

# SOLAPUR UNIVERSITY, SOLAPUR

**M.Sc. I & II ENVIRONMENTAL SCIENCE**  
Choice Based Credit System Syllabus  
(w.e.f. June 2015-16)  
**STRUCTURE OF THE COURSE**

## SEMESTER – I

<b>SR. NO</b>	<b>PAPER CODE</b>	<b>TITLE OF THE PAPER</b>	<b>LOAD / WEEK (hrs)</b>	<b>TOTAL LOAD (hrs)</b>	<b>CREDITS</b>
1	EST 101	FUNDAMENTALS OF ENVIRONMENT	04	56	04
2	EST 102	ENVIRONMENTAL CHEMISTRY	04	56	04
3	EST 103	ENVIRONMENTAL STATISTICS AND COMPUTER APPLICATIONS	04	56	04
4	EST 104	INTRODUCTION TO GEO-SCIENCE	04	56	04
5	ESP 105	PRACTICAL RELATED TO EST 101 & EST 102	04	56	04
6	ESP 106	PRACTICAL RELATED TO EST 103 & EST 104	04	56	04
7	EST 107	SOFT SKILL ICT, SCIENTIFIC ENGLISH	01	07	0.75
		SEMINAR	01	07	0.25
8	TOTAL			350	25

## SEMESTER – II

SR. NO	PAPER CODE	TITLE OF THE PAPER	LOAD / WEEK (hrs)	TOTAL LOAD (hrs)	CREDITS
1	EST 201	BIODIVERSITY AND CONSERVATION	04	56	04
2	EST 202	ANALYTICAL TECHNIQUES AND INSTRUMENTATION	04	56	04
3	EST 203	WATER AND WASTEWATER ENGINEERING	04	56	04
4	EST 204	REMOTE SENSING AND GIS IN ENVIRONMENTAL SCIENCE	04	56	04
5	ESP 205	PRACTICAL RELATED TO EST 201 & EST 202	04	56	04
6	ESP 206	PRACTICAL RELATED TO EST 203 & EST 204	04	56	04
7	EST 207	SOFT SKILL ICT, SCIENTIFIC ENGLISH	01	07	0.50
		TOUR & TOUR REPORT			0.25
		SEMINAR	01	07	0.25
8	<b>TOTAL</b>			<b>350</b>	<b>25</b>

**SEMESTER – III**

<b>SR. NO</b>	<b>PAPER CODE</b>	<b>TITLE OF THE PAPER</b>	<b>LOAD / WEEK (hrs)</b>	<b>TOTAL LOAD (hrs)</b>	<b>CREDITS</b>
<b>1</b>	<b>EST 301</b>	<b>ENVIRONMENTAL POLLUTION</b>	<b>04</b>	<b>56</b>	<b>04</b>
<b>2</b>	<b>EST 302</b>	<b>ENVIRONMENTAL BIOTECHNOLOGY</b>	<b>04</b>	<b>56</b>	<b>04</b>
<b>3</b>	<b>EST 303</b>	<b>ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT</b>	<b>04</b>	<b>56</b>	<b>04</b>
<b>4</b>	<b>EST 304</b>	<b>NATURAL RESOURCE MANAGEMENT</b>	<b>04</b>	<b>56</b>	<b>04</b>
<b>5</b>	<b>ESP 305</b>	<b>PRACTICAL RELATED TO EST 301 &amp; EST 302</b>	<b>04</b>	<b>56</b>	<b>04</b>
<b>6</b>	<b>ESP 306</b>	<b>PRACTICAL RELATED TO EST 303 &amp; EST 304</b>	<b>04</b>	<b>56</b>	<b>04</b>
<b>7</b>	<b>EST 307</b>	<b>SOFT SKILL ICT, SCIENTIFIC ENGLISH</b>	<b>01</b>	<b>07</b>	<b>0.75</b>
		<b>SEMINAR</b>	<b>01</b>	<b>07</b>	<b>0.25</b>
<b>8</b>		<b>TOTAL</b>		<b>350</b>	<b>25</b>

### SEMESTER – IV

SR.NO	PAPER CODE	TITLE OF THE PAPER	LOAD / WEEK (hrs)	TOTAL LOAD (hrs)	CREDITS
1	EST 401	ENVIRONMENTAL POLICY, ACTS, LAWS AND ENVIRONMENTAL MANAGEMENT SYSTEM	04	56	04
2	EST 402	ENVIRONMENTAL TOXICOLOGY	04	56	04
3	EST 403	WATERSHED MANAGEMENT	04	56	04
4	EST 404	RESEARCH METHODOLOGY	04	56	04
5	ESP 405	PRACTICAL RELATED TO EST 401 & EST 402	04	56	04
6	ESP 406	PRACTICAL RELATED TO EST 403 & EST 404	04	56	04
7	EST 407	RESEARCH PUBLICATION / SEMINAR PAPER PRESENTATION	01	07	0.75
		TOUR & TOUR REPORT	01	07	0.25
8	<b>TOTAL</b>			<b>350</b>	<b>25</b>

**NOTE:**

**Each semester will have 1 credit (25 marks) for- field training for long tour/ in plant training/remote sensing institute visit or field work, data acquisition related to dissertation.**

(Academic Flexibility)  
**M.Sc. Environmental Science, Part I, Semester – I**  
[Core theory course with 04 credits]

**EST- 101: Fundamentals of Environment**  
**(Includes current developments in the subject)**

Preamble: This paper introduces the students, coming from disparate backgrounds, to the basics of Environmental Science. Major themes and issues confronting our present day environment are introduced in this paper from developing a scientific perspective.

