Post - Graduate Programme in Environmental Sciences

Courses of study, Schemes of Examinations & Syllabi

(Choice Based Credit System)

DEPARTMENT OF ENVIRONMENTAL SCIENCES

BISHOP HEBER COLLEGE (Autonomous)
(Reaccredited with 'A' Grade (CGPA – 3.58/4.0) by the NAAC &
Identified as College of Excellence by the UGC)
DST – FIST Sponsored College &
DBT Star College
TIRUCHIRAPPALLI – 620 017
TAMIL NADU, INDIA

2017 – 2018

Post – Graduate Programme in Environmental Sciences

Structure of the Curriculum

Parts of the Curriculum	**No. of courses**	**Credits**
Core (Theory)	11	44
Core (Practical)	5	19
Elective	4	17
Project	1	6
NMEC	1	2
VLOC	1	2
Total	**23**	**90**

M.Sc. Environmental Sciences
(For the candidates admitted from the academic year 2017 onwards)

Sem	Course	Course Code	Course Title	Pre requisites	Hours Per Week	Credits	Marks		
							CIA	ESA	TOTAL
I	Core I	P16ES101	Fundamentals of Physical Environment		5	4	25	75	100
	Core II	P16ES102	Fundamentals of Ecology		5	4	25	75	100
	Core III	P16ES103	Environmental Chemistry		5	4	25	75	100
	Core IV	P16ES104	Environmental Microbiologyand Biotechnology		5	4	25	75	100
	Core Prac. I	P16ES1P1	Ecologyand Environmental Chemistry	P16ES101, P16ES103	5	4	40	60	100
	Elective I	P16ES1:1	Energy and Environment		5	4	25	75	100
II	Core V	P16ES205	Environmental Toxicology and Bioremediation		4	4	25	75	100
	Core VI	P16ES206	Research Design and Instrumental Methods		4	4	25	75	100
	Core VII	P16ES207	Mathematical Models in Environmental Sciences		4	4	25	75	100
	Core Prac. II	P16ES2P2	Environmental Microbiology, Biotechnology and Toxicology	P16ES104	4	4	40	60	100
	Core Prac. III	P16ES2P3	Mathematical Models in Environmental Sciences	P16ES207	3	3	40	60	100
	Elective II	P16ES2:1	Environmental Management Sustainable Development and Biodiversity Conservation		5	4	25	75	100
	NMEC	P16ES2E1	To be selected from courses offered by other departments		4	2	25/40	75/60	100
	VLOC	P15VL1:1/ P15VL1:2	RI / MI		2	2	25	75	100
III	Core VIII	P16ES308	Environmental Pollution		5	4	25	75	100
	Core IX	P16ES309	Environmental Engineering		5	4	25	75	100
	Core X	P16ES310	Industrial Pollution and Safety Management		5	4	25	75	100
	Core XI	P16ES311	Environmental Impact Assessment		5	4	25	75	100
	Core Prac. IV	P16ES3P4	Water Pollution and its control Engineering	P16ES308	5	4	40	60	100
	Elective III	P16ES3:1	Remote Sensing and GIS for Environmental Sciences		5	4	25	75	100
IV	Core Prac. V	P16ES4P5	Air and Soil Pollution and Air Pollution Control Engineering	P16ES308	5	4	40	60	100
	Elective IV	P16ES4F1	Internship and Field Work		5	5	25	75	100
	Project	P16ES4PJ			20	6	--	--	100
Total						**90**			**2300**

CIA- Continuous Internal Assessment **NMEC- Non Major Elective Course**
ESA- End Semester Assessment **VLOC- Value added Life Oriented Course**

NMEC offered by the Department: Environmental Management-P16ES2E1

Core I: FUNDAMENTALS OF PHYSICAL ENVIRONMENT

Semester I **Code: P16ES101**
Credits: 4 **Total Hours: 75**

General objectives

1. To understand about the physical environment encompassing atmosphere, hydrosphere, lithosphere and biosphere
2. To realize the importance of interactions among various spheres and appreciate the interrelationships among them.

Unit 1

Introduction: Definition, principles and scope of Environmental Sciences.

Atmosphere: Structure and composition of atmosphere – Radiation and heat balance. Global Surface Circulation model, actual surface circulation, secondary surface circulation, Climate and Climate change (El-Nino, ENSO) Indian monsoon, Tropical cyclone.

Unit 2

Hydrosphere: Hydrological cycle – Surface water, ground water, infiltration, Floods and droughts; Precipitation-Convectional precipitation, orographic precipitation; Oceanic circulation – an over view.

Unit 3

Lithosphere: Earth's structure - internal layer, outer layer; Rock types, Soil formation, types of soil, soil horizon

Unit 4

Biosphere: The development of Biosphere on Earth, Biogeographic regions of the world – Phyto-geographic (10 zones from tropic, temperate, sub arctic and arctic regions) and Zoogeographic realms – 8 zones.

Unit 5

Indian biogeography: Biogeographical classification of India (10 zones); major forests in India – 16 Forest type groups.

Textbooks

1. Miller GT, Environmental Sciences, 10th Edition. Thomson Brooks /Cole, 2004
2. Edward A, Keller, Introduction to Environmental Geology, 4/E, Edward A. Keller, ISBN-10:0132251507ISBN-13:9780132251501, Pearson Prentice Hall, 2008.
3. Peter O. Muller, Harm J. de Blij, Richard S. Williams, Environmental Geography, Oxford University Press, USA, 2004.

4. Singh JS, Singh SP and Gupta SR, Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi, 2006.
5. Strahler and Strahler, Environmental Geology, Willey and Sons, NY, 1970.

References

1. Bailey Ronald Albert, Chemistry of the Environment, Academic Press, New York,1978.
2. Carla W, Montgomery, Environmental Geology, McGraw Hill Publishers, ISBN 0073661953, 9780073661957, 2002.
3. Johnson DO, Netteville JT, Wood JC and James M, Chemistry and the Environment, W.B. Saunders Co., Philadelphia, 1973.
4. Sawyer CN, Mc Carty PL and Perkinn GF, Chemistry for Environmental Engineering, II edition. McGraw Hill, 1994.
5. Sharma BK and Kaur H, Environmental Chemistry, Goel Publishing House, Meerut, 1994.

Core II: FUNDAMENTALS OF ECOLOGY

Semester I **Code: P16ES102**
Credits: 4 **Total Hours: 75**

General objectives

1. To understand the concept, principles and dynamics of ecosystem.
2. To realize the importance of interactions among the various components of ecosystem and appreciate the interrelationships among them.

Unit 1

Structure, principles and concepts of ecosystem:

Components of ecosystem - biotic and abiotic factors- producers, consumers, and decomposers, food chain, food web; Dynamics of Ecosystems - energy flow –primary productivity and secondary productivity; Biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles.

Unit 2

Ecosystem types: (Classification, basic concepts & adaptations) Aquatic– Freshwater–lentic, lotic; Marine – neritic - estuarine – mangrove, intertidal zones, tidal flats, seagrass bed, coral bed; oceanic – pelagic, benthic; Terrestrial ecosystem – forest, grassland, desert.

Unit 3

Population: Definition, characteristics of population - density, natality, mortality, age distribution, growth patterns, population fluctuation, population equilibrium, biotic potentials, population dispersion, regulation of population; biotic interactions- intra-specific and inter-specific.

Unit 4

Community: Physical Structure: - structure, stratification; Biological structure: Species richness, Species diversity, Abundance, Dominance, Frequency, Importance value, Keystone species; Community characteristics: guild, ecotone, ecocline, edge effect, ecological niche, ecological equivalents, ecological pyramid, and ecolo gical succession.

Unit 5

Ecological tools & Techniques: Sampling plant populations: Qualitative assessment–Floristic composition, stratification; Quantitative assessment – Frequency, density, abundance, cover and basal area; Sampling phytoplankton, Sampling animal populations.

Textbooks

1. Agarwal KC, **Global Biodiversity**, Nidhi Publishers, Bikaner, 2002.
2. Clarke GL, **Elements of Ecology**, John Wiley, London, 2003.

3. Odum Eugene P, **Fundamentals of Ecology**, W.B., Saunders Co, Philadelphia and London, 1971.
4. Sharma PD, **Ecology and Environment**, Rastogi Publication, Meerut, 2003.

References

1. Chapman JL and Reiss MJ, **Ecology-Principles and applications**, Cambridge University Press (Low price edition), 1995.
2. Mishra PC and Trivedy RK, **Ecology and Pollution of Indian Lakes and rivers**, Enviromedia, Karad, 1994.

Core III : ENVIRONMENTAL CHEMISTRY

Semester I **Code: P16ES103**
Credits: 4 **Total Hours:75**

General objectives

1. To understand the basic chemical principles governing the reactions of the environment (in various spheres).
2. To comprehend the chemical reactions taking place in natural environment.

