture and structure:* Size, composition and aggregates of soil particles. *Soil reaction:* Soil colloidal system, cation and anion exchange phenomena, soil pH, buffering capacity, soil acidity and alkalinity, reclamation of saline and alkaline soils.

Unit II: Soil temperature: Absorption and loss of heat, heat of vapourisation, thermal conductivity through a soil profile, factors affecting soil temperature, soil-temperature fluctuations, effect of soil temperature on the soil

condition and plant growth *Soil Aeration:* Composition of soil air, gaseous exchange between atmosphere and soil air, factors affecting soil aeration, effects of soil aeration, aeration in relation to soil and crop management

Unit-III: Soil water: Different forms-Hygroscopic, capillary and gravitational, movement of soil water under saturated and unsaturated conditions, retention of soil water in the field, effect of soil moisture on soil condition, soil development and plant growth.

Unit-IV: Soil Organic Matter: Sources, composition and decomposition of organic matter, C/N ratio of organic materials, influence of C/N ratio on decomposition humus formation, Nature and properties of humus, Influence of organic matter on plant growth and soil properties, management of soil organic matter.

Selected References:

1. Lynch, J.M. (1983). Soil Biotechnology: Microbiological factors in crop productivity. Blackwell Scientific Publications, Oxford.
2. Santra, S.C. (2011). Environmental Science. New Central Book Agency. p760.
3. Dash. M.C. and Mishra, P.C. (2000). Man and Environment. Macmillan Publishers India Limited. p 302.
4. Goudie, A. S. (2001). The nature of the Environment. Wiley- Blackwell Publications. p 580.
5. Nyle C.**Brady** and Ray R. Weil. Elements of the Nature and Properties of **Soils** (3rd Edition) 2009, A.G. Publisher p.680.
6.Rathinswamy, A. (2014). Fundamentals of Soil Science, Scientific Publisher, New Delhi. p.354.

ENS 422 C Nonrenewable and Perpetual Energy Resources 4CH

Objectives: Human society depends on the resources for its different activities. While some of the resources are renewable, many others are non-renewable. Moreover, resource extraction and product generation and use are adversely affecting the environment. Therefore, student must have the idea on the renewable, nonrenewable and perpetual resources, their consumption and effects on the environment. The course aims to provide the students with an understanding on i) classification of renewable and non-renewable resources and ii) fossil fuels and mineral resources.

Outcome: On completion of the course, the candidate will have an understanding on i) resource types and their classification, ii) different energy resources, iii) products from coal and petroleum . The student will develop a skill to understand the adverse effects of resource consumption.

Unit-I: Non-renewable Mineral Resources: Economic mineral deposits, grouping of ores minerals, various steps involved in extraction processes of pure metals, uses of common metals and their recycling, Radioactive minerals, Environmental impact of mining and processing mineral resources, conservation of mineral resources.

Unit II: Fossil fuels: Classification; Coal, its type and its analysis, Carbonisation; oil, fractionation, cracking Octane and octane number, addition of TEL; natural gas and other gaseous fuels derived from fossil fuels, Environmental Impact of Fossil Fuel use.

Unit-III: Perpetual and Nonrenewable energy source: Geothermal energy **:** Source, Principle of harnessing energy and its operation. Nuclear Energy : Source, fission and fusion reactions, broad idea of nuclear reactor, its operations, management and electrical power generation, safety measures. *Solar energy :* its secret, devices based on solar energy, their advantages and drawbacks,

Unit-IV: **Perpetual and renewable energy source :** Wind mills and applications, aero-generators, their advantages and disadvantages, Water energy : Hydroelectricity, wave and tidal energy, tidal power plant. Energy from biomass : Biomass as fuel, Biogas plants and generation, uses of biogas

Selected References:

1.Trivedy, P.R. and Raj, Gurdeep (1997). Environmental Energy Resources, Encyclopedia of Environmental Sciences-7. Akashdeep publishing House, New Delhi.

2. Rao, L.P. (1987). Remote Sensing for Earth Resource-, AEG Publication, Hyderabad.

3. Strahler, A.N. and Strahler, A.H. (1973). Environmental Geoscience: interaction between Natural Systems and Man. Hamilton Publishing Company, California. p. 511.

4. Goudie, A. S. (2001). The nature of the Environment. Wiley- Blackwell Publications. p 580.

5. Rao, S. and Parulekar, B.B. (2000). Energy Technology: Nonconventional, Renewable and Conventional, Khanna Publicshers, p.1144.

6. Desai, A.V. (ed) (2001). Nonconventional Energy, New Age International (P) Limited, United Nations University, Tokyo.p.203.

ENS 423 C Data Analysis in Environmental Sciences 4CH

(At least 50 % of the questions shall be of problem solving)

Objectives: Statistical measures are important tools for the understanding of the Environmental processes and development of management methods. Environmental models are based on different statistical measures and algorithms. The models provide solutions to environmental problems. Therefore, it is necessary generate trained manpower with skill to analyse and interpret the environmental data on spatial and temporal scales. The course aims to provide the students with an understanding on i) research designs, ii) non parametric and parametric tests iii) regression models etc.

Outcome: On completion of the course, the candidate will be able to understand the principles and methods of statistical techniques such as a)sampling b) data representation and interpretation in terms of graphs and diagrams, c) probability distributions, d) descriptive statistics and e) hypothesis tests . The student will take practical examples and calculate the measures and interpret the results.