**Unit – I: Introduction to Environment** **9**

Definition, principle and scope of environmental science, man & environment, media and people, decision making and applications in environmental science, environmental ethics, environmental consciousness, environment and evolution of human society, civilization and environment, biological evolution and environment, concept of Gaia hypothesis, modern concept of evolution, Sern experiment and God particle-Boson.

**Unit -II: Components of Environment** **9**

Holistic concept, Environmental complex, Environmental factors: Atmosphere, Hydrosphere, Lithosphere and biosphere and their interrelationships.

**A. Atmosphere:** structure and composition atmosphere.

**B. Lithosphere:** structure and composition of lithosphere, soil: physical, chemical and biological characteristics, **Chemical composition** and general composition of soil, soil formation: physical, chemical, biological weathering, soil profile, soil erosion.

**C. Hydrosphere: Global water balance,** Hydrological cycle, structure and composition of hydrosphere, global water balance, Origin and composition of seawater, Ice sheet and, fluctuations of sea levels, types of water, factors influencing the surface water, ground water exploration, rain water harvesting, resources of oceans. Human usage of surface and ground water.

**A. Biosphere:** Concept of biosphere, physical, chemical and biological factors of environment.

**Unit -III: Ecosystem dynamics** **9**

Concept of ecosystem, abiotic and biotic components, Tolerances, ecological amplitude, limiting and inhibiting effects. Climatic (light and temperature) factors, edaphic factors - soil - Biotic factor, relationship between organisms, competition- symbiosis, parasitism, prey predator, neutralism, commensalism, mutualism, proto-cooperation, antibiosis, allelopathic interactions. energy flow in ecological system, concept of productivity, food chain, food web, ecological pyramids, cybernetic nature and stability of ecosystem, concept of Habitat, ecological niche, guild, concept of ecotone, edge effect, ecological succession, mechanism of succession, concept of climax.

**Unit IV: Restoration of Degraded ecosystems** **9**

Types of ecosystems, natural and human engineered ecosystems, ecological restoration of degraded ecosystems such as, forest, grassland, mangrove ecosystem, desert ecosystem, lentic and lotic ecosystems, coastal ecosystems etc., role of pioneer species in restoration, major biomes of world.

## **Unit- V: Population dynamics and community ecology**

9

Concepts of population ecology, population dynamics, characteristics of population: natality, mortality, fecundity, biotic potential, growth rate, density, age distribution, prey predator relationship, population explosion; Adaptations, Concept of community, interspecific and interspecific competition, concept of carrying capacity ecological sustainability, population change-k and r selections..

### **List of Practical ESP-105A on EST- 101:**

#### **Environmental Ecology:**

1. Identification of different tools and instruments,
2. Identification of common weeds, Herbarium preparation,
3. Biodiversity categorization and measurement studies.
4. Collection of injured leaves from heavy polluted roadsides and its comparison with healthy leaves,
5. A visit to aquatic ecosystem and methods for water and plankton collection,
6. Plankton identification and quantification from river / lake water samples,
7. Vegetation studies by line, Quadrates and belt transect methods and their analysis.
8. **Qualitative and quantitative estimation of Phytoplankton.**
9. Qualitative and quantitative estimation of Zooplankton.
10. Study of Macrophytes of lakes and Study of adaptive characteristics.
11. Estimation of Primary Productivity by light and dark bottle method.
12. Estimation of primary productivity of grasses by Harvest method.
13. Analysis of local lake with special reference to their conservation and management.
14. Effect of light/pollutant on Photosynthetic activity.
15. Bioremediation of contaminated soil site by heavy metals with plants.
16. Effects of bioremediation on plants physiology (stomata, xylem, phylum).
17. Thermal study of water bodies with respect to Temperature, pH, free CO<sub>2</sub>, dissolved oxygen, acidity, alkalinity.
18. Study of Eutrophication of water bodies with respect to
  - i. Total Nitrogen by Kjeldhal method.
  - ii. Total Phosphate by Stannous chloride method.
19. Classification water bodies on the basis of Nitrogen, Phosphorous ratio for Oligotrophic, Mesotrophic and Eutrophic conditions.
20. Comparative study of fresh water body and eutrophic water body for the following parameter :
  - i. Dissolved Oxygen
  - ii. Phytoplanktons
  - iii. Zooplanktons
24. Determination of Organic matter of forest floor and waste land and its interpretation.
25. Determination of Bulk Density of forest floor and wasteland.
26. Determination effect of Industrial water on river bed (clay sand, silt, bacteria and fungi).

## References:

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2. Anjaneyulu. Y, (2004), Introduction to Environmental Science. B. S. Publications.
3. D. Daniel Chiras, (2001), Environmental Science, 6<sup>th</sup> Ed., Jones and Bartlett Publishers.
4. Daniel Botkin and Edward Keller (1997), Environmental Sciences, John Wiley and Sons, New York.
5. A. K. Jain (1989), Forests in India, Vorha Publication, Allahabad.
6. Edward J. Kormondy (2009), Concepts of Ecology (Fourth Edition)- Prentice Hall of India Pvt. Ltd. New Delhi.
7. Eldon D. Enger and Bradley F. Smith (1995), Environmental Science, WCB Publishers, Boston.
8. Gaudy, A.F.and Guady, E.T. (1980), Microbiological Methods for Environmental Scientists and Enginners McGraw Hill.
9. Grainer, J.M. and Lynch, J.M. (1984). Microbial Methods for Environmental Biotechnology: Academic Press.
10. Linton, A. H. and Burns, R.G. (1982) Microbes, Man and Animals: The Natural History of Microbial Interactions : John Wiley and Sons.
11. Mukherji Shormila, (2004), Fragile environment, Manak Publication Pvt. Ltd.
12. Nileema Rajvaidya (1989), Advances of Environmental Science and Technology, APH Publishing House, Delhi.
13. P.D. Sharma, (1986), Environmental Biology Rastogi Publication, Meerut.
14. P.D. Sharma, Ecology and Environment(1989), Rastogi Publication, Meerut.
15. Pelczar, M.J. and Chan ECS, 1981, Elements of Microbiology, John Wiley and Sons, McGraw Hill.
16. R.K. Trivedi, P.K. Goel and Trisal, (1989) Practical Method in Ecology Enviro Publication, Karad.
17. R.Ramesh, M. Anbu. (1996), Chemical methods for Environmental Analysis Water and sediments –Macmillan India Ltd. New Delhi.
18. Subramanian. V, (2002), A text book in Environmental Science, Narosa Publishing House, New Delhi.
19. T.D. Bishwas & S. K. Mukharji, 2<sup>nd</sup> Ed. (1997), A.J.B. of Soil Sciences, Tata McGraw hill pub. Co. Ltd. New Delhi.
20. Wart K.E.F. (1973) Principles of Environmental Science –Mc Graw Hill Book Company.
21. Wright. R.T, and Nebel. B. J, (2004), Environmental Science, 8<sup>th</sup> Ed. Prentice Hall India Ltd.