Unit 1

Fundamentals of Chemistry: Introduction to Modern Periodic table, elements, compounds, Types of chemical bonds. Avogadro's hypothesis. Molecular weight, equivalent weight, mole concept, Normality, molarity, molality, stoichiometry – concept. Volumetric analysis –principles of acid-base titrations.

Primary and secondary standards - preparations, calculations of concentrations of solutions using specific gravities and molecular weights. Ionic product of water, pH and pOH, buffer solutions. Solubility product, solubility of gases in water, the carbonate system.

Unit 2

Chemical composition of Air: Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermo chemical and photochemical reactions in the atmosphere. Oxygen and ozone chemistry. Units of measurement – ppm(v/v), ppb(v/v), $\mu g/m^3$

Unit 3

Water Chemistry: Physico-chemical characteristics of water. Sampling methods of water. Principles of Determination of DO, BOD, COD, pH, Electrical Conductivity, Dissolved solids, Hardness, Chloride, Fluoride, Sodium, Potassium, Phosphate.

Unit 4

Chemistry of the soil: Physico - Chemical properties of soil: Temperature, Texture, Structure, Minerals of soil - colloids in soil; ion exchange reactions in soil. Soil pH and its effects.

Chemical speciation: Speciation scheme- classification of heavy metal speciation in water. Chemical speciation of copper, lead, mercury, arsenic, selenium and chromium. Trace elements and its significance (Molybdenum and zinc only).

Unit 5

Biochemistry: Classification and functions of carbohydrates, proteins and lipids. Metabolism - Glycolysis, Citric acid cycle, Electron transport, Oxidative phosphorylation and regulation of ATP production. Photosynthetic pathway.

Textbooks

1. Banerji SK, Environmental chemistry, Prentice-Hall of India Private Limited, New Delhi, 2002.
2. De AK, EnvironmentalChemistry, 5th Edition, New Age International (P) Limited, Publishers, New Delhi, ISBN 81 – 224 – 1488 – 5, 2003.
3. Sharma BK and Kaur H, Environmental Chemistry, Goel Publishing House, Meerut, 1994.
4. Stanley E. Manahan, Environmental Chemistry, CRC Press, 2005.
5. Lehninger AL, Principles of Biochemistry, CBS Publishers and Distributors. Delhi, 1982.

References

1. Bhatia SC, Environmental Chemistry, CBS Publishers and Distributors. New Delhi, 2002.
2. Cunningham P, Cooper H, Eville G and Hepworth MT, Environmental Encyclopedia, Jaico Publishing House, Mumbai, 1999.
3. Esmarch S. Gilreath, Fundamental Concepts of Inorganic Chemistry, McGraw Hill Publishers, NY, 1958.
4. Glasstone S and Lewis, Essentials of Physical Chemistry, R.R. Bowker Company.
5. Johnson DO, Netteville JT, Wood JC and James M, Chemistry and the Environment, W.B. Saunders Co., Philadelphia, 1973.
6. Williamson SJ, Fundamentals of Air Pollution, Wesley Publishing Company, 1971.

Core IV: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester I **Code: P16ES104**
Credits: 4 **Total Hours: 75**

General objectives

1. To understand the world of microorganisms, their types, importance and role in the environment.
2. To comprehend the basic concepts of biotechnology in solving the environmental issues (in treatment of wastes, bioremediation etc.).

Unit 1

Microbial Diversity & Systematics: Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Ampli fied rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit 2

Microbial Growth & Physiology: Ultra structure of Archaea (Methanococcus); Eubacteria (E. coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group).

Unit 3

Microbial Interactions and Infection Host–Pathogen interactions: Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence - Microbes and Environment- Role of microorganisms in natural system and artificial system; Influence of Micro bes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.

Unit 4

Industrial Applications: Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Bio technologically important intracellular products; exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH Microbial processes-production, optimization, screening, strain improvement, factors affecting downstream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.

Unit 5

Molecular Techniques in Environmental Management: Pathway construction- Operons regulation, Vectors, Hybrid pathways and enzymes, catabolic transposons, ration enzyme design, GEM survival – promotion and prevention of GEM survival – Molecular probes – Bioluminescence – PCR-RFLP-RAPD-Immunological techniques – Hybridization techniques, GMOs – pros and cons, Bioethics, patents.

Textbooks

1. Michael J. Pelczar, Microbiology, Tata McGraw-Hill, 2010
2. L.E Casida, JR, Industrial Microbiology, New Age International, PJ Limited, Publisher, 2015
3. G. Reed, Prescott and Dunn'sIndustrial Microbiology, CBS Publisher and Distributor, 2004
4. Gerand J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology, Pearson, 2014
5. DP & SK Dwivedi, Environmental Microbiology and Biotechnology.1stEdition, New Age International (P) Ltd., Publishers, New Delhi, 2005.

References

1. SubbaRao NS, Soil Microbiology, 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2004.
2. Robert L Tate, Soil Microbiology, 1st Edition, John Wiley & Sons, Inc. New York, 1995.
3. Mitchell R, Introduction to Environmental Microbiology, Prentice -Hall. Inc. Englewood Cliffs, New Jersy, USA, 1974.
4. Alexander N. Glazer Hiroshi Nikaido, Microbial Biotechnology, WH Freeman and Company, NY, USA, 1995.
5. Bernaral R. Glick and Jack J. Pastemak, Molecular Biotechnogy: Principles and Applications of Recombinant DNA, ASM Press. Washingto n, DC USA, 1994.

Core Practical I: ECOLOGY AND ENVIRONMENTAL CHEMISTRY

Semester I **Code: P16ES1P1**
Credits: 4 **Total Hours: 75**

General objectives

1. To experience the methods of assessing the abiotic factors of the environment.
2. To assess the biodiversity and compute the biodiversity indices.
3. To analyse the basic methods in analytical chemistry.

Unit 1

Abiotic Factors

a. pH, Temperature, Relative Humidity, Transparency, Estimation of Dissolved oxygen
(All the above parameters (except Relative Humidity) to be analyzed in ground water, lentic, lotic, domestic sewage, hot water and cold water)
b. Morphometric studies of the pond – mapping – outline, mean length, breadth, width and depth

Unit 2

Habitat Ecology: Habitat characteristics and adaptations with common examples of plants and animals in the following habitats:

a. Fresh water habitat
b. Marine habitat – rocky, sandy, muddy, inter – tidal and deep sea.
c. Terrestrial habitat – Desert, burrowing, arboreal

Unit 3

Biodiversity Assessment

Qualitative analysis

i. Inventory of floral biodiversity of campus
ii. Inventory of faunal biodiversity of campus

Quantitative analysis

i. Biotic index – Shannon – Weaver Index
ii. Primary productivity in pond ecosystem
iii. Primary productivity of standing crop in grass land

Unit 4

Titrimetry

1. Acidimetry –Alkalimetry
Estimation of HCl

2. Permanganometry
   Estimation of Mohr's salt.
3. Complexometry
   EDTA Vs $CaCO_3$ + $MgCO_3$

Unit 5

Colourimetric Analysis (Calibration curve)

a. Estimation of Ferric iron
b. Estimation of Nickel

Textbooks

1. Daisy A, Butterfly of Bishop Heber College, Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978 – 81 – 906267 – 9 – 8,2010.
2. Prema Michael, Ecological Methods for Field and Laboratory Investigations, Tata McGraw Hill, 404 pages, ISBN 0074517651, 9780074517659,1984.
3. Relton A, Bird of Bishop Heber College, Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978 – 93 – 80767 – 00 – 0,2010.
4. ShailajaRavindranath and SudhaPremnath, Biomass Studies – Field Methods for Monitoring Biomass, Centre For Environmental Education, Southern Regional Cell, Bangalore, ISBN – 81 – 2-4 – 1113 – 4, 1997.
5. Trivedy and Goel, Practical Methods in Ecology and Environmental Science, Karad, 1986.
6. Doughlas A. Skoog, West DM, Hollar FJ, Grouch SR, Fundamentals of Analytical chemistry, Thomas Books, Bangalore, 2004.
7. Gopalan R, Subramanian PS, Rengarajan K, Elements of Analytical Chemistry, Sultan Chand and sons, New Delhi,1997.
8. Sawyer CN, Mc Carty PL and Perkinn GF, Chemistry for Environmental Engineering, II edition. McGraw Hill, 1994.

Elective I: ENERGY AND ENVIRONMENT

Semester I **Code: P16ES1:1**
Credits: 4 **Total Hours: 75**

General objectives

1. To know the energy sources (both renewable and non-renewable).
2. To realize the importance of conservation of energy and developing green energy technologies.