Unit-I: Fundamentals of statistics: population & sample, Variables, Primary and secondary data, Collection of data, Classification and tabulation of data, Need and usefulness of Diagrams & Graphs, Different types of diagrams and graphs. *Frequency distribution:* Discrete and continuous frequency distribution, sampling methods, sampling errors

Unit-II: Descriptive statistics: Measure of central tendency (Averages), Types of mean: Arithmetic mean, Geometric mean, Harmonic mean; Median, Mode, relation between mean median and mode ;Measure of dispersion: Range, Mean deviation & Standard deviation; Skewness and Kurtosis .

Unit-III: Theoretical Probability Distribution: Binomial, Poisson and normal distribution; Testing of Hypothesis: Null and Alternative Hypothesis, level of significance, Student't' distribution and its application, Chi-square(x^2) test & its application.

Unit-IV: Correlation, Regression and ANOVA analysis: Types of correlation; simple, partial and multiple correlation, Method of study & testing the significance of correlation coefficient, Rank correlation, *Regression analysis*: regression equations and regression lines, Properties of regression lines, regression coefficient, testing the significance of regression coefficient. *Analysis of variance (ANOVA):* One way and two way classification and their applications.

Selected References:

7. Gupta, S.P. (2014). Statistical Methods. Sultan Chand and Sons. p1426.

8. Das, N.G. (2009) Statistical Methods, Tata Mc Graw Hill Education, p.907
9. Jasra, P.K and Gurdeep Raj (2016). Krishna Prakashan Media (P) Ltd, New Delhi, p.370
10. Belavendra Antonisamy, Prasanna S. Premkumar, Solomon Christopher (2017). Principles and Practice of Biostatistics, Elsevier India, p.390.
11. Kothari, C.R. (2016). Research Mehoodology: Methods and Techniques. New age international, New Delhi, p. 403
12. Gurumani, N. (2015). An introduction to Biostatistics. MJP Publisher. p 375.

ENS 424 C Laboratory Practical and Field Studies on ENS 421C- ENS423C Including Computer Application in data Analysis **4CH**

ENS 425 C Summer Training and Project Report/Term Paper **2CH**

to be evaluated by Departmental Teachers

ENS 426 C Seminar Presentation to be evaluated by Departmental Teachers **2CH**

IDC < Code as per the course opted> Inter-disciplinary course: offered by different departments to be opted by the student **3CH**

IIIrd Semester

ENS 511 C Environnemental Pollution **4CH**

Objectives: The quality of air, water and soil are degrading day by day. There has been the necessity to generate trained manpower to prevent the pollution. Therefore a student working in the area of Environmental science and Technology needs to understand different aspects of the air, water, soil and radiation pollution and their remediation methods. The course aims to provide the students with an understanding on i) the structure and physical as well as chemical functions of the air, water and soil, ii) pollution effects on air, water and soil and their prevention and control technologies.

Outcome: On completion of the course, the candidate will be able to understand a) Chemical, physical processes operative in the atmosphere, hydrosphere and pedosphere b) effects of pollution on atmosphere, hydrosphere and pedosphere and c) pollution prevention and control technologies. The student will develop skill to work in the areas of air, water and soil quality assessment and pollution remediation programs.

Unit-I: Air pollution: Concept and definition of Environmental Pollution, types and classification of Air Pollution, Pollutants and source of pollution, History of major air pollution episodes. *Air pollution:* Air pollution meteorology, Major and Minor Pollutants in atmosphere (SO_x, NO_x,CO_2, Fluoride,)Acid rain, photochemical Smog, Green House effect and ozone layer depletion, Prevention and control of Air Pollution.

Unit-II:Water Pollution: History of major water pollution episodes, Classification and types of Water Pollution: Industrial wastes, Municipal waste, Agriculture chemicals, oil pollution, Eutrophication, Heavy metals (mercury, lead, Arsenic)ecological magnification, ground water pollution, Prevention and control of water pollution.

Unit-III: Soil Pollution: Pollution effect of pesticides in soil, Biological control of pests, Integrated pest management, Types of solid wastes and their effect, management of solid wastes, Pollution due to fertilizers.

Unit-IV: Pollution by radiation: Sources of radioactive pollution, effects of radiation, protection and control from radiation, disposal of radio active waste. *Pollution due to noise:* Sources of noise, Loudness on Decibel scale, noise levels in decibel scale, effect of noise on human health, prevention and control of noise pollution.

Selected References:

1. Mishra, P.C. (2008). Fundamentals of Air and Water Pollution. APH Publishing Corporation. p.157.
2. Nemerow N.L. (1978). Industrial Water Pollution, Addison - Wesley Publishing Company Inc., USA,
3. Speeding, D.J. (1974). Air Pollution. Oxford Chemistry Series, Clarendon Press, Oxford.
4. Gupta, P.K. (1986). Pesticides in Indian Environment. Inter Print, The University of Michigan. p 206.
5. Trivedy, R.K. and Goel, P.K. (2012). Introduction to Air Pollution, Goel, B.S. Publication, p.284
6. Goel, P.K. (1997). Water pollution: causes, Effects and Control. New Age International. p 269.

ENS 512 C Forest and Wild Life Ecology 4CH

Objectives: Forest ecosystem is an important system without which life cannot exist on earth. However, with time there has been loss in forest cover and extinction of species leading decline in biodiversity. Therefore, Forest and wildlife ecology is an important area of environmental science. The course aims to provide the students with an understanding on i) Forest as a resource, ii) types and importance of forest, c) Forest loss and principles and techniques of forest management, d) Social forestry, e) wild life, its protection and management.