**(Academic Flexibility)**  
**M.Sc. Environmental Science, Part I, Semester – I**  
**[Core theory course with 04 credits]**

**EST- 102: Environmental Chemistry**  
(Includes current developments in the subject)

**Preamble:** The course introduces the students to some basic chemistry relevant to the course, and to the general chemistry of the lithosphere, hydrosphere and atmosphere. Emphasis is also placed on understanding the chemistry of various anthropogenic pollutants and basic analytical techniques.

**Unit-I: Basic concepts of Environmental Chemistry** **12**

Classification of elements, theory of valency, basic concepts of colorimetry from quantitative chemistry, molecular weight, equivalent weight, mole concept, normality, molarity, molality, molar solution, standardization, primary standards, secondary standards, blank titration, principle of colorimetry, Lambert's law, Beer's law, Nernst distribution law, principle of colloidal chemistry, emulsions, adsorption, absorption, Energy- Definition, types (kinetic and potential), forms of energy; laws of thermodynamics (First & Second), stoichiometry, Gibbs energy, chemical reactions, chemical potential, chemical equilibrium, acid-base reactions, Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclide, Concept of Green chemistry for sustainable future.

**Unit -II: Chemistry of air** **12**

Classification of elements; composition of air; chemical speciation; particles ions and radicals in the atmosphere; chemical processes for formation of inorganic and organic particulate matter. Chemical aspects of acid rain and photochemical smog, Formation of acid rain; adverse effects of acid rain; chemistry and concepts of green house effect, photochemical smog and ozone layer depletion, CFCs, NO<sub>2</sub>, HC and PAN, other toxic chemicals in environment, pesticides, insecticides, arsenic, cadmium, lead, mercury, carbon monoxide and ozone, MIC and other carcinogens in air and water, major air pollutants, their sources, effects on biotic and abiotic components, air, soil, water and organisms.

**Unit -III: Chemistry of water** **10**

Chemistry of water; structure of water molecule, hydrological cycle, distribution of water, water quality parameters and standards, Physico-Chemical parameters of water, concept of DO, BOD, COD, sedimentation, coagulation, filtration, Redox potential, water cycle, types of water, sampling techniques, sources and uses of water, solubility of compounds in water; dissociation constant, ionic product of water, the hydrogen ion exponent (pH), buffer solutions, , alkalinity and acidity, the carbonic acid system, buffering in water system, metals in aqueous solution.

**Unit IV: Chemistry of Soil** **11**

Introduction to Soil Chemistry, Formation of soil, weathering of rocks, composition, soil profile, reactions in soil, cation and anion exchange phenomenon, Nature and composition of soil, soil water - soil air - soil temperature -mechanical composition- structure and texture, physical and Chemical properties of soil,. Soil survey, Soil Fertility, chemical and mineralogical composition of soils, soil organic matter, soil nutrients, concept and role of macronutrients and micronutrients, biogeochemical cycles (nitrogen, oxygen, carbon, sulphur, phosphorus etc); Minerals of soil - colloids in soil; ion exchange reactions in soil. Soil fertility, micronutrients of soil; factors affecting the soil quality; adsorption of contaminant in soil; toxic chemicals present in soil, major soil types in India and Maharashtra



## **List of Practical ESP-105B on EST- 102**

1. Study of Sampling and storage techniques of water and soil
2. Determination of pH and Electrical conductivity (EC) calibration and metric titration
3. Determination of Dissolved Oxygen (DO) by Winkler's method.
4. Determination of Biochemical Oxygen Demand (BOD)
5. Determination of Chemical Oxygen Demand (COD)
6. Determination of Solids (TDS, TSS and TS)
7. Determination of Hardness (Ca, Mg and Total Hardness)
8. Determination of Alkalinity and Acidity
9. Determination of Residual Chlorine and Chlorides
10. Estimation of Silicates (SiO<sub>2</sub>)
11. Determination of H<sub>2</sub>S in water sample
12. Estimation of free CO<sub>2</sub> from wastewater sample
13. Determination of Anionic surfactants
14. Determination of Iron
15. Estimation of alkali metals in various samples by flame-photometry