Unit 1

Fundamentals of energy and measurements: Origin of fossil fuel – Classification –Conventional, Non-conventional energy – Renewable, Non – renewable energy – Heat capacity of fuels – Units of expressions – (Joule, Joule/Kelvin, watt, watt/second, kilowatt – kilowatt hour). Electrical units – Reading through energy meter – power, phases, reactive power, apparent power, power law. Thermodynamic calculations, Assignment–Domestic power audit.

Unit 2

Sun as source of energy: Solar radiation and its spectral characteristics; Estimation of solar radiation. Physical principles of the conversion of solar radiation into heat –Solar energy collectors: Flat plate collectors - Solar air Heaters – Concentrating collectors –Focusing type – Non - focusing type, Solar ponds – Applications of solar ponds, Solar photovoltaics – solar cell.

Unit 3

Wind Energy: Introduction, Basic principles of wind energy conversion - wind data and energy estimation – site selection considerations – Basic components of a wind energy conversion system (WEC). Classification of WEC systems, Types of wind machines –Applications of wind energy – Environmental aspects. Energy from the Ocean: Ocean thermal energy conversion (OTEC) – Tidal Energy – Energy from ocean waves – micro –hydel power.

Unit 4

Energy from Biomass: Introduction - Biomass conversion technologies – Biogas generation - classification and types of biogas plants – construction: and Design considerations. Bio -energy resources: Petro-plants – Biodiesel from *Jatropha sp*., Fuel cell, Principles, - Hydrogen fuel cell-Alcohol fuel cell-advantages and disadvantages, Briquetting of solid wastes, Pyrolysis, and combustion.

Unit 5

Nuclear energy – nuclear reactors, nuclear agreements, List of nuclear power plants in India, safety measures, Disposal of radioactive wastes.

Textbooks

1. Rai GD, Non-conventional energy sources, Khanna publishers, New Delhi, 2001.
2. Lampety J, Desai AV and Owino F, Bio energy, Wiley Eastern Ltd., New Delhi .1990.
3. Raymond L Murray, Nuclear Energy – An Introduction to Concepts, Systems and Applications of Nuclear Processes, 6th Edition, Elsevier 2009.
4. Sukhatme SP, Solar Energy, Tata McGraw Hill publishing company Ltd., New Delhi, 1996.
5. Tyagi PD, Fuels from weeds and wastes,Batra Book Service Publishers, 1989.

References

1. AnubhaMaheswari and GeethaParmar, A Text book of Energy, Ecology Environment and Society,Anmol Publications, New Delhi, 2002.
2. Dunn PD, Appropriate Technology. Macmillan Education limited, 1979.
3. Johnson Gary L, Wind Energy System Prentice - Hall Inc., New Delhi,1985.
4. Trivedi PR and Sudarshan KN, Environment and natural resources conservation, Common Wealth Publishers, New Delhi,1994.
5. Nathanson JA, Basic Environmental Technology: Water supply Management and Pollution, Prentice Hall, 2003.

Core V: ENVIRONMENTAL TOXICOLOGY AND BIOREMEDIATION

Semester II **Code: P16ES205**
Credits: 4 **Total Hours: 60**

General objectives

1. To understand the basic concepts of biotechnology in solving the environmental issues (in treatment of wastes, bioremediation etc.).
2. To understand and analyse various toxic agents of the environment and the basic concepts of mode of action of these toxic substances in human body.

Unit 1

Toxicology – Definitions, Classification, Origin and General Nature of Toxicants in Environment, Basic Probit analysis, concepts – Toxicants – Toxicity - Acute, sub-acute, chronic, dose effect, LD50, LC50 and response safe limits, Dose response relationship - graphs, concentration response relationship, Safe Limits - Biological, chemical factors that influence, Influence of route of administration abnormal response to chemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals.

Unit 2

Sources, transport, mobility, disposition and effect of pesticides – Organo chlorine pesticides, Organo phosphorous, Carbamate and Synthetic pyrethroids.

Non-pesticidal organic chemicals – low molecular weight hydrocarbons, aromatic hydrocarbons, PCBs, chlorophenols, dioxins, furan, phthalate, esters, plasticizers, PAHs.

Unit 3

Sources, transport, mobility, disposition and effect of heavy metals – As, Hg, Cd, Cr, Pb, Se, Inorganic ions – nitrates, phosphates, fluorides, asbestos, SO_2, NO_x, CO, H_2S.

Unit 4

Bioremediation of xenobiotic compounds – organic (chlorinated hydrocarbons, substituted simple aromatic compounds, poly-aromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclide, phosphates, nitrates).

Unit 5:

Role of immobilized cells/enzymes in treatment of toxic compounds. Biopesticides – Bioreactors – Bioleaching – Biomining – Biosensors. Biotechniques for air pollution abatement and odour control.

Textbooks

1. Ronald L. Crawford and Don. L. Crawford, Bioremediation – Principles and applications, Cambridge University Press, 1996.
2. P. Rajendran and P. Gunasekaran, Microbial Bioremediation, MJP Publishers, Chennai, 2006.
3. Klassen, Curtis. D and John.B. Watkins Casarett and Doull's, The Basic Science of Poisons Companion Handbook, Toxicology 6th Ed, Newyork, N.Y: McGraw-Hill, 2001.

Reference

1. Ricci, P and Rowe, M.D., Health and Environmental Risk Assessment, Pergamon Press, New York, 1985.

Core VI: RESEARCH DESIGN AND INSTRUMENTAL METHODS

Semester II **Code: P16ES206**
Credits: 4 **Total Hours: 60**

General objective

1. To understand the basic principles of various instruments used in environmental monitoring/sampling and analysis.

Unit – 1

Meaning & Objectives of Research; Significance of research; Research & scientific methods; Criteria of good & advanced research; Types of Research: (Survey, Observation, case study, experimental, historical and comparative methods) Stages in preparation; Research methods versus methodology; Writing of Research Proposal, Report and Research paper Features of a good design; Different research designs; Sampling – Types of sampling design. Data collection – methods; Measurement and scaling – Quantitative and qualitative; Classification; goodness

Unit 2

Basic principles of Chemical analysis: Precision, accuracy, errors and minimization of errors in analyses. Conductometry – Strong acid Vs Strong base titrations. Potentiometry –types of electrodes, redox titration, Polarography–Principle and application.

Unit 3

Colorimetry and Spectrophotometry – UV and VIS, Flame photometry, Nephelometry and Turbidimetry, Piezometery.

XRF, Atomic Absorption Spectrophotometer (AAS), Fourier Transform Infra-Red Spectroscopy (FTIR) – Applications.

Chromatography: TLC, GC, HPLC and Ion exchange chromatography. GCMS, ICP.

Unit 4

Microscopy – Light microscope, Scanning Electron Microscopy (SEM) Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Centrifugation – Differential, Density gradient, Reverse Osmosis – Applications.

Electrophoresis - PAGE, PFGE, SDS-PAGE, Agarose gel, Immuno-electrophoresis, 2D electrophoresis - Gel documentation. Applications

Unit 5

NDIR for CO, chemiluminescent analyzer for NO_X, Fluorescent analyzer for SO_2,Auto analyzer for water quality using flow injection analysis.

Textbooks

1. William H, Merritt L, Dean DA and Settle FA, Instrumental Methods of Analysis, CSS publishers, New Delhi, 1986.
2. Sharma BK, Instrumental Methods of Chemical Analysis, Goel Publishing house, Meerut, 1999.
3. Willard LL, Merritt and John and Dean, Instrumental Methods of analysis, D Van Nostrand Company, New York, 1966.

References

1. APHA Standard Methods for the examination of water and wastewater, 20thEdition, Washington, 1998.
2. Barnes JDJ, Denney RC, Jeffery GH and Mendham J Vogel's, Text Book of Quantitative Inorganic Analysis, 6th Edition, Pearson Education Ltd., U.K, 1999.

Core VII: MATHEMATICAL MODELS IN ENVIRONMENTAL SCIENCES

Semester II **Code: P16ES207**
Credits: 4 **Total Hours: 60**

General objectives

1. To know the basic concepts of statistics and its role as an important tool in arriving at conclusions in the study of environment.
2. To analyze the environmental data, for solving the environmental issues, using the software package R.

Unit 1

Statistical data – Random variable – Probability – Measures of central tendency – Measures of dispersion – Correlation – Regression – Distribution – Binomial – Poisson – Normal.

Unit 2

Sampling techniques – t-test – Chi-square test – ANOVA test.

Unit 3

Derivative of a function – Initial value problems for first order Ordinary Differential Equations – Ecological and Environmental models – Methods of solving.

Unit 4

System of linear equations – Closed system – Open system – Methods of solving – Ecological and Environmental Models.

Unit 5

Introduction to R – Installation – Working with R commands.