Outcome: On completion of the course, the candidate will be able to understand a) Types and composition of forests,, b) importance of forest, c) mechanism and methods to control forest loss, d) Social forestry, Agroforestry and extension forestry, e) wild life their importance and conservation methods with some case studies.

Unit-I: Forest Resources: Major types and composition of forests with references to India, Structural organization of forest ecosystems, Primary production in different Forest ecosystems & methods of measurement. *Importance of Forests*: With reference to major and minor produce, climate, soil erosion, pollution control and water management, Concept of Biosphere Reserve, Biodiversity and forest.

Unit-II: Forest Loss and management: Loss of forest cover with reference to world and Indian Context Impact of deforestation and shifting cultivation on forest ecosystems, Objective, Principle and techniques of forest Management. Management of forests involving different silvicultural principles and practices, Sustainable yield relation.

Unit-III:. **Social forestry:** Objective, scope and necessity of social forestry . Agroforestry and Extension Forestry, Eucalyptus dilemma, Joint Forest management, People's participation and role of NGOs

Unit-IV: Wild Life Protection and management : Wild life & its importance . Human activities and Wild Life, Concept of Endangered Species and Red data Book, How species become endangered and extinct, Protecting wild species from extinctions, Ecological basis of wild Life conservation and management, Case studies on Crocodile and Sea Turtle conservation, Project Tiger.

Selected References:

1 Dash, M.C. and dash, S.P. (2009). Fundamentals of Ecology. (2009). McGraw-Hill Education (India) Pvt Limited. p. 370.
2. Michael, P. (1984). Ecological methods for field laboratory investigation. Tata McGraw-Hill, New Delhi & London.
3. Krishna Murthy, A.V.R.G. (1983). Forests and Wild Life in India. Committee on Science and Technology in Developing Countries, International Council of Scientific Unions. p 375.
4. Tritsch, M.F. (2001). The Wild life of India. Collins. p 192.

5. Hand Book of Environment,Forest and Wild life laws in India ,WPSI /Natraj
6. Agrawal, K. C.(2000). Wildlife of India, Conservation and Management. Nidhi Publisher, Bikaner.

ENS 513 C Environmental Toxicology 4CH

Objectives: Toxic substances are released to the environment by natural process and some developmental activities. This leads to hazards and pose risk on the human society. To minimize the toxicity related risk an understanding on the natural laws concerning toxicology, toxicity pathways and tolerance limits is required. The course aims to provide the students with an understanding on i) natural laws concerning toxicology ii) Body processes and their response to toxic substances iii) toxic effects of heavy metals and insecticides.

Outcome: On completion of the course, the candidate will be able to understand a) natural laws concerning toxicology ii) absorption, distribution and excretion of toxic substances iii) Biotransformation and bioacumulation of xenobiotics. The student will develop skill to work in the areas where assessment of toxicity effects, toxicity related risk are important.

Unit-I: Introducing Toxicology: History, types of toxicology, Toxicity, Hazards, Risks, Benefit-to-risk-ratio, tolerance limits, Acceptable daily intake, Threshold value. *Natural Laws Concerning toxicology :*Factors affecting toxicity : Host factor, Age, species and strain, sex, feed and feeding, Idiosyncratic toxicity, interaction between chemicals (synerism, antagonism).Environmental factors, Physico-chemical properties of toxic substances, route and rate of administration, Dose, Effect and response, Dose-response curves, & Dose effect relationships (Graded & Quantal response)Statistical concept of toxicity(Acute toxicity, margin of safety).

Unit-II: Translocation of toxicity: Absorption, , Distribution and Excretion of toxic substances. Absorption : membrane permeability, mechanism of chemical transfer, absorption (Gastrointestinal, skin, lungs), Distribution: tissue affecting distributions and tissues retention. Excretion: Renal excretion, Biliary excretion and Gastrointestinal. Receptor Concept, Nature of receptors, Theory of toxicant receptor interaction, Mechanism of action of Pesticides and heavy metals.

Unit-III: Biotransformation and Bioaccumulation of Toxicants*:* Site, Biotransformation reactions, Phase I and Phase II reactions and associated enzymes (Oxidation, reduction, Hydrolysis), factors affecting biotransformation of xenobiotics, Process of accumulation and elimination of toxicants

Unit IV: Toxicity Tests: Types of test based on number of species(single species, Multipecies and Ecosystem tests), based on exposure(single dose and multiple dose), based on duration of exposure (acute and chronic toxicity test)

Selected References:

1. Gupta, P.K. (1986). Pesticides in Indian Environment. Inter Print, The University of Michigan. p 206.
2. Gupta, Toxicology. Vol I, II and III. Metropolitan book Co.
3. Ray Choudhury and Gupta. Environmental Pollution and Toxicology, Today & Tomorrow Publ.
4. Moriarty, F. (1999). Ecotoxicology: The study of pollutants in the Ecosystem. Academic press, Elsevier. p 347.
5. Omkar. Ahmad Pervez and Prof. Bhoomittra Dev (2017). Concept of toxicology. Vishal Publishing Co. p.295
6. Sood, A. Toxicology. Sarup and Sons. New Delhi.

ENS 514 C Disaster Management 4CH

Objectives: The disasters are increasing along the time-line. There are geophysical, climatological and technological hazards. Their increase is leading to large scale interruption and economic loss to human society. Therefore, a student should have basic understanding of hazards, risk and disaster and their management measures. The course aims to

provide the students with an understanding on i) Difference between hazards and disaster ii) Different types of hazards iii) Disaster management models and iv) Case studies on some disasters.