### **References:**

1. A.K. De (2001), Environmental Chemistry, New Age International Publishers, New Delhi.
  2. A.Singh and R. Singh (2005), Surface Chemistry, Campus Book International, New Delhi, India.
  3. B.K. Sharma, (2001), Instrumental Methods of Chemical Analysis, Goal Publishing House, Meerut, India.
  4. Dara S S.,(1998), A text book of environmental chemistry and pollution control, S. Chand & Company Ltd, New Delhi
  5. Ewing G.W, (1985), Instrumental Methods of Chemical Analysis, 5th Edition McGraw Hill, U.K.
  6. Howard S Peavy (2003), Environmental Engineering, Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
  7. J.D. J., Denney, R.C., Jeffery, G.H and Mendham, J. (1999), Vogel's Text Book of Quantitative Inorganic Analysis, Barnes, 6th Edition, Pearson Education Ltd., U.K.
  8. P. W. Atkins and Julio de Paula (2006), Atkins' Physical Chemistry, Oxford University Press, NY, USA.
  9. R. D. Madan (2010), Modern Inorganic Chemistry, S. Chand & Company Ltd, New Delhi, India.
  10. Roy I Donalue, Raymond W Miller and John C Shiekluna (1987), An Introduction to Soils and Plant Growth, 5th Ed, Prentice Hall of India.
  11. S. E. Manahan (2000), Environmental Chemistry, CRC Press, USA.
  12. Sawyer C.N., Mc Carty P.L., and Parkin,G.F (2003), Chemistry for Environmental Engineering and Science, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
  13. Skoog, D.A and D.M.West, (2004), Fundamentals of Analytical Chemistry, Thomson Asia Pvt Ltd, Singapore.
  14. Standard Methods for the Examination of Water and Wastewater, (1998), 20th (Ed.) APHA, Washington, D.C.
  15. Web References
1. [www.gibbsenergy.com](http://www.gibbsenergy.com)
  2. [www.chem.unep.ch/pops/pdf/lead/leadexp.pdf](http://www.chem.unep.ch/pops/pdf/lead/leadexp.pdf)
  3. [www.icrisat.org/aflatoxin/aflatoxin.asp](http://www.icrisat.org/aflatoxin/aflatoxin.asp)
  4. [bioenergy.asu.edu/photosyn/courses/bio\\_343/lecture/dna-rna.html](http://bioenergy.asu.edu/photosyn/courses/bio_343/lecture/dna-rna.html)
  5. [www.cem.msu.edu/cem333/Week09.pdf](http://www.cem.msu.edu/cem333/Week09.pdf)

**(Academic Flexibility)**  
**M.Sc. Environmental Science, Part I, Semester – I**  
**[Core theory course with 04 credits]**

**EST- 103: Environmental Statistics & Computer Applications**

(Includes current developments in the subject)

**Preamble:** This paper introduces the students to various methods used in the collection of data and analysis for environmental sciences. The students are to get well acquainted with the computer and internet access for various applications in earth science to make them enough competent for its use to analyse the data and investigate the complexity of environmental aspects.

**Unit I: Basic concepts in Environmental Statistics** **10**

Statistical sampling, purpose of sampling, principles of sampling, merits of sampling, basics and types of samplings, simple random sampling, Stratified random sampling, Systematic sampling, Multistage sampling. Statistical methods for environmental systems, Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves, pie diagram etc.

**Unit II: Statistical measures and Probability** **12**

Measures of central tendency and their properties -mean and its types, median, mode, Measures of dispersion-Variance, Standard Deviation, Mean Deviation, Coefficient of Variation, range and quartile deviation, concept and types of skewness and kurtosis, moments. measure of central location, mean, mode, median, measure of shapes. Properties of mean, measure of spread, variance and standard deviation, co-efficient of variation. Concept of probability, addition and multiplication theorem of probability, conditional probability and unconditional probability, Simple problems on probability.

**Unit III: Techniques for statistical testing** **10**

Concept and types of hypothesis, Sampling theories and Hypothesis testing, null and alternative hypotheses, tests of hypothesis- t test, f test, z test and Chi-square tests, Sampling techniques and experimental designs. Testing hypothesis : Significance level and X<sup>2</sup> test, t and F test Variables of environmental interest, Concept of Correlation, its types and application in Environmental Science, Concept of Regression lines-x on y and y on x, regression analysis.

**Unit IV: Computer applications** **13**

Introduction to computer, : History of Computer, types and generations of computer, computer organization, commonly used commands, laptop, tablet, PC, mainframes and Super-computers, concept of software and hardware, Input and output devices, Types of memory, primary (RAM, ROM, PROM, EPROM, EEPROM) and secondary (Floppy, hard disc, e band DVD) as storage devices, their functions, Printers and scanners Operating system, LAN, WAN, capabilities and limitations of computers, Use of computer in environmental Science, applications of Windows XP, MS Word, MS Excel, MS Power Point, Adobe Page Maker, Adobe Photoshop in environmental science, introduction to web and internet access, application of internet in environmental science and earth sciences.

**List of Practical ESP-106A on EST- 103: Environmental Statistics & Computer Application.**

1. Tabulation of data.
2. Introduction to computer system and its components.
3. Applications of computers in Earth Sciences
  - a) Report presentation using MS-Office
  - b) Simple statistical work using Excel spread sheet
  - c) Presentation using Power Point

4. Representation of Statistical data using computer in two and three dimensional forms by
  - a) Histograms b) Ogive Curves c) Pie diagrams
5. Determination of Statistical averages (Manual or using Excel spread sheets).
  - a) Arithmetic mean b) Median c) Mode
6. Determination of measures of Dispersion
  - a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation
7. Tests of Significance for testing of hypothesis-Application of following
  - a) Chi- Square test b) t- test c) z-test, d) Standard error
8. Calculations for correlation and regression analysis.
9. Use of Data sheet and data management.
10. Creating table for given scientific table.
11. Plotting of scatter diagram using computer in Excel.
12. Email and internet accessibility in Environmental Sciences.
13. Creating files, folders and directories.
14. Creating word document and reporting.
15. Creating an e-mail account, sending and receiving mails.
16. An introduction to INTERNET, search engines, websites, browsing and Downloading of PDF files.
17. Creating Power point presentation on suitable topic on Environmental Science.
18. Design and creation of website.