Textbooks

1. Gurumani, N, Research Methodology for Biological Sciences, MJP Publishers, Chennai, 2007.
2. Zar, J.H, Biostatistical Analysis, 4th Edition, Pearson Education (Singapore) Pte. Ltd., Delhi, 1999.
3. Mark Gardener, Beginning R – The statistical Programming Language, Wiley Publications, 2015
4. Miguel F. Acevedo, Simulation of Ecological and Environmental Models, CRC Press, 2013.
5. George F. Simmons, Differential Equations with Applications and Historical Notes, McgrawHill Publishers, 2nd edition, 2003.

Core Practical II: ENVIRONMENTAL MICROBIOLOGY, BIOTECHNOLOGY AND TOXICOLOGY

Semester II **Code: P16ES2P2**
Credits: 4 **Total Hours: 60**

General objectives:

1. To prepare the microbiological culture techniques.
2. To analyse toxicological assays in determining the lethal concentrations / doses of a toxicant.

Unit 1

Observation of compound microscope, micrometry, Photomicrography, Microscopic preparation of diseased leaves, Sterilization procedures - Autoclave, Hot air oven,

a. Types of media, plating techniques.

Unit 2

a. Preparation of media, staining procedures - gram stain. MPN technique; TC, FC, FS
b. Methylene blue test for determining the microbial quality of milk.

Unit 3

a. Isolation of Genomic DNA and Quantization of DNA
b. Isolation of bacterial plasmid DNA
c. Agarose gel electrophoresis of DNA
d. Enumeration bacteria from water and wastewater - total coliform and total fecal coliform
e. Estimation of Ammonium and Phosphorus content of wastewater
f. Biodegradation of environmental pollutant by bacteria – synthetic dye
g. Microbiological treatment of industrial (dye or paper) effluent and determination of BOD and COD.
h. Production and quantification of enzyme activity – lactase. Production and quantification of enzyme activity – lactase.

Unit 4

a. Bioassay - Toxicity studies: Application of LC_{50} in animals and the significance of dose response curves.
b. Estimation of proteins, Sugars and lipids in fishes;
c. Separation of free amino acids by paper chromatography.

Unit 5

a. Estimation of chlorophyll content and total phenols in plants (experimental animals/plants are to be treated already with pesticides and heavy metals, industrial waste water or sewage for the above practicals).

References

1. Dubey RC, Maheswari DK, Practical Microbiology, S. Chand & company Ltd. New Delhi,2009.
2. Pelczar MJ, Reid and Chan ECS, Microbiology, Tata McGraw Hill, New Delhi, 2008.
3. Prema Michael (1983) Ecological Methods, Tata McGraw Hill, New Delhi.
4. Jayaraman,J, Laboratory manual in Biochemistry, New Age International Publishers, 2011.

Core Practical III: MATHEMATICAL MODELS INENVIRONMENTAL SCIENCES

Semester II **Code: P16ES2P3**
Credits: 3 **Total Hours: 45**

General objectives

1. To understand various statistical models in Environmental sciences.
2. To apply statistical tools in environmental problems.

List of Practicals

Part I

Data Analysis

a. Measures of central tendency
b. Measures of dispersion
c. Correlation
d. Regression
e. Distribution
f. Binomial
g. Poisson
h. Normal
i. Sampling Techniques
j. t – test
k. Chi – Square test
l. ANOVA test

Part II

Application of derivatives – Finding maximum or minimum for a given function

Population models and Chemical fate model

A closed system of two compartments - Bioaccumulation – Two compartment models, Bioaccumulation – Multi compartment models

References

1. Miguel F. Acevedo, Simulation of Ecological and Environmental Models, CRC Press, 2013.
2. Mark Gardener, Beginning R – The statistical Programming Language, Wiley Publications, 2015.
3. George F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill Publishers, 2nd edition, 2003.

Elective II: ENVIRONMENTAL MANAGEMENT, SUSTAINABLE DEVELOPMENTAND BIODIVERSITY CONSERVATION

Semester II **Code: P16ES2:1**
Credits: 4 **Total Hours: 75**

General objectives

1. To understand the concepts of environmental management.
2. To analyze environmental problems and develops skills to solve for sustainable development.

Unit 1

Statement of environment: Consumption patterns of natural resources – renewable and non – renewable; Environmental issues due to population growth in India and the world; Environmental priorities and Sustainable Development in India, Environmental ethics, Provision of Constitution of India regarding Environment (Article 48A and 51A (g)), National Environmental Policy, Environmental awareness and education – importance and approaches.

Unit 2

International and National efforts for Environmental Protection- Global conventions – Stockholm Conference, Rio Summit, Rio+10, Brundtland commission, Rio+20, Montreal Protocol, Kyoto protocol, Copenhagen summit; Global organizations – IPCC, UNEP, IUCN, WWF, Greenpeace; National organizations – ATREE, BNHS, BSI, BVIEER, CEE, CSE, NEERI, NCF, PETA, SACON, TERI, WII, ZSI (major objectives, activities and achievements only).

Unit 3

Water management: Watershed: Concept, characteristics and types, Land devel opment, water investigation and watershed management; Rain Water Harvesting (RWH). Land Management: Land use pattern, Urban Planning and management

Forest Management: Forest Fire, Eco tourism. Afforestation – Social and agro forestry schemes, Joint Forest Management.

Disaster management: Earth quakes, Volcanoes, Tsunami – Restoration and rehabilitation technologies. Case studies – National Calamities.

Unit 4

Environmental law: The Indian Forest Act, 1927, The Indian Wild Life (Protection) Act, 1972, The Water (Prevention and Control of Pollution) Act, 1974, Forest (Conservation) Act, 1980, The Air (Prevention and Control of Pollution) Act, 1981.

Environment (Protection) Act, 1986 - Hazardous wastes (Management and Handling) Rules 1989, Biomedical Waste (Management and Handling) Rules 1998, Municipal Solid Waste (Management and Handling) Rules (2000), **The Noise Pollution (Regulation and Control) (Amendment)** Rules 2000,

e-waste (Management and Handling) *Rules 2010,* Plastic wastes (Management and Handling) Rules 2011 and CPCB guidelines, National Green tribunal Act, 2010; (All with the latest amendments).

Unit 5

Threats to biodiversity – habitat alteration, invasive species, pollution, population explosion, and over-exploitation of resources

Conservation and Management – Protection of Natural Habitats - National and International Protected Areas – Current Practices in Conservation - in *situ* Conservation and *ex situ* Conservation of Threatened Species – The Biological diversity Act, 2002, Biological Diversity Rules, 2004– Patent Act - Intellectual Property Rights (IPR).

Textbooks

1. Agarwala VP, Forests in India, Oxford and IBH Publishing Co. Pvt. Ltd.,NEW DELHI, 1985.
2. Gopal LJ, Rural Development, Mangal Deep publications, Jaipur, 1997.
3. Kurian Joseph and Nagendran R, Essentials of Environmental Studies, Pearson Education Limited, New Delhi, 2004.
4. Murty JVS, Watershed Management in India, Wiley Eastern Ltd., New Delhi, 1994.
5. TNPCB, Pollution control legislations - TamilNadu Pollution Control Board, Vol-I and II, Chennai, 1999.

References

1. Nandhithakrishna, Environmental Laws of India – An Introduction, C.P.R. Environmental Education Centre, Chennai,1998.
2. Canter LW, Environmental impact assessment, McGraw Hill Book co. NY, 1977.
3. Centre for Science and Environment, The State of India's Environment: The second Citizen's Report, CSE, New Delhi, 2008.
4. Krishnamurthy KV, An Advanced Textbook on Biodiversity, Principles and practice, Oxford & IBH Publishing Co., New Delhi, 2004.

Core VIII: ENVIRONMENTAL POLLUTION

Semester III **Code: P16ES308**
Credits: 4 **Total Hours: 75**

General objectives

1. To understand various forms of pollution and contaminants of the environment – their sources / causes and effects.
2. To analyse the chemical reactions /processes taking place in the environment.

Unit 1

Air Pollution: Types of air pollutants, primary and secondary – particulate and gaseous contaminants, their sources and impact on vegetation, animals, human beings and materials, Photochemi cal smog, Bhopal gas disaster, Acid rain formation its effects on environment, Green house effect-Global Warming - stratospheric ozone depletion.

Unit 2

Introduction to Climate change: Climate system and its mechanism, the green house gases and global warming, Carbon cycle and climate, natural climate variability, human induced climate variability. Climate change – Scientific basis: Anthropogenic GHGs and radioactive forcing, aerosols and climate forcing, land use pattern and other climate forcing, obse rved changes in climate (temperature, precipitation, and sea level), impacts of climate change on ecosystem, biodiversity and man.

Unit 3

Water Pollution: Sources of water pollution, Classification of water pollutants - Oxygen demanding wastes, pathogens, plant nutrients, synthetic organic compounds, inorganic chemicals and mineral substances, Thermal pollution - sources and effects.