Outcome: On completion of the course, the candidate will be able to understand a) Basic properties of the hazards and their types b) Difference between Hazards and disaster; Hazards vs. risk, c) Disaster management models. The student will develop skill to work in intensity and magnitude scales of disasters.

Unit I : Hazard, Risk and Disaster : Hazard in the Environment, the concepts of hazard, risk and disaster, Human vulnerability to hazard, Disaster trends, complexity in hazard and disaster, Hazard zoning and risk assessment, Environmental Security and Hazards Zoning, hazard zoning maps & preparedness plan. Risk Assessment management: Disaster management models, Hazards vs. Risk, Evaluation of Risk, Strategies for Hazard Mitigation: Priorities, Prediction, warning & Public information, Minimizing the probability of hazards, Public policy for hazard management.

Unit II: Earthquakes, Volcanic and Mass movement Hazards: Origin of Earthquake, its magnitude and intensity, Earthquake prone zones in the Earth, Reservoir induced seismicity, effects of earthquake, stability of structure & Risk Assessment, coping with seismic hazards, seismic zoning map, seismotectonic map, earthquake prediction & control. Types of volcanic eruptions, Active volcanic belts in the world, nature and magnitude of volcanic hazards, prediction of volcanic eruptions, mitigation of volcanic hazards. Mass movement hazards: Landslides, Rock fall, snow avalanche hazards with some case studies.

Unit-III: Floods, Cyclones, Tornados and Tsunamis: Floods and flood management, causes of excess flows, reduced carrying capacity of rivers, Runoff versus infiltration, sediment load & changing course of rivers, management of floods - strategy, treatment of watersheds, reservoir &detention basis, water spreading, ground water recharge, stream channelization, flood embankments, flood plain zoning, flood forecasting & warning. Regions of flood prone zones in India. Origin of cyclones, tornados and tsunamis, their severity and impacts, coastal hazards mitigation measures.

Unit IV: Technological hazards: Nature and definition of technological hazards, Concepts of industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires, chemical spills, and technological hazards as a result of the impacts of a natural hazard. Definition of hazardous waste, solid waste generation, concept of solid waste management. Onsite handling and processing, disposal techniques- open dumping, land filling, incineration, composting, potential methods of disposal- utilisation, recovery and recycling. The growth of industrial hazard, Some case studies of Technological Disasters like Bhopal gas Tragedy (3 December, 1984), NALCO ash-pond breach in Orissa, Chernobyl Nuclear accident 1986, Minnamata Japan, Japan's earthquake-tsunami- Fukushima nuclear disaster: 2011

Selected References:

1. Smith, K. and Petley, D.N. (2013). Environmental Hazards: Assessing risk and reducing hazards. Routledge (Taylor and Francis Group). London. p.478.
2. Siddhartha, K. (2002). Atmosphere, weather and climate: A textbook on climatology. Kisalaya Publications Pvt. Ltd. New Delhi. p. 512.
3. Valdiya, K.S. (1987). Environmental Geology. Tata McGraw-Hill Education. p 664.
4. Strahler, A.N. and Strahler, A.H. (1973). Environmental Geoscience: interaction between Natural Systems and Man. Hamilton Publishing Company, California. p. 511.
5. Goudie, A. S. (2001). The nature of the Environment. Wiley- Blackwell Publications. p 580.
6. Cutter, Susan L.(1993). Living with Risk: The Geography of Technological Hazards. Hodder Education Publishers. p 224.

ENS 516 C Laboratory Practical and Field Studies on ENS 511C- ENS 514C 4CH

EDPS 439 Entrepreneurship Development (Offered by Department of Business Management) 2CH

MOOCs < Code as per the Course opted> **3CH**

Massive Open Online Courses (**MOOCs**) are free online courses available for anyone to enroll **NPTEL, mooKIT, edX, Coursera, and SWAYAM** are the prominent online platforms in India. MOOC Coordinator of the Department will guide the students

IVth Semester

ENS 521 C Project work **4CH**

Objectives: The course aims to provide the students with an understanding on i) Formulating Research Hypothesis ii) Planning and Execution of Research work iii) Deriving conclusion from the research work

Outcome: On completion of the course, the candidate will be able to understand i) Framing Research Hypothesis ii) Framing Research design iii) Writing project report.

Project work of 4th Semester will be assigned to the students (jointly or individually) at the beginning of the III Semester and will be completed in the IV Semester. The distribution of the work/marks will be as follows

Semester-wise work distribution and mark in % for project work			
III Semester (20%) Evaluation of Interim Report of the Project work			
Background of the problem (5%)	Review of Literature (5%)	Objectives (5%)	Methodology (5%)
IV Semester (80%) Evaluation of the Final Report of the Project Work			
Result, Discussion and Conclusion (50%)		Viva-voce (30%)	

ENS 522 C Environmental Law and Society **4CH**

Objectives: The environment is degrading because of the human intervention on its different spheres. This demands implementation and refinement of national and internal laws and rules on environment and policy frameworks.
The course aims to provide the students with an understanding on i) environmental policies ii) important acts and rules for prevention and control of pollution, iii) rules and notifications on waste management, and iv) Laws related to forest, wildlife and forest dwellers. The student will be exposed to different provisions under these policies, acts and laws.

Outcome: On completion of the course, the candidate will be able to understand a) different national and international policies b) different acts and rules on prevention and control of pollution and protection of environment and c) forest and wildlife acts. Develop skill to participate and contribute to the areas where legal compliance on pollution and protection of environment is required.