#### **References:**

1. Campbel, R.C., (1974), Statistics for Biologist, Cambridge University Press, UK.
2. Ford, E.D. 2000, Scientific methods for Ecological Research. Cambridge University Press, Cambridge.
3. Rosner, B. (1986), Fundamentals of Biostatistics, Duxbury Press, Boston.
4. Zar, J.H. (1984), Biostatistical Analysis. Prentice-hall, Inc Englewood Cliff, New Jersey.
5. INTERNET – CDC publication, India.
6. Snedecor, W and G. Cochran, (1967), Statistical Methods. Oxford and IBH Publishing Co. Calcutta.
7. Bodkin, Daniel D. (1995), Environmental Science- Earth As a Living Planet, John Wiley & Sons, New York.
8. Clark, C.W. (1976), Mathematical Bioeconomics: Optimal Management of Renewable Resources, John
9. Gore, Anil and Paranjpe, S.A. (2000), A Course on Mathematical and Statistical Ecology, Kluwer.
10. Ludwig, J.A. and Judwig, J.F. (1988), Statistical Ecology, Wiley and Sons, New York.
11. S. E. Jorgeson (1994), Fundamentals of Ecological Modelling, Levis Publications, New York.
12. Pielou, E.C. (1997), An Introduction to Mathematical Ecology, John Wiley and Sons, New York.
13. Ray, Devraj (1998), Development Economics, Oxford University Press, Oxford.
14. Snape and Dunn (1995), Dynamics of Environmental Bioprocesses-modeling and simulation.
15. Sen, A. (1997), Poverty and Inequality, Oxford University Press, Oxford.
16. Smith, J. M. (1982), Evolution and the Theory of Games, Cambridge University Press, Cambridge.

**(Academic Flexibility)**  
**M.Sc. Environmental Science, Part I, Semester – I**  
**[Core theory course with 04 credits]**

**EST- 104: Introduction to Geoscience**  
(Includes current developments in the subject)

Preamble: All human activities take place on earth using a large variety of its resources where we live and use these resources, so need the knowledge of the science of the earth for sustainable society and to sustain the biosphere. The subject Environmental Geology is an applied one, wherein basic knowledge of geological forms and process is used to maximize the utilization of all natural resources, minimize their degradation and minimize the destructive potential of natural processes to sustain a healthy life system on earth.

**UNIT-I: Introduction to Environmental Geo-science** **10**

Environmental Geo-science: Fundamental concepts, Primary differentiation and formation of core, mantle, crust, magma generation, eruptions and volcanoes. Formation and classification of rocks: plate tectonics – sea floor spreading, mountain formation, rock deformation and evolution of continents, weathering and soil formation, soil profile, soil classification, soils of India. Global water balance, ice-sheets and fluctuations of sea levels.

**UNIT-II: Environmental Geochemistry** **12**

Concept of major, minor and trace elements. Mobility of elements, geochemical cycles, sedimentary cycle, deforestation and erosion, Geo-indicators, geological consequences of industrialization, groundwater pollution and management-case studies related to fluoride, pesticide, fertilizers and arsenic contaminations in India, Environmental ethics, Mineral resources in relation to plate tectonics and geology, geology of mineral resources, mineral sources and reserves, distribution of mineral resources in India, environmental impact of mineral development, recycling of mineral resources, Mineral resources of Maharashtra, Oceans as new areas for exploration of mineral resources, ocean ore and recycling of resources, Environmental impact of exploitation, processing and smelting of minerals, Water resources and environment, global water balance, ice sheets and fluctuation of sea levels. Origins and composition of seawater, hydrological cycle factors influencing the surface water.

**UNIT-III: Atmosphere** **11**

Radiation, conduction and convection, forms of condensation-dew, frost, fog, mist, smog and cloud, Atmospheric stability, adiabatic character, dry and wet adiabatic lapse rate, Turbulence and diffusion, Different layers and their characteristics, meteorological aspects-inversions, mixing height, wind-rose, electromagnetic radiations, solar radiation and terrestrial radiation, heat budget, Temperature measurements and controls, Environmental lapse rate, humidity, mixing ratio, clouds-types and their characteristics, Atmospheric transport, diffusion and dispersion, Application of meteorology to air pollution study, Atmospheric moisture, general atmospheric circulation, Precipitation and types of storms, Indian monsoon, El Nino, La Nina effect, and western disturbances,

**UNIT-IV: Environmental Geo-Climate** **12**

Elements of Weather and Climate, classification, energy balance in atmosphere, greenhouse effect, Geo-strophic wind and gradient wind, cyclones, Forms of cloud condensation; Precipitation, Thunderstorms, floods and droughts, Climatic change in of recent times; identification and characteristics of bio-climatic and agro-climatic regions of India; urban climatology; climate and human comfort, Climate variability and climate change, its causes, climate change impacts on water resource management, health impacts, Global warming and its impact upon the ecosystem- Controlling measures of global warming, Acid rain, Effects of acid rain on environmental components, drinking water standard, introduction to weather forecasting models.

### **List of Practical ESP-106B on EST- 104A:**

1. Preparation of global and Indian natural hazard maps
2. Interpretation of transport of pollutants in the subsurface
3. Preparation of local level maps of pollution case studies
4. Preparation of groundwater flow nets and assessment of probable contaminant movement in the subsurface
5. Problem solving on movement of pollutants in the subsurface using simple computer assisted models
6. Study of Geomorphological models: a) Coastal plain b) Volcanoes c) Fault blocks mountains d) Folded mountains e) Glaciers f) Canyon g) Cost line
7. Petrology: Identification of major rock types
8. Mineralogy: Identification of common rock forming minerals
9. Study of the conventional signs and symbols from toposheet and their interpretation
10. Study of the conventional signs and symbols from weather map and interpretation of weather map.
11. Geological survey for investigations and identification of land fill sites for solid hazardous waste management
12. Determination of Fluoride from ground water samples
13. Determination of Arsenic from ground water samples
14. Measurement and analysis of weather related data (Rainfall, Humidity, Temperature, wind velocity and wind direction, wind speed etc.)
15. Quantify hydrological cycle in different land use types in or around specified premises
16. Use of survey instruments: Theodolite, Dumpy level and plane table.