Unit 4

Marine pollution: Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system, Impact of marine pollution, Oil pollution - sources and effects, an episode of oil pollution-coastal management.

Unit 5

Radioactive Pollution: Radiation - types and units-sources natural and man-made, Effect of radioactive pollution and nuclear explosions.

Noise pollution: Sources, impacts of noise pollution.

Textbooks

1. Kannan K, Fundamentals of Environmental Pollution, S. Chand and Co., Delhi.1991.
2. Rao MN and Rao HVN, Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1989.
3. Sharma BK and Kaur H, Soil and Noise Pollution, Water Pollution, Goel Publishing House, Meerut, 1994.
4. Ravi Malhotra, Climatology, Global vision publishing House, New Delhi, 2010.

References

1. Abbasi SA, Environmental pollution and its control, Cogent international, Pondicherry, 1998.
2. Bhatia HS, Environmental pollution and its control, GolgotiaPublications (P) Limited, Delhi, 1998.
3. Kudesia VP, Air pollution,Pragati publications, Meerut, 1997.
4. Kumaraswamy K, Alagappamoses A, and Vasanthy M, EnvironmentalStudies, BharathidasanUniversity, Tiruchirappalli, 2004.

Core IX: ENVIRONMENTAL ENGINEERING

Semester III **Code: P16ES309**
Credits: 4 **Total Hours: 75**

General objectives

1. To know the concepts of water distribution systems, sewer networks, working principles and design of various treatment systems.
2. To apply the basic engineering principles in controlling the air and noise pollution.

Unit 1

Water quality standards (BIS, TNPCB, International standards, WHO, ICMR, USPHS), Water Supply – Layout of water distribution systems, Process technology of water treatment, Cleaner production and Clean Development Mechanism

Unit 2

Wastewater Treatment – Primary, Secondary and advanced treatment: Physical, Chemical and Biological unit processes for purifying the wastewater. Design, Layout and specifications of Industrial and Municipal wastewater treatment systems.

Unit 3

Air quality standards. Air Pollution control - its limitations, control by process changes, control systems. Control of particulate emissions - settling chambers, centrifugal collectors, wet collectors, fabric filters and Electrostatic precipitators, their techniques. Community air pollution survey. Meteorological factors in air pollution survey. Meteorological factors in air pollution, wind, Atmospheric stability, plume behavior. Air pollution monitoring, principles of sampling and analysis of particulate and gaseous contaminants.

Unit 4

Control of gaseous contaminants - Adsorption and Absorption techniques. Condensation and combustion techniques. Noise pollution control - control at source and at receiver.

Unit 5

Principles and methods of Municipal solid waste collection, Recovery, Reuse and Recycling of useful solid wastes. Treatment and design of disposal mechanisms - Land filling, composting and incineration techniques.

Text books

1. Duggal KN, Elements of Environmental Engineering, Chand and company Ltd., New Delhi,1998.
2. Masters GM, Introduction Environmental Engineering and Science, Prentice -Hall of India Pvt. Ltd., New Delhi, 1991.
3. Metcalf and Eddy, Waste water Engineering, McGraw Hill Publishing Co., New York, 2001.

4. Peavy HS, Rowe DR and Tchobanoglous G, Environmental Engineering, McGraw Hill Book Co., New York, 1986.
5. Benefield, L.D. and C.W. Randall, Biological process design for wastewater treatment. Published by Englewood Cliffs: Prentice Hall, 1980

References

1. Hammer MJ, Water and Wastewater Technology, 2nd edition, John Wiley and Sons, NY, 1986.
2. Rao CS, Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1991.

Core X: INDUSTRIAL POLLUTION AND SAFETY MANAGEMENT

Semester III **Code: P16ES310**
Credits: 4 **Total Hours: 75**

General objectives

1. To understand the manufacturing process and control measures available to mitigate the impact of industrial emissions and discharges into the environment.
2. To apply the different treatment and control methods ofwaste.

Unit 1

Tanneries and Distillery: Production of leather, vegetable tanning and chrome tanning processes. Sources and characteristics of wastes, Effect of tannery effluent and other wastes on receiving bodies and treatment methods of the wastes. **Sugar mills and Distilleries** - their manufacturing processes, sources and characteristics of their wastes, on receiving bodies, Treatment of their wastes and disposal.

Unit 2

Paper and Pulp, and textile industries: Manufacturing processes, sources and characteristics of wastes. Effect of wastes, Treatment processes of the wastes, Textile mills - manufacturing processes, sources and characteristics of wastes, Effects of the wastes on receiving bodies, Treatment of the wastes.

Unit 3

Cement and energy Industries: Manufacturing process, sources of pollution and wastes. Effect of wastes, Control technique of pollution, **Oil refineries and thermal power plants**-processes involved, Sources of pollution characteristics of pollutants and their effects. Pollution controltechniques.

Unit 4

Fertilizer and pharmaceutical Industries: Manufacturing processes, sources and characteristics of wastes and their effects, treatment processes. **Pharmaceutical plants**: manufacturing processes sources and characteristics of wastes and their effects, Treatment of wastes.

Unit 5

Safety Management and Industrial Acts: Industrial safety- Causes of accident, Accident reporting system, Accident prevention, Disaster planning, Safety committee, Hazards control - Elimination, Control, Isolation, Substitution, Personal protective equipment, medical first aid- management of medical emergencies.

Labour laws: factories act 1948, Mines act 1952, ESI act 1948- Health organizations: NIOH, AIIHPH, NHO, WTO, OSHA standards.

References

1. Austin GT, Shreves, Chemical processes in industries, McGraw Hill Book Co., New York, 1977.
2. Mahajan SP, Pollution Control in process industries, Tata McGraw Hill Co. Ltd., New Delhi, 1986.
3. Rao MN and Datta, Wastewater treatment, Oxford and IBH, 1982.
4. Trivedy, B.K, Pollution control in industries, Enviro media publishing Co., Karad, 1991.
5. Bill Walash and Lawrence Russel, ABC of industrial safety, Pitman Publishers, UK, 1974.

Core XI: ENVIRONMENTAL IMPACT ASSESSMENT

Semester III **Code: P16ES311**
Credits: 4 **Total Hours: 75**

General objectives

1. To know about the basic concepts and recent developments of E nvironmental Impact Assesment.
2. To understand the methods of preparation of Environmental Impact Assesmentreports.

Unit 1

Environmental Impact Assessment – History and perspectives. EIA – Definition and Terminologies. Regulatory framework in India, EIA guidelines, Govt. of India EIA Notifications and further amendments. NABET criteria for EIA consultants.

Unit 2

Environmental Impact Assessment Methodologies – Adhoc, Overlays, Matrix, Checklist and Network approach. Battle Columbus Technique and modeling. EIA Process, EISand EMP. Public Hearing, list of industries attracting EIA, Environmental Clearance.

Unit 3

Environmental Impact Analysis and Assessment - Air, Noise, Water, Land, Socio – economic and biotic environment.Environmental setting, Identification, evaluation and prediction of environmental impacts.

Unit 4

Environmental Audit, ISO 14001 & OHSAS 18001, Environmental Management Systems. Case studies of EIA of developmental projects – Hydel project, Oil Pipeline project, East Coast Road, Mining project.

Unit 5

Principles of Risk Assessment: Human Health Risk Assessment, Ecological Risk Assessment, Probabilistic Risk Assessment. The role of Risk assessment in Environmental Management decision. Evaluation of human health risks associated with airborne exposures. Risk management and risk communication. Life Cycle Assessment and Cost BenefitAnalysis.

Textbooks

1. Canter LW, Environmental impact assessment, McGraw Hill Book Co., New York, 1977.

2. Munn RE, Environmental Impact Assessment, McGraw Hill Book Co., New York, 1982.

3. Rau JG and Wooten DC, Environmental impact analysis handbook, McGraw Hill Book Co., New York, 1980.

References

1. Cutter L, Environment risks and hazards, Prentice Hall of India Private Limited, New Delhi, 1999.
2. Kofi Asante. D-Duah, Risk Assessment in Environmental Management, John Wiley and Sons, New York, 1998.
3. Peter Calow, Hand Book of Environmental Risk Assessment and Management, Blackwell, Swence, London, 1998.
4. Westman WE, Ecology, Impact Assessment and Environmental Planning, John Willey and Sons, New York, 1985.

Core Practical IV: WATER POLLUTIONAND ITS CONTROL ENGINEERING

Semester III **Code: P16ES3P4**
Credits: 4 **Total Hours: 75**

General objectives:

1. To know the methods of collection, handling and preservation of the water samples.
2. To analyze the water quality parameters.

Water and effluent analysis:

Unit 1

Physical parameters: Temperature, Turbidity, Odour, Colour, Total solids, Total Dissolved Solids, Total Suspended Solids.