Unit-I: Human impact on the Earth: Hunting and Gathering Society, Agriculture Society, Industrial Society, *Sustainable -Earth Society:* Concept of throw-away and sustainable -Earth Society, our future society; a prediction. Environmental movement and peoples participation with special references to Gandhamardan, and Narmada Bachao

Andolan. Women and Environmental protection. Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States. National river conservation plan – Namami Gange and Yamuna Action Plan

Unit-II: Air, Water, Forest and Wildlife related Laws in India: Constitutional provisions in India (Article 48A and 51A). Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982. Constitution of Central and State Pollution Control Boards, Power, Function and responsibility of Central and State Boards (Objectives, Area of jurisdiction, responsibility of an industry, power and function of state and central Government, Cognizance of offence, Penalties and Punishment). Environmental (Protection) Act, 1986 and Rules 1986.*Forest conservation Act. 1980*:Objective and Jurisdiction, Responsibility of Industry. Wildlife Protection Act 1972 Authorities under the Act. Wild life Advisory Boards and their functions, Detection and prevention of offences. Cognizance of offences, The wildlife (protection) Amendment Act. 1991. Biological Diversity Act, 2002. National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

Unit III: Acts and Rules for Environment Protection: The Environment Protection Act 1986 - Necessity and Scope of the Act. Powers of the Central Government, Parallel Provisions with the water and the Air act. Important rules & notification under the Environment Protection Act *1986.* The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, 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, Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

Unit-IV: Economics and Environment and Environmental Ethics: Economic growth, Gross National product and the quality of life: Sustainable-earth economy, Economics and Pollution control, Discount factor, Cost-benefit and cost effectiveness analysis, Environmental Ethics: Ethics and moral, Throw-away society ethics, Sustainable-Earth Society ethics, Ethical guidelines. Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

Selected References:

1. Hand Book of Environment,Forest and Wild life laws in India ,WPSI /Natraj
2 Environmental Science ,Santra ,Central
3. Environmental Law in India ,Gurdip Singh ,Quality Law Books
4. CPCB: Pollution Control Acts, Rules and Notifications issued there under, Pollution Control Law series: PCLS/02/2010, GSR 475(E), Gazette no. 202 dated 05.05.92. Central Pollution Control Board (CPCB). Ministry of Environment and Forests. Government of India. Parivesh Bhawan, East Arjun Nagar, New Delhi. India. 1992.
5. CPCB: Pollution Control Acts, Rules and Notifications issued there under, Pollution Control Law series: PCLS/02/2010, GSR 422 (E), Gazette no. dated 19.05.93. Central Pollution Control Board (CPCB). Ministry of Environment and Forests. Government of India. Parivesh Bhawan, East Arjun Nagar, New Delhi. India. 1993.
6. Agrawal, K. C. (2000). Environmental Laws: Indian Perspectives. Nidhi Publisher, Bikaner.

SPECIALISATION-Group A

ENS 523 E Pollution Control and Management 4CH

Objectives: The quality of air, water and soil are degrading day by day. There has been the necessity to generate trained manpower to prevent the pollution. Therefore a student working in the area of Environmental science and Technology needs to understand different aspects of the air, water, soil and radiation pollution and their remediation methods. The course aims to provide the students with an understanding on i) the structure and physical as well as chemical functions of the air, water and soil, ii) pollution effects on air, water and soil and their prevention and control technologies.

Outcome: On completion of the course, the candidate will be able to understand a) Chemical, physical processes operative in the atmosphere, hydrosphere and pedosphere b) effects of pollution on atmosphere, hydrosphere and pedosphere and c) pollution prevention and control technologies. The student will develop skill to work in the areas of air, water and soil quality assessment and pollution remediation programs.

Unit-I: Water quality standard : Drinking Water quality standard, Irrigation water standard, Stream standard and effluent standard, Characterization of Municipal waste water, Characterization of some major water polluting industries (Paper Mills, Sugar Industry, Iron and steel and Textile) and air polluting Industries (Coal-based Thermal Power Plants, Aluminium smelter and Cement industry) Origin and composition of sewage, treatment of sewage (Physical, chemical & Biological), Indicator organisms of polluted water body.

Unit-II: Methods of treatment of waste water: Preliminary Treatment, Primary treatment, (Sedimentation, Equalisation and Neutralisation etc.), secondary treatment(Activated Sludge Technique & Trickling Filter) Tertiary treatment methods for waste water treatment (Evaporation, Ion Exchange, Adsorption, Electrodialysis, Electrolytic Recovery, Reverse Osmosis). Aquaculture: Concept, conventional & non-conventional aquaculture practices. Utilisation of sewage in aquaculture practices.

Unit-III: Permissible limit and ambient air quality, Methods for control of gaseous air pollutants (Combustion, Absorption and Adsorption). Methods for control of Particulate air pollutants Mechanical device, Filtration, , Wet scrubber, Dry Scrubber, Electrostatic precipitator)

Unit-IV: Municipal Solid waste disposal and Management, Industrial Solid waste disposal and Management, Pollution due to Pesticides and Fertilisers Alternate methods of pest control: Biological control, Hormonal control, Integrated pest management.