### **Reference Books**

1. A.N. Strahler and A.H. Strahler (1973), Environmental Geo-science-Hamilton Publication
2. Basu S.K. (2003), Handbook of Oceanography, Global Vision, Delhi.
3. Bell F. G., (1998), Environmental geology: Principles and practice. Blackwell Sc.. Oxford.
4. Bennett, M. R. and Doyle, P. (1997), Environmental geology - Geology and the Human Environment. John Wiley and Sons.
5. Botkin, Daniel B. and Keller, Edward A (2007), Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA.
6. Bouwer, H. (1978), Groundwater Hydrology. McGraw-Hill, New York.
7. Butz, S.D. (2004), Science of Earth Systems. 2nd ed. Thomson Delmar Learning, USA
8. Chamley, H. and Chamley, H. (2003), Geosciences, Environment and Man Elsevier Science & Technology pub.
9. Chiras, D.D (1989), Environmental Science-A frame work for decision maling- Addison-Wesley publishing company- New York.
10. D.P.Coates (1981), Environmental Geology-John Wiley and Sons –New York.
11. Eby, N.( 2003), Principles of Environmental Geochemistry. Brooks Cole, USA.
12. Joseph, G. (2007), Fundamentals of Remote Sensing. Universities Press (India) Pvt. Ltd.
13. Kale, V. S. and Gupta, A. (2001), Introduction to Geomorphology, Orient Longman,
14. Keller, E.A.( 1999), Environmental Geology. 8th ed. Prentice Hall of India.
15. Keller, E.A. (2007), Introduction to Environmental Geology. 4th ed. Prentice Hall of India.
16. Kemp, M.J. (1997), Environmental Science. The McGraw-Hill Companies.
17. Kusky, T. M. (2003), Geological Hazards, Greenwood Press, Westport, Conn. London.
18. Lutgens F. K., Tarbuck, E. J. and Tasa, D. (2008), Essentials of Geology, Prentice Hall Publishers.

19. Randolph, J. (2004), Environmental land use planning and management, Island Press,
20. Raven, Peter H., Berg, Linda R. and Hassenzahl, David M. (2008), Environment. 6th ed. John Wiley & Sons., USA.
21. Savindra Singh (2002), Geomorphology, PrayagPustakBhawan, Allahabad.
22. Schwartz, F.W. and H. Zhang. (2003), Fundamentals of Ground Water. John Wiley & Sons, USA.
23. Strahler, A.H and Strahler A.N (2002), Modern Physical Geography, John Wiley and Sons.
24. Thurman, H.V and Trujillo, A.P., (2004), Introductory Oceanography, Prentice Hall. Washington.

**PART- I**  
**SEMESTER – II**

**EST – 201 Biodiversity and Conservation**

Marks: External 70  
Internal 30

Unit	Topic	Credit	Lectures
UNIT-1	<p><u>Introduction to Biodiversity:</u> Level of biological organization, the global perspective, Global Environmental changes, Biogeographical regions of India, Biodiversity concepts and patterns, Microbial diversity, Plant diversity, Agro-biodiversity, Soil biodiversity.</p> <p><u>Types:</u> Species diversity, Genetic diversity, Pattern diversity, Alpha, Beta and Gama diversity, Gradients of Biodiversity, Ecosystem diversity, Measuring of species diversity, richness and evenness, factors related to tropical species diversity.</p>	1	14
UNIT-2	<p><u>Factors governing biodiversity:</u></p> <p>a. Biodiversity hot-spots, diversity distribution, factors affecting diversity, Mega diversity regions of India, Diversity trends of different ecosystem, Major forest types and distribution of wild life in India.</p> <p>b. Impact of exotic species, disturbance on diversity, dispersal, diversity-stability relationship, keystone species.</p>	1	14
UNIT- 3	<p><u>Conservation of Biodiversity:</u></p> <p>a. Threats to biodiversity, Human interference and habitat destruction, Human &amp; Wildlife Conflicts, biological invasion. Importance of biodiversity conservation, direct and indirect benefits, Bioprospecting, Biopiracy, REDD.</p> <p>b. Strategies for biodiversity conservation. In-situ and ex-situ conservation, wildlife habitats and their conservation. Protected Area network, Biosphere Reserves, National Parks, sanctuaries, sacred groves; ex-situ conservation, gene pools, germplasm banks.</p>	1	14
UNIT-4	<p><u>Biodiversity Action Plan:</u> International conventions on biodiversity, IUCN Criteria, Endemic, extinct, endangered, vulnerable and rare species, Red Data Book. National Policy and Action Plan, Role of Forest Department in Conservation, Biodiversity Legislation in India. Integrated Protected Area System, RAMSAR sites. Existing conservation projects: Tiger, Rhino, Elephant, Turtles, Crocodiles, coral reefs and Mangroves.</p>	1	14