Unit 2

Chemical parameters:

pH, Electrical Conductivity, Alkalinity, Acidity, Total Hardness, Calcium, Magnesium, Chloride, Fluoride, Iron, Manganese, Total Nitrogen, Nitrates, Nitrites, Phosphates, Sodium, Potassium, Silicates, Sulphates, Ammonia (one water sample and one available effluent sample are to be analyzed).

Unit 3

Demand parameters:

Dissolved Oxygen, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

Unit 4

Wastewater treatment studies

Aeration, fixing optimum pH and optimum coagulant dose using Jar test apparatus.

Unit 5

Design of Wastewater treatment units

1. Calculation and designing of Sedimentation Tank, Clariflocculator
2. Calculation and designing of Aeration Tank
3. Calculation and designing of Activated Sludge Processes
4. Calculation and designing of Trickling Filter
5. Calculation and designing of Disinfection Process

Textbooks

1. Patnaik, P, Handbook of Environmental Analysis – Chemical Pollutants in Air; Water; Soil and Solid wastes –Lewis publishers, Boca Raton, 1997
2. APHA Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Edition. ISBN 0875530478, 9780875530475 APHA Publisher, 2005.
3. Trivedy RK, Goel PK and Trisal L, Practical Methods in Ecology and Environmental Sciences, Environmental Publications, Karad, 1987.
4. Saxena MM, Environmental Analysis Water, Soil and Air, Agro Botanical Publishers, India. ISBN: 81-85031-22-3, 1987.

Elective III: REMOTE SENSING AND GIS APPLICATIONSFOR ENVIRONMENTAL SCIENCES

Semester III **Code: P16ES3:1**
Credits: 4 **Total Hours: 75**

General objectives

1. To understand the principles and applications of remote sensing and Geographic Information System (GIS) technologies.
2. To apply the techniques of GIS software.

Unit 1

Principles of Remote Sensing: Definition - Electromagnetic Radiation (Source, Mode of Energy transfer, Radiation Principles, Black body radiation). EMR Spectrum - EMR Interaction with Atmosphere (Absorption, Scattering & Atmospheric windows) - EMR Interaction with Earth surface (Absorption & reflection) - Spectral Response pattern - Energy budgeting in Remote Sensing. Resolutions (Spectral, Spatial, Temporal, Radiometric) - Platforms - Sensors - Scanning & Orbiting Mechanism of Satellites and Data Acquisition. Environmental satellites (GOES, NOAA, AVHRR, CZCR) - Applications of remote sensing for Environmental Sciences.

Unit 2

Principles of Geographic Information System (GIS): – Components of GIS – Hardware, software and organizational Context- Data – (spatial and non-spatial) – Maps (types of maps) - Projection (types of projection) Data input (digitizer- scanner-editing) Raster and vector data structure- analysis using raster and vector data- retrieval, reclassification, overlaying, buffering- data output - Levels / Scales of measurement- block diagram, Scaling of maps, Contouring, Thematic mapping for pollution studies

Unit 3

Soil degradation study using Remote Sensing and GIS: Taxonomical classification of soils - soil survey interpretation and mapping – impact of agricultural and industrial activity on soil properties – soil salinity – soil erosion studies –Mining and mine pollution – Waste land mapping - Site selection for the disposal of hazardous, solid, liquid wastes and Effluent Treatment Plants- Application of Remote Sensing and GIS in assessing the soil degradation and soil erosion.

Unit 4

Surface and Ground water pollution: Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization - organic and inorganic contamination of groundwater and its remedial measures - water logging problems due to the indiscrete construction of canals, reservoirs and dams –Marine pollution mapping - Role of Remote Sensing and GIS in surface and ground water pollution control and monitoring.

Unit 5

Air quality Monitoring: Atmosphere (chemicals – particulate matters present in the atmosphere – allowable limit) – Remote Sensing techniques to monitor atmosphere constituents – air pollution due to industrial activity – monitoring of air pollution modeling using GIS.

Textbooks

1. Lillesand, T.M. and P.W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York. Third Edition, 2007.
2. Sabins, F.F.Jr, Remote Sensing Principles and Interpretation, Freeman, Sanfrancisco, 1978.
3. Burrough, P.A, Principles of Geographical Information Systems for Land Resources Assessment, Clarandone Press, Oxford, 1986.
4. Kang - Tsung Chang, Introduction to Geographic Information System, McGraw Hill, Boston, 2002.
5. Richadson, B.F.Jr. (Ed), Introduction to Remote Sensing of the Environment, Kendall / Hunt, Dubuque, Iowa, 1978.

References

1. Surendra Singh, Geomorphology and Remote Sensing in Environmental Management, Scientific Publishers, Jodhpur, 1992.
2. Pirazizy A.A., Environmental Geography and Natural Hazards, Concept Publishing Company, New Delhi, 1992.

Core Practical V: AIR AND SOIL POLLUTION AND AIR POLLUTIONCONTROL ENGINEERING

Semester IV **Code: P16ES4P5**
Credits: 4 **Total Hours: 75**

General objectives

1. To know the sampling techniques.
2. To analyse the air pollutants and soil pollutants.

Unit 1

Air analysis:

1. Particulates:
   Estimation of PM_{10} in the ambient air
2. Gaseous Contaminants:
   Estimation of SO_2, H_2S, NO_x in the ambient air
3. Vehicular pollution - Emission check

Unit 2

1. Calculation and Designing of Settling chambers
2. Calculation and Designing of Cyclones
3. Calculation and Designing of Electrostatic Precipitator
4. Fabric filters

Unit 3

1. Temperature, Humidity
2. Preparation of wind roses
3. Determination of Atmospheric Stability – Pasquill – Turner Method

Unit 4

Noise Monitoring:

Ambient noise levels and L_{eq} calculation using sound level meter

Unit 5

Soil analysis:

1. Soil sampling techniques, pH, Electrical Conductivity, Alkalinity, Total Organic Matter, Total Phosphorous, Total Nitrogen, Sodium, Potassium, Ca, Mg, C/N ratio.
   Soil texture: sand, silt, clay.
2. Spot tests: Nitrate, ammonia and carbonate.

References

1. Trivedy R K, Goel PK and Trisal L, Practical Methods in ecology and Environmental Sciences, Environmental Publications, Karad, 1987.
2. Margesin R and Schinner, Manual of Soil Analysis – Monitoring and Assessing Bioremediation, Springer –Verlag Berlin Heidelberg, 2005.
3. James P. Lodge, Methods of Air Sampling and Analysis, Inter Society Committee Publicaion, 1988.
4. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous,Environmental Engineering, 2017

Elective IV: INTERNSHIP AND FIELDWORK

Semester IV **Code: P16ES4F1**
Credits: 5 **Total Hours: 75**

General objectives

1. To understand the environmental pollution and control practices in various industries.
2. To understand the selected ecosystems and the ecological principles.

Unit 1

Field Work/Study: Need for fieldwork, Methods of field study, importance, steps involved in field study. Field report preparation: Report writing methods.

Unit 2

Internship: (Minimum duration of 15 days in any one of the industries mentioned below).

Internship – Distillery, Tannery, Pulp and Paper industry, Sugar factory, Textile and dyeing units, Dairy, Thermal Power plants, Pharmaceutical industry, Fertilizer factory, Food processing industries, Iron and Steel industry, Steel Rolling mills, Oil refineries, Cement factory, Sugar factory.

Waste management facility: Common Biomedical waste management facility, Common Effluent Treatment Plants – Tannery, Textile and Dyeing units. Solid waste management facility, Municipal sewage treatment plants.

Environmental Laboratories, Environmental Consultancy Agencies, Non-Governmental Organizations etc.

Unit 3

Eco-Tour: Visit to ecosystems - Pond ecosystem, Riverine ecosystem, Hill / Mountain ecosystem, Coastal Ecosystem, Mangroves.

Mudumalai Tiger Reserve, Anamalai Tiger Reserve, Eravikulum National Park

Mukurthi National Park, Guindy National Park, Gulf of MannarNatioanl Park and Biosphere Reserve, Nilgiri Biosphere Reserve, PeriyarTigar Reserve, Karaivetty/Udhayamarthandam/Vaduvoor Bird Sanctuary, Point Calimere Wild life and Bird Sanctuary

Unit 4

Visit to Industry / Environmental Management Facility:

Distillery, Tannery, Pulp and Paper industry, Sugar factory, Textile and dyeing units, Dairy, Food processing industries, Steel Rolling mills, Cement factory.

Waste management facility: Common Biomedical waste management facility, Common Municipal Solid waste management facility, Municipal sewage treatment plants.

Environmental Laboratories, Environmental Consultancy Agencies, Non-Governmental Organizations etc. (Minimum 5 industries)

Unit 5

Environmental Impact Assessment: Case study – Impact of developmental activity/ Industrial activity (Tannery, Textile, Distillery, Mining operations, Cements units, Dam construction).