Selected Readings:

1. Kudesia V. (2014). Air Pollution : Pragati Prakashan, Meerut p.917
2. Kudesia V. (2014). Water Pollution : Pragati Prakashan, Meerut
3. Dey A.K. Environmental Chemistry, New Age International Publisher, New Delhi
4. Trivedy A. (ed) (1988). Ecology and Pollution of Indian rivers : Trivedy, Ashish Publishing House. New Delhi.
5. Ray Choudhury and Gupta. Environmental Pollution and Toxicology, Today & Tomorrow Publ.
6. Tyagi, O.D., Mehra, M. and Mehta, M. (1996). A text book of Environmental Chemistry: Tyagi & Mehera, Anmol. p.408

ENS 524 E Environmental Biotechnology 4CH

Objectives: Biotechnology is an emerging science that has wider applications in cleansing the pollutants from different spheres of the environment. Therefore, the objective of this paper is to train the students on different biotechnological methods used for controlling pollution.

Outcome: On completion of the course, the candidate will be well versed in the a) Biological treatment of waste water b) Biotechnological approach to pollution control, c) Bioremediation methods and d) methodologies for management and remediation of contaminated soils.

Unit I: Biological Treatment of Waste Water: Microbial processes in waste water treatment, Microbial biofilm and waste water treatment, Secondary treatment systems, Microbial removal of Nitrogen and Phosphorous, Nutrient removal through biomass production

Unit-II: Biotechnology for pollution Control: Air Pollution Abatement: Bioscrubber and Biofilter,Water Pollution Abatement :Aerobic (Activated Sludge Process, Career advanced Activated Sludge Process, Biological Filters, Rotating Biological Contractors, Fluidized Bed Reactors, Inverse Fluidized Bed Biofilm Reactor, Expanded Bed Reactor) Anaerobic Biological Treatment(Contact digester, Packed bed or Packed Volume Reactor, Anaerobic baffled digester, Upflow anaerobic sludge blanket reactors), Membrane Bioreactor and Biocatalyst

Unit- III: Bioremediation: Bioreactors for Bioremediation, Types of bioremediation (Natural, solid phase, slurry phase and bioventing), application of bioremediation, biodegradation of xenobiotics and pollutants, Biodgradation of pesticides, Enzyme catalyzed pesticide degradation reactions Biosorption: Use of bacteria, fungi and algae in biosorption, Biomineralization and bioleaching.

Unit-IV: Management and Remediation of Problem/Contaminated Soil : Coastal saline soil, Alkali soil, Mine waste soil, , Organic Pollutant contaminated soil, Biotechnology for solid waste management: Potential availability and composition of crop residues, Advantages of composting, Principles of Composting, Factor influencing composting, Methods of composting, Techniques of compost enrichment, Alternate use of crop residues Vermicomposting: Earthworm as a potential source, Culturing of Earthworms, Food preference by earthworms, Types of earthworm suitable for vermicomposting,, Method of vermicomposting Changes during vermicomposting, Nutrient value of worm casts and vermicomposts, Effect of vermicomposts on soil fertility, Vermicomposts and crop productivity, Use of earthworm in land reclamation and improvement.

Selected References:

1. Trivedy, R.K. (1998). Advances in Waste water Treatment and Technologies, Vol I II Global Science Publications.p. 486.
2. Manivasakam, N. (2003) Industrial Effluents Origin, Characteristics, Effects, Analysis and Treatment. Sakthi Publications, Coimbatore.
3. Gupta, P.K. and Salunkhe, D.K. Modern Toxicology. Volume I, II and III. Latest edition. Publisher: B.V. Gupta, Metropolitan Book Co. (p) Ltd, New Delhi
4. Colin Ratledge and Bjorn Kristiansen (eds). (2008). Basic Biotechnology (Third Edition): Cambridge University Press, Cambridge, UK
5. Agarwal SK (1998) Environmental Biotechnology, 1st edn. APHnPublishing Corporation, New Delhi,
6. Jack E. Rechcigl and Nancy A. Rechcigl[editors] (1998). Biological and biotechnological control of insect pests, Boca Raton, FL :Lewis Publishers, p.374.

ENS 525 E Laboratory Practical and Field Studies on ENS 523 E- ENS 524 E 4CH

SPECIALISATION-Group B

ENS. 526 E Soil Biology & Ecology 4CH

Objectives: Soil is an important sphere of the environment. Soil biology and ecology controls the enonomy of nations and is an important area for the sustenance of life-support system. The course aims to provide the students with an understanding on i) soil microorganisms and mesofauna, ii) organic matter decomposition processes, iii) cycling of important elements (nutrients).

Outcome: On completion of the course, the candidate will be able to understand a) Sampling and extraction methods of microorganisms and mesofauna and their characterization, b) Decomposition of organic matters, c) metabolic activities in soil and nutrient cycling.

Unit-I: Microorganisms and Microfauna: Sampling and extraction methods of microorganisms (bacteria and fungi) and microfauna (protozoa and nematode), their general characteristics, density, biomass, production and community structure.

Unit-II: Mesofauna and Macrofauna: Sampling and extraction methods of mesofauna (micro-arthropods and enchytraeidae) and macrofauna (earthworm) their general characteristics, density, biomass, production and community structure.

Unit-III: Decomposition: Composition of plant residues and sources of dead organic matter, Decomposition of organic compounds, Decomposition type and process, Influence of resource quality and physicochemical factors on decomposition process, biological systems of regulation of decomposition (the litter system, the rhizosphere, the drilosphere and the termitosphere).

Unit-IV: Soil metabolism and nutrient cycling: Soil respiration, soil enzymes, nitrogen fixation by symbiotic and nonsymbiotic organisms, molecular basis of nitrogen fixation, cycling of nitrogen, carbon and phosphorus and sulphur.