**INTERNAL EVALUATION**  
**(Seminar + term paper + test)**

**30 MARKS**

## Reference books:

1. Simpson, G.G. (1949). *The meaning of evolution, A Study of the History of Life and of Its Significance for Man*. Oxford University Press.
2. Magguran, A.E. (1996). *Ecological diversity and its measurements*. Princeton University.
3. Gadgil, M. () *A methodology manual for scientific inventorying, monitoring and conservation of Biodiversity*.
4. Sutherland, W. (2006). *Ecological census technique: A Handbook, 2nd Edn*. Cambridge University Press.
5. Gadgil, M. et. al. *A Methodology Manual for Documenting People's Priorities for Biodiversity and Conservation. Shrustiygyaan*.
6. Malhotra, K.C. et. al. (2001). *Cultural and Ecological Dimensions of Sacred Groves in India*. INSA, New Delhi.
7. Gadgil, Madhav and Rao, P.R.S. *Nurturing Biodiversity: An Indian Agenda*. Centre for Environment Education, Ahmadabad, India. 1999.
8. Dobson, A.P., 1996, *Conservation and Biodiversity*. Scientific American Library, New York, NY.
9. Gaston, K J. and J.I. Spicer, 1998, *Biodiversity: An Introduction*. Blackwell Science, London, UK.
10. Loreau, M., and P. Inchausti, 2002, *Biodiversity and Ecosystem functioning: Synthesis and Perspectives*. Oxford University Press, Oxford, UK.
11. Primack, R.B., 2002, *Essentials of Conservation Biology*, 3<sup>rd</sup> Edn., Sinauer Associates, Sunderland, Ma. USA.
12. Hunter, Malcolm L., Jr., and Gibbs, James P. *Fundamentals of Conservation Biology*. 3rd ed. Wiley-Blackwell. 2006.



Unit	Topic	Credit	Lectures
UNIT-1	<b>Electrochemical Methods</b> <b>Principles and applications:</b> pH meters, Ion selective electrodes, Conductivity Meters, Gravimetric Methods-TS,TSS,VSS High Volume Sampler, Scrubber, Electrostatic Precipitator, Bag Filter, Incinerator	1	14
UNIT-2	<b>Photometric methods</b> <b>Principles and applications:</b> Nephelometry and Turbidometry Spectrophotometer, UV Visible – Spectrophotometer, Flame photometry (FP), Atomic Absorption Spectrophotometry, Nuclear Magnetic Resonance (NMR), X-ray Fluorescence, X-ray Diffraction	1	14
UNIT- 3	<b>Chromatography-</b> <b>Principles and applications</b> Gas liquid chromatography, GC-MS &- High Performance Liquid Chromatography (HPLC), Inductively Coupled Plasma Spectroscopy (ICP), Aerosol Time of Flight Mass spectrophotometry (ATOMFS)	1	14
UNIT-4	<b>Dosimetry:</b> Geiger Muller Counter & Scintillation counter <b>Electrophoresis:</b> Gel electrophoresis & Immuno electrophoresis (ELISA, RFLP) <b>Microscopy:</b> Light microscope, - Fluorescent microscope Transmission Electron Microscope (TEM) and Scanning Electron Microscopy (SEM) <b>Micrometry:</b> Micro techniques- Fixation, Sectioning, Histological and Histochemical staining	1	14

**INTERNAL EVALUATION**  
(seminar+term paper+test)

**30 MARKS**

**Reference books:**

1. Environmental Chemistry : Moore and Moore Wiley's Publication
2. Environmental Chemistry : A.K. De
3. Environmental Chemistry : S.J.Arnikaar
4. Text Book of Environmental Chemistry and Pollution Control : S.S.Dara
5. Instrumental method Analysis: G.W.Ewing
6. Instrumental method Analysis: Chatwal Anand
7. Environmental Pollution Analysis: S.N. Khopkar

**EST-203: Water and Wastewater Engineering****Marks: External 70  
Internal 30**

<b>Unit</b>	<b>Topic</b>	<b>Credit</b>	<b>Lectures</b>
<b>UNIT-1</b>	<b>Water:</b> Water requirement - domestic, institution, firefighting, commercial, industrial and cultural places, consumption, population forecasting - demographic, arithmetical progression, geometrical progression and logistic method, BIS, WHO standards for drinking and package drinking water	1	14
<b>UNIT-2</b>	<b>Water Treatment:</b> Physical Units- Principles, applications and designing aspects of - Bar screen, grit chamber, barmunitors, skimming tanks Chemical Units - Principles, applications and designing aspects of - Coagulation and Sedimentation, flocculation, disinfection, clarifier	1	14
<b>UNIT- 3</b>	<b>Biological Units:</b> Aerobic treatment- Principles, applications and designing aspects of - Activated Sludge Process, Aerobic ponds, Oxidation ponds, Stabilization ponds Anaerobic treatment- Principles, applications and designing aspects of - Trickling filter, Rotatory Biological Contactors (RBC's), Continuous Stirring Tank Reactor, UASB, Fluidized Bed Reactor,	1	14
<b>UNIT-4</b>	<b>Advanced treatment</b> Wastewater: Ultra filtration, Nano-filtration, Reverse Osmosis, Wet Air Oxidation, ozonization, PACT, ion exchange, Membrane bioreactor, Green Technology- Bioremediation Sludge: Composting, land filling, thickening, alkaline stabilization, Conditioning, incineration, Dewatering	1	14

**INTERNAL EVALUATION  
(seminar+term paper+test)****30 MARKS****Reference books:**

1. Wastewater Engineering: B.C.Punmia and Ashok Jain. Laxmi Publication N.Delhi
2. Water and Wastewater Engineering : G.S.Birdie and G.S.Birdie
3. Water and Wastewater Engineering Vol.I: Garg and Garg
4. Water and Wastewater Engineering: Metcalf and Eddy
5. Environmental Engineering: R.S.Gidde
6. Water and Wastewater Engineering: Arcivala
7. Water and Wastewater Engineering : Mackenzie L Devis WEF Publication
8. Principles of Foundation Engineering : Braja M.Das
9. Standard Handbook of Environmental Engineering 2<sup>nd</sup> Edi. Robert A.Corbitt