Environmental Impact Assessment studies should conducted as per the EIA Notification 2006 of MoEFCC covering any one of the following components:

a. Air, Water, Land, Socio-economic, Ecology and biodiversity
(Evaluation of reports will be done only by the Internal Examiners)

PROJECT

Semester IV **Code: P16ES4PJ**
Credits: 6 **Total Hours: 300**

EXTRA CREDIT COURSE - Environmental Audit

Code: PXES3:1

General objectives

1. To understand the concepts of environmentalaudit.
2. To analyse the resource and risk assessment.

Unit 1

Fundamentals – Definition, aims, principle elements (External and Internal audit), Types and Scope (Industrial and Institutions). Needs for Environmental Audit at local and global levels.

Unit 2

Resource Assessment: Natural Resources – Air, Water, Soil, Space, Biodiversity (Greenbelt). Facility – Infrastructure, Energy, Transport, Aesthetics – Internal and External.

Unit 3

Process Environment, Economic management and Risk Assessment – Process environment : Process efficiency, pollution, waste generations and recycling. Economic management – process cost analysis, Environmental protection cost analysis. Lifecycle cost analysis. Risk Assessment – types of risk, expected value, assessment of the degree of risk.

Unit 4

Pre-Audit requisites: Tools for auditing : Auditors (Internal and External) : Connected with audit, Policy impact matrix. Legal implications (Environmental Legislation – Gazette Notification of Environmental Audit, 1992).Geographic database.Statutory agencies.Community awareness and involvement.Environmental education.

Unit 5

Audit processing (Site audit and Post Audit processes): Site Audit: Primary and Secondary data collection using appropriate methods and establishment of database. Drafting of Environmental Statement.Environmental Management Plan – case Study.

Textbook

1. Hamies, Energy Auditing and Conservation; Methods, measurements, management and case study, Hemisphere, Washington, 1980.

EXTRA CREDIT COURSE -Environmental Economics

Code: PXES3:2

General objective

1. To understand the concepts of environmental economics and various economic instruments, resource exploitation and cost-benefitanalysis.

Unit 1

Introduction – Economy and the Environment - Resource use in Society – Consumer Choice theory – Efficiency and welfare – Monetary economy and markets – Competition and efficiency – monopoly – public goods – externalities – trade and environment – international environmental agreements.

Unit 2

Economic instruments for Environmental Protection: Regulatory versus Economic instruments – Charges and subsidies – Non compliance fees, bonds and deposit refunds – marketable permits – Pigovian and Pollution Taxes – Polluter pays principle – Evaluation of instruments – Choice of instruments for Environmental Policy.

Unit 3

Economics of Natural Resource Exploitation : Types, scarcity and classification of Natural Resources – Renewable and non-renewable resources –Capital theory – production costs and Environmental costs – economics of forestry and fisheries exploitation – Utilitarianism and discounting – efficient and optimal use of environmental resources.

Unit 4

Valuation of Environmental Costs and Benefits : Principles of Cos t benefit analysis – valuing the Environment – Direct and indirect methods – Surrogate markets – Travel cost – Non market valuation – Alternatives to valuation – Measuring resource scarcity – Cost of sustainability – assessment of Loss of Ecology – Uncertainties – Environmental accounting – Environmental indicators.

Unit 5

Methods of Profitability Analysis – Payback period – Present value estimation – internal rate of return – opportunity costs –Economic analysis of pollution prevention options – case studies.

Textbooks

1. GOI, Guidelines for strengthening of Joint Forest Management Programme, No.22-8/2000-JFM (FPD) Ministry of Environmental and Forests (Forest Protection Division), New Delhi, 2000.
2. Hanley N, Jaison F, Shogren and White B, Environmental Economics – in theory and Practice, Macmillan India Ltd., New Delhi, 1999.
3. John Bowers, Sustainability and Environmental Economics, Addison Wesley Longman Ltd., Singapore, 1997.
4. Perman R, Yue Ma and McGilvray J, Natural Resources and Environmental Economic s, Second Edition, Addison Wesley Longman Ltd., Singapore, 1997.

EXTRA CREDIT COURSE - Occupational Health And Industrial Safety

Code: PXES3:3

General objectives

1. To understand the significance of occupational health and industrial safety.
2. To learn about the safety management system.

Unit 1

Introduction: Parameters of safety – Policy factors affecting the conditions of occupational and industrial safety –safety Regulations. Factories Act

Unit 2

Principles of Ergonomics: Role of ergonomics in designing work place, effects of work environment – light –ventilation-vibration – noise. Work physiology and its relevance to safety. Performance evaluation of systems involving man and environment.

Unit 3

Occupational Health and Safety : Occupational health and hazards – physical –chemical – biological hazards, Occupational diseases-prevention and control, Health protection measures for workers – health education – medical first-aid. Management of medical emergencies.

Unit 4

Industrial Safety Management Techniques: Industrial safety standards. Accidents- definition –frequency rate-prevention and control. Work study – work measurement – measurement of skills, safety cost and expenses. Principles of functions and safety management.

Unit 5

Safety Management System: Concepts of safety management systems. International safety certification.OHSAS compliance.

Textbooks

1. Diberardinis LJ, Handbook of Occupational Safety and Health, John Wiley, New York,1998.
2. Peterson RD and Cohen JJ, The complete guide to OSHA Compliance, Lewis publishers, New York, 1997.
3. Scott RM, Basic Concepts of Industrial Hygiene, Lewis publishers, New York, 1997.

EXTRA CREDIT COURSE - Forest Management

Code: PXES3:4

General objectives

1. To learn about the forest ecology, types of forests, its resources and threats.
2. To know the forest policy, legislation and forest management strategies.

Unit 1

Forest ecology – Forest community concepts; vegetation concepts; productivity nutrient cycling and relations, physiology in stress environments (drought, water logging salinity and alkalinity).

Unit 2

Forest Resources and Economics : Forest Resources ; Timber environment sound forest harvest practices; logging extraction techniques and principles, transportation system, storage and sale ; Non – Timber forest Products (NTFPs) definition and scope; (gums, oil seeds nuts, bamboos, medicinal plants). Forest economics – fundamental principles, cost-benefit analyses; estimation of demand and supply; analysis.

Unit 3

Forest- threats and Protective Measures: Forest Fire (cause, effects -economic and environmental costs and control measures). Human – animal conflicts (encroachment, poaching, grazing, fencing, theft, shifting cultivation and control). Grazing and browsing (Rotational and controlled grazing, different methods of control against animals) Effect of wild animals on forest regeneration, Role of Afforestation and forest regeneration in absorption of CO_2

Unit 4

Forest policy and Legislation: Indian forest policy 1990. National Forest Policy 1998 – Wildlife Protection Act 1972 and their amendments. Forest Conservation Act 1980.Application of Indian penal Code to forest – international timber law.Scope and objective s of forest inventory.

Unit 5

Forest management and management systems, objective and principles; techniques; stand structure and dynamics, sustained yield relation, rotation, normal forest, growing stock; regulation of yield management of forest plantations, commercial forests, forest cover monitoring. Agro forestry, Social Forestry, Joint Forest Management.

Textbooks

1. Puri GS, Gupta RK, Meher – Homji VM and Puri, Forest Ecology, Oxford & IBH publishing Co., Pvt. Ltd, New Delhi, 1989.
2. FSI, State of Forest Report 1997, Forest survey of India, Ministry of Environment and Forests, Dehradun, 1998.
3. Gadgil M and Guha R, Ecology and Equity: the use and abuse of nature in contemporary India, Penguin books, New Delhi, 1995.

EXTRA CREDIT COURSE - Solid Waste Management

Code: PXES4:1

General objectives

1. To understand the types of solid waste (both biodegradable and non-biodegradable).
2. To apply the waste management technologies to solve environmentalproblems

Unit 1

Introduction to waste

Wastes – Introduction, sources, characteristics, composition, classification, waste generated per capita - Global scenario of wastes - Waste collection, Storage and segregation - Transportation and disposal methods - Sanitary land filling techniques.

Unit 2

Municipal Solid Waste Management

Municipal solid waste – Sources, types, collection and transportation, Waste processing and resource recovery (typical material recovery facility operation (TMRF)) - Reuse and recycling of paper, glass and rubber - Disposal methods*:* Incineration, Pyrolysis, composting, sanitary landfills and aerobic and anaerobic digestion.

Unit 3

Hazardous Waste Management

Hazardous waste - Introduction, characteristics - Classification of hazardous waste (Industrial, hospital and domestic) - Handling of hazardous solid wastes (segregation, recovery of hazardous waste substances) - Hazardous waste disposal techniques - Radioactive wastes: Sources, pollution, types of radioactive waste and its control and management.