Selected Readings:

1. Burges, A. and Raw, F. (ed) (1967). Soil Biology and Biotechnology, Academic Press..
2. Dinda, D.L. (1990) Soil Biology Guide, John Wiley
3. Dickson, H.C. and Pugh, H.J.F. (1975). Biology of Plant Litter Decomposition Vol. I and II
4. M. J. Swift , O. W. Heal , J. M. Anderson. Decomposition in Terrestrial Ecosystems. Blackwell scientific publication p.372.
5. Lynch, J.M. (1983). Soil biotechnology: Microbiological factors in crop productivity. Blackwell Scientific Publications, 1983.
6. Paul, E.A. and Clark, F.E. (1989). Soil Microbiology and Biochemistry, Acdemic Press, p. 273

ENS.527 E Soil Biotechnology 4CH

Objectives: Pedosphere is polluted day by day and fertility of the soils are decreasing. Therefore there is necessity of soil management methods using different techniques. The course aims to provide the students with an understanding on i) Soil fertility management, ii) wasteland development, iii) Bioremediation and bioleaching methods, iv) composting and vermicomposting techniques.

Outcome: On completion of the course, the candidate will be able to understand a) Importance of humus, soil fertility, TSBF programme and LEISA technologies, b) hazards from solid waste, characterization and management of solid wastes, c) Bioremediation applications d) Principles and mechanism of composting and vermicomposting.

Unit-I: Soil fertility management: Importance of humus, polyphenol and clay in soil fertility, maintenance of nutrient demand and supply synchrony between plant and soil, use of bio-fertilizer (Blue green algae, water hyacinth, mycorrhizae, bacteria, azolla) for soil fertility, Tropical Soil Biology and Fertility (TSBF) Programme, concept of sustainable agriculture, principle and possibilities of Low-External-Input Sustainable Agriculture (LEISA) technologies.

Unit-II: Waste Management, Energy Recovery and waste land development: sources, nature and characterization of solid waste, Hazards from solid waste, various methods of disposal and management of solid waste, utilization of waste materials, aquatic plants and energy crops for biogas, alcohol and hydrogen production using microorganisms,. Waste land, types of waste land, microbial and earthwormic way of amelioration of waste lands.

Unit-III: Bioremediation: Types of Bioremediation application, Biodegradation of pesticides & hazardous wastes. Degradation of oil spills. Biosorption, Use of bacteria in biosorption, use of fungi in biosorption, use of algae in biosorption, Biomineralisation & Bioleaching Microorganisms involved in Bioleaching of ores, mechanisms of bioleaching, Bioleaching & Metal recovery.

Unit-IV: Composting and Vermicomposting: Principles of Composting, Advantages of composting, Factor influencing composting, Methods of composting, Techniques of compost enrichment, Vermicomposting: Earthworm as a potential source, Culturing of Earthworms, Food preference by earthworms, Types of earthworm suitable for vermicomposting,, Method of vermicomposting Changes during vermicomposting, Nutrient value of worm casts and vermicomposts, Effect of vermicomposts on soil fertility, Vermicomposts and crop productivity.

Selected Readings:

1. Paul, E.A. and Clark, F.E. (1989). Soil Microbiology and Biochemistry, Acdemic Press, p. 273
2. Bewick Michael W. M. (1980). Hand Book of Organic Waste Conversion, Van Nostrand Reinhold Co., 419 p. :
3. P. C. Mishra ((2001) Soil Pollution and Soil Organism, Ashish Publications, p. 300
4. Trivedi, P.R. and Raj, Gurdeep (1992): Solid Waste Pollution; Akashdeep Publishing.House; New
5. Holmes, J.R. (1981). Refuse, Recycling and Recovery; John Wiley and Sons: New York, NY, USA. .
6. White, R.E. (1979). Introduction to the principle and Practices of Soil Science : White, Blackwell Scientific Publ. p.198

ENS 528 E Laboratory Practical and Field Studies on ENS 526 E- ENS 527 E 4CH

Non-Credit Course

I. Yuva Sanskar – 1st Semester – HOD of the concerned Department will take care of this course
II. N.C.C. / N.S.S./ Sports/ Performing Arts/ Yoga (only one is to be opted) – 2nd or 3rd Semester
The course in-charge of the University will float the course at the beginning of the semester

Course	In-Charge
NCC	Officer In-Charge NCC Cell
NSS	Coordinator NSS Cell
YOGA	Coordinator School of Performing Arts
SPORTS	Physical Education Officer
PERFORMING ARTS	Coordinator School of Performing Arts

QUESTION PATTERNS (COURSE STARTS FROM THE SESSION 2023)

Each Paper: 100 marks

Theory Papers:

Periodical Test: 20 marks

(Internal assessment =10 marks and Home assignments = 10 marks)

Mid-term for 20 marks will consists of 10 marks each for two class tests, 5 for assignment, 5 for case study

End term Test: 80 marks

Part-A: 20 marks: Each question 1 mark x 20 questions

(Preferably multiple choice type covering 5 questions from each unit)

Part-B: 60 marks: Question carrying 15 marks will be asked from each unit separately. The distribution of 15marks will be decided by the paper setter. Suggested patterns of distribution of 15 marks are 15, 8+7, 7.5 +7.5, 5+10, 2+3+10, 5+5+5.