**INTERNAL EVALUATION****30 MARKS**

<b>UNIT</b>	<b>TITLE</b>	<b>CREDIT</b>	<b>LECTURES</b>
<b>UNIT-1</b>	Principles of Remote Sensing, History, Stages of Remote Sensing, Remote Sensing In India, Types of Remote Sensing, and Types of Resolution: Spectral, Spatial, Temporal, Radiometric, Spectral Signatures. Electro Magnetic Radiation, EM Spectrum, Energy Interaction with the Atmosphere and Earth Surface.	1	14
<b>UNIT-2</b>	Types of platform, Types of sensor and cameras, processes of sensor & its characteristics. Element of Image Interpretation: Tone, Color, Texture, Pattern, Shape, Size and associated features.	1	14
<b>UNIT-3</b>	Definition, History, Objectives of GIS, components of GIS, Application of GIS. Types of Geographical Data: Raster Data Model, Vector Data Model, GIS Tasks: Input, Manipulation, Management, Query, Analysis and Visualization. Layer, Geographic Reference,	1	14
<b>UNIT-4</b>	Types of data: Spatial Data, Non Spatial Data, Level of Measurement: Nominal, Ordinal, Interval, Ratio. Definition, Advantages of Topology, Concept of Arc, Node and Vertices, Connectivity, Containment, Contiguity.	1	14

**(Seminar + term paper + test)****Reference Books:**

1. Fundamentals of Remote Sensing: George Joseph
2. Remote Sensing and Image Interpretation: Lillesand & Keifer.
3. Remote Sensing Principles and Interpretation: F.F. Sabins.
4. Introduction to Remote Sensing: J.B. Campbell.
5. Concepts and Techniques of Geographic Information Systems CP Lo Albert K W Yeung, 2005 Prantice Hall of India.
6. Principles of GIS for Land Resources Assessment by P.A. Burrough, Oxford : Science publications, 1986.
7. Geographic Information Systems – An introduction by Tor Bernhardsen, John Wiley and Sons, Inc, New York, 2002.
8. GIS – A computing Perspective by Micheal F. Worboys, Taylor & Francis, 1995.
9. Remote Sensing and Image Interpretation by Thomas M. Lillesand and Ralph W. Kiefer, John Wiley and Sons Inc., New York, 1994.

## **PRACTICAL**

### **PRACTICAL ESP – 205 (BASED ON BIODIVERSITY AND CONSERVATION & ANALYTICAL TECHNIQUES AND INSTRUMENTATION)**

#### **BIODIVERSITY AND CONSERVATION**

**Marks: External 35  
Internal 15**

1. Determination of phytoplankton diversity of a water body by Nygaard index.
2. Determination of population density of insects/birds/reptiles/mammals.
3. To observe the impact of invasive species on vegetation and species composition.
4. To study the impact of disturbance on vegetation.
5. Preparation of a list of herbicides / pesticides / insecticides commonly used in the area.
6. Estimation of Ecological indices:
  - i) index of diversity, richness,
  - ii) evenness and dominance of species.
7. Calculation of similarity & dissimilarity index between two adjoining communities.
8. Calculations of Niche overlap between two species.
9. Survey of local market for studying vegetable diversity.
10. Visit to plateaus, grasslands, forests to understand plant diversity.
11. Visit to local fish market for identification.

#### **ANALYTICAL TECHNIQUES AND INSTRUMENTATION**

**Marks: External 35  
Internal 15**

1. Determination of pH and EC of water and wastewater samples
2. Determine SPM concentration from the ambient air
3. Determine SO<sub>x</sub> concentration from the ambient air
4. Determine NO<sub>x</sub> concentration from the ambient air
5. Determination of Calcium by flame photometer
6. Determination of Sodium by flame photometer
7. Determine max of cobalt and nickel solution by spectrophotometer
8. Examine microscopic structure of xerophytes / mesophytes stem
9. Examine and prepared a permanent slide of plant (Stem/ Leaf) by using staining.
10. Visit to Central Facility Centre (XRD, XRF, NMR, AAS, GC-MS and UV spectrophotometer).

#### **INTERNAL EVALUATION**

**30 MARKS**

**(viva-voce + journal + data evaluation )**

**PRACTICAL ESP – 206 (BASED ON WATER AND WASTEWATER ENGINEERING & REMOTE SENSING AND GIS IN ENVIRONMENTAL SCIENCE)**

**WATER AND WASTEWATER ENGINEERING**

**Marks: External 35  
Internal 15**

1. Determine sludge volume index of given wastewater sample
2. Determine MLSS of given wastewater sample
3. Determine MLVSS of given wastewater sample
4. Determine oil and grease of given wastewater sample
5. Study of Jar test for wastewater treatment
6. Determine nitrate concentration in given wastewater sample
7. Determine phosphate in given wastewater sample
8. Determine sulphate in given wastewater sample.
9. Visits to industries, water treatment plant and sewage treatment plant.

**REMOTE SENSING AND GIS IN ENVIRONMENTAL SCIENCE**

**Marks: External 35  
Internal 15**

1. Satellite Referring Scheme (Digital) and Browsing Satellite Data (from NRSC/GLCF/Glovis).
2. Familiarization with DIP s/w, Image Display
3. Image Rectification, Enhancement and Registration.
4. Image Classification: Supervised and Unsupervised.
5. Accuracy Assessment.
6. Field Work (GPS Demo and Image Interpretation).
7. Familiarization with GIS Software and Geo-referencing.
8. Spatial data entry, Editing, Topology creation and Layout preparation.

**INTERNAL EVALUATION**

**30 MARKS**

**(viva-voce + journal + data evaluation )**