Unit 4

Biomedical, Plastic & e-waste management

Biomedical wastes: Sources, types of biomedical wastes – Impacts of biomedical wastes on environment - Control measures of biomedical wastes - Plastic wastes: Sources, Facts & figures of plastic waste scenarios in National & International – Effect of plastic wastes on environment – Control measures of plastic wastes. E-wastes: Sources, types of e wastes – Impacts of e-wastes in environment - Control measures of e-wastes.

Unit 5

Energy Recovery from Wastes

Vermicomposting, mushroom sheds, fly ash bricks, biogas, and Bio -electro chemical systems – Microbial electrolysis cell – Microbial fuel cell - Production of methane, Hydrogen peroxide, ethanol, electricity.

Textbooks

1. Hester RE and RM. Harrison, Electronic Waste Management, Design Analysis & Application, RSC Publishing, UK, 2009.
2. James Saling, Radioactive Waste Management, CRC Press, FL, USA, 2001.
3. John Pitchel, Waste Management Practices, Municipal, Hazardous, and Industrial, Taylor & Francis Group, LLC, 2005.
4. Lagrega MD, Buckingham PL and Evans JV, Hazardous Waste Management, McGraw Hill Int. Ed. New York, 2001.

EXTRA CREDIT COURSE - Green Science And Technology

Code: PXES4:2

General objectives

1. To know about the green science and technology.
2. To apply the techniques of green science in development and management of environment.

Unit 1

Anthrosphere: Five spheres of the earth and their interaction and interrelationships. Anthrosphere – Definition, its effects of Anthrosphere on environment. Anthrospheric constructs, anthrospheric flows, anthrospheric conduits. Infrastructure, transportation, the communication revolution, technology and Engineering (Brief description only).Acquisition of Raw materials. Agriculture – the most basic industry. Industries and their classification.

Unit 2

Green Chemistry: Twelve principles of green chemistry, and green science and technology. Reasons for Green Chemistry (resource minimization, waste minimization concepts).Yield and atom economy.Green oxidation and photochemical reactions. Microwave and Ultrasound assisted reactions. Important techniques and directions in practicing Green Chemistry.

Unit 3

Green Synthesis and Reactions: Feed stocks – biological feed stocks. Green Reagents - Stoichiometric and catalytic reagents. Green solvents and reaction conditions.Green synthesis – case studies. Green catalysts – Use of zeolites, silica, alumina, clay, polymers, cyclodextrin and supp orted catalysts. Biocatalysts – enzymes.

Unit 4

Waste management: Waste reduction and minimization - recycling, solvent recovery and recycling. Recovery of water from waste water.Physical methods of waste treatment.Chemical treatment.Thermal treatment, biodegradation.Land treatment and composting.Preparation of wastes for disposal.Ultimate disposal of wastes.In-situ-treatment.

Unit 5

Green Energy technologies and Green Buildings: Sources of energy in the anthrosphere. Energy devices and conversions.Green technology and energy conversion efficiency. Energy conservation and renewable energy sources (list of sources only). Unrealized potential of lingo -cellulose fuels. Hydrogen. Combined power cycles. Green Composites for buildings: Concepts of Gree n Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management.Management of Solid Wastes.Management of Sullage Water and Sewage.Urban Environment and Green Buildings. Green Cover and Built Environment.

Textbooks

1. Stanley Manahan, , Fundamentals of Environmental Chemistry, 3rd edition, CRC press, Taylor and Francis Group, Boca Raton, 2009.
2. Stanley Manahan, Environmental Science and Technology – A Sustainable Approach to Green Science and Technology, 2nd Edition, CRC press, Taylor and Francis Group, Boca Raton, 2011.
3. Liu David, H.F. and Liptak, B.G, Environmental Engineers Handbook, 2nd Edition, Lewis Publishers, Boca Raton, 1997.
4. AsimK. Das, Environmental Chemistry with Green Chemistry, Books and Allied (P) Ltd., Kolkata, 2010.
5. Shukla, Mohit, S.P., Green Chemistry, Books International, New Delhi, 2012.
6. R. Sanghi, M.M. Srivastava, Green Chemistry – Environment Friendly Alternatives, Narosa Publishing House, New Delhi, 2009.
7. Dennis C. Brewer, Green My Home: 10 Steps to Lowering Energy Costs and Reducing Your Carbon Footprint, ISBN:9781427798411, Kaplan Publishing, 2008.
8. K.S.Jagadish, B. U. Venkatarama, Alternative Building Materials and Technologies, New Age International, 2007.
9. TERI, Sustainable Building Design Manual, Vol 1 and 2, New Delhi, 2004.
10. O. H. Koenigs Berger, T. G. Ingersoll, Alan Mayhew and S. V. Szokolay, Manual of Tropical Housing and Building, Orient Long man, 1975.

EXTRA CREDIT COURSE - Ecotourism

Code: PXES4:3

General objective

1. To understand the importance of ecotourism, its components, impacts andmanagement.

Unit 1

Scope and definitions; Objectives of tourism (geographical, social, economic, religious, cultural and environmental); Components of tourism (information services, transport and accommodation).

Unit 2

Ecotourism – definition and characteristics features (Ecosystem &biodiversity, support to local economy, conservation of biosphere, learning experience); Goals (social, economical and environmental); criteria (conservation, low impact and green efforts, sustainability, recreation, community involvement and environmental education and interpretation.

Unit 3

Ecotourism in India – India a land of pluralism: land, people, flora and fauna and climatic variations – biogeographic classification of India (10 regions) – Ecosystem types available (terrestrial and aquatic including coastal mangrove and deep sea) – Contrast from tropics to snow.

Unit 4

Impacts of tourism on environment: population growth and carrying capacity leading to environmental pressures – biophysical, socio psychological, resource exploitation, poor management, pollution and environmental disturbances.

Unit 5

Management of ecotourism: Development of information services, transport and accommodation – Regulation of funds (for operational facilities and administration) – Equitable management and distribution of resources and waste management – Eco certification, policies and regulations – Ecotels&Ecomorals – Sustainable ecotourism.

Textbooks

1. Bhatia AK, Tourism in India: Its History and Development, Sterling Pub., New Delhi,1978.
2. Bhatia AK, Tourism Developments: Principles & Practices, Sterling Pub., New Delhi,2002.
3. Ratandeep S, Dynamics of Modern Tourism, Kanishka Pub., New Delhi, 1998.
4. Seth, Praveen, Hand Book of Modern Tourism, Ammol Pub., New Delhi, 1999.

PG - Non Major Elective Course (NMEC)
(For the candidates admitted from the year 2016 onwards)
(Offered to Students of other Disciplines)

Sem.	Course	Code	Title	Hrs./ week	Credits	Marks		
						CIA	ESA	TOTAL
II	NMEC	P16ES2E1	Environmental Management	4	2	25	75	100

NMEC I: ENVIRONMENTAL MANAGEMENT

SEMESTER II **Code: P16ES2E1**
Credits: 2 **Total Hours:60**

Objectives

1. To understand the basic knowledge of the concepts of environmental management
2. To comprehend the global issues and initiatives taken for sustainable development

Unit 1

Global Environmental Problems: Environmental Pollution, Acid rain, Green house effect, global warming, Ozone depletion, Loss of biodiversity.

Unit 2

Water resource Management: Water resources and their significance; water balance, water utilization and related problems, water resource management – Rain water harvesting, Water sharing.

Unit 3

Land Resources Management: Soil Erosion causes and control measures ; wasteland management, Deforestation and its impacts. Afforestation social and agro forestry schemes. Forest (Conservation) Act, 1980,

Unit 4

Solid waste Management: Municipal, Industrial, nuclear and Hazardous, biomedical and e – waste. Environment (Protection) Act, 1986 - Hazardous wastes (Management and Handling) Rules 1989, Biomedical Waste (Management and Handling) Rules 1998, Municipal Solid Waste (Management a nd Handling) Rules (2000), *e -waste* (Management and Handling) *Rules 2010,* Plastic wastes (Management and Handling) Rules 2011.

Unit 5

Environmental Management Systems (EMS): ISO 14000 series. Legal instruments available for protection of environment – The Water (Prevention and Control of Pollution) Act, 1974, The Air (Prevention and Control of Pollution) Act, 1981; The Noise Pollution (Regulation and Control) (Amendment) Rules 2000.

Text Books

1. Joseph K and Nagendran R, Essentials of Environmental Studies, Pearson education limited, New Delhi, 2004.
2. Munn R.E, Environmental Impact Assessment, McGraw Hill book Co. NY, 1982.
3. Murty J.V.S, Watershed Management in India, Wiley Eastern Ltd., New Delhi, 1994.
4. Nandhithakrishna, Environmental Laws of India – An Introduction, C.P.R. Environmental Education Centre, Chennai, 1998.