(Each question must carry an alternative)

Practical Papers:

Total : 100 marks (70 Marks Practical+15 Marks Viva Voce, 15 Marks Records)
List of Practicals will be provided to the students at the beginning of the semester

Theory Papers ESDMS 419, IDC <Code as per the course opted by the candidate > and EDPS 439

Periodical Test: 40 marks

(Internal assessment =20 marks and Home assignments = 20 marks)

Mid-term for 40 marks will consists of 20 marks each for two class tests, 10 for assignment, 10 for case study

End term Test: 60 marks

Part-A: 12 marks: Each question 1 mark x 12 questions

(Preferably multiple choice type covering 5 questions from each unit)

Part-B: 48 marks: Question carrying 12 marks will be asked from each unit separately. The distribution of 12 marks will be decided by the paper setter. Suggested patterns of distribution of 12 marks are 12, 8+4, 6 +6, 5+10, 2+3+7, 4+4+4.

(Each question must carry an alternative)

MOOC Course: MOOCs course will be chosen by the candidate and the candidate will register in the programme paying the registration fee in consultation with the MOOC Course coordinator of the Department

Project Work:

Project work of 4th Semester will be assigned to the students (jointly or individually) at the beginning of the IIIrd semester and will be completed in the IVth semester. The distribution of the work/marks will be as follows

Semester-wise distribution of marks in % for Project work (Total 100 marks)			
IIIrd Semester (20%) (20 Marks)			
Background of the Problem (5% = 5 marks)	**Review of Literature (5%= 5 marks)**	**Objectives (5%= 5 marks)**	**Methodology (5%== 5 marks)**
IVth Semester (80%)			
Project work (50%= 50 Marks)		**Viva-voce (30%=50 Marks)**	

Head of the Department

COURSE AT A GLANCE

SUBJECT: **M.Sc. Environmental Science**

ACADEMIC SESSION: **2023-25, 2024-2025 (Batch:2023-2025)**

First Semester-December,2023

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS. 411C	Fundamentals of Ecology and Environmental Sciences	4	PT-20, ET-80	100
ENS. 412C	Remote Sensing and Geographical Information System	4	PT-20, ET-80	100
ENS. 413C	Instrumental Techniques : Principle and Application	4	PT-20, ET-80	100
ENS. 414C	Methods of Analysis of Environmental Samples	4	PT-20, ET-80	100
ENS. 415C	Laboratory Practical and field studies on ENS 411 C to ENS 414 C	4	ET-100	100
ESDMS 419	Environmental Field Survey	2	PT-40, ET-60	100
	TOTAL CREDIT HOUR	**22**		

Second Semester-April, 2024

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS. 421C	Fundamentals of Soil Science	4	PT-20, ET-80	100
ENS. 422C	Nonrenewable and perpetual Energy Resources	4	PT-20, ET-80	100
ENS. 423C	Data Analysis in Environmental Sciences	4	PT-20, ET-80	100
ENS. 424C	Laboratory Practical on ENS 421 C to ENS 424C including Computer application in Data Analysis	4	ET-100	100
ENS. 425C	Summer Training and Project Report/ Term Paper to be evaluated by Departmental Teachers	2	ET-100	100
ENS. 426C	Seminar (to be evaluated by Departmental Teachers)	2	ET-100	100
IDC <Code as per the course opted>	Interdisciplinary Course	3	PT-10, ET-40	50
	TOTAL CREDIT HOUR	**23**		

Third Semester-December, 2024

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS. 511C	Environmental Pollution	4	PT-20, ET-80	100
ENS. 512C	Forest and Wild Life Ecology	4	PT-20, ET-80	100
ENS. 513C	Environmental Toxicology	4	PT-20, ET-80	100
ENS. 514C	Disaster Management	4	PT-20, ET-80	100
ENS. 516C	Laboratory Practical & field studies on ENS 511 C and 514C	4	ET-100	100
EDPS 439	Entrepreneurship Development	2	PT-40, ET-60	100
MOOCs <Code as per the course opted>	MOOC Course is to be opted by the candidate <One Number>	3	ET-100	100
	TOTAL CREDIT HOUR	**25**		

Fourth Semester-April, 2025

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ENS 521C	Project Work	4	ET-100	100
ENS 522C	Environmental Law and Society	4	PT-20, ET-80	100
Specialisation: A student shall opt for one of the following groups				
GROUP- A: Pollution Control and Environmental Biotechnology				
ENS.523 E	Pollution Control and Management	4	PT-20, ET-80	100
ENS.524 E	Environmental Biotechnology	4	PT-20, ET-80	100
ENS 525 E	Laboratory Practical and field studies relating to ENS.523 E & 524 E	4	ET-100	100
GROUP- B: Soil Biology and Biotechnology				
ENS 5267E	Soil Biology and Ecology	4	PT-20, ET-80	100
ENS 527 E	Soil Biotechnology	4	PT-20, ET-80	100
ENS 528 E	Laboratory Practical and Field studies on ENS 526 E & 527 E	4	ET-100	100
	TOTAL CREDIT HOUR	**20**		

TOTAL CREDIT HOURS FOR THE PROGRAMME = **90**

NON-CREDIT COURSES

I. Yuva Sanskar – 1st Semester – HOD of the concerned Department will take care of this course

II. N.C.C. / N.S.S./ Sports/ Performing Arts/ Yoga (only one is to be opted) – 2nd or 3rd Semester
The course in-charge of the University will float the course at the beginning of the semester

Course	In-Charge
NCC	Officer In-Charge NCC Cell
NSS	Coordinator NSS Cell
YOGA	Coordinator School of Performing Arts
SPORTS	Physical Education Officer
PERFORMING ARTS	Coordinator School of Performing Arts

Head of the Department