SCHOOL OF ENVIRONMENTAL SCIENCES, MAHATMA GANDHI UNIVERSITY , KOTTAYAM

M.SC. Environment Science and Management

2016 onwards

Scheme

Semester I

Course	Sl .No.	Course Code	Name of the Course	Credits	Credits Required	Total Credits
Core	01	SES M I C 16 01	Ecology and Environment	**2**	**14**	**20**
	02	SES M I C 16 02	Environmental Geosciences	**3**		
	03	SES M I C 16 03	Environmental Chemistry	**2**		
	04	SES M I C 16 04	Environmental Pollution and Control	**3**		
	05	SES M I C 16 05	Research Methodology and Statistics	**2**		
	06	SES M I C 16 06	Lab course-I (Environmental Chemistry, Geosciences and Ecology)	**2**		
Elective	07	SES M I E 16 07	Natural and anthropogenic disasters	**2**	**6**	
	08	SES M I E 16 08	Energy Resources	**2**		
	09	SES M I E 16 09	Nature Studies-Field skills and techniques	**2**		
	10	SES M I E 16 10	Introduction to Remote Sensing, GNSSs and GIS	**2**		

Semester II

Course	Sl .No.	Course Code	Name of the Course	Credits	Credits Required	Total Credits
Core	11	SES M II C 16 11	Analytical Techniques and Instrumentation	2	16	20

	12	SES M II C 16 12	Environmental Biotechnology and Waste Management	3		
	13	SES M II C 16 13	Environmental Economics and Sustainable Development	2		
	14	SES M II C 16 14	Environmental Microbiology	2		
	15	SES M II C 16 15	Environmental Laws, Ethics, Education and Policy	2		
	16	SES M II C 16 16	Biodiversity and Conservation Biology	2		
	17	SES M II C 16 17	Lab course-II (Environmental Chemistry, Environmental microbiology, Biotechnology, RS & GIS)	2		
	18	SES M II C 16 18	Field Study	1		
Elective	19	SES M II E 16 19	Ecotoxicology	2	6/4	
	20	SES M II E 16 20	Green Chemistry and Nano Technology	2		
	21	SES M II E 16 21	Fundamentals of Management	2		

Semester III

Course	Sl .No.	Course Code	Name of the Course	Credits	Credits Required	Total Credits
Core	22	SES M III C 16 22	Environment Management	3	16	20
	23	SES M III C16 23	Environmental Engineering	3		
	24	SES M III C 16 24	Advanced Analytical Instrumentation	2		
	25	SES M III C 16 25	Environment Impact Assessment	2		
	26	SES M III C 16 26	Advanced Geomatics and Applications	2		

	27	SES M III C 16 27	Climate Change and Governance	2		
	28	SES M III C 16 28	Group Project	2		
	29	SES M III C 16 29	Current issues and trends in Environmental Science	0		
*Open Course offered					4	

Semester IV

Course	Sl .No.	Course Code	Name of the Course	Credits	Credits Required	Total Credits
Project	30	SES M IV C 16 30	Project Work (Report/Thesis)	16	16	20
		SES M IV C 16 31	Project Course	4	4	

Credit for core Courses : 46

Credit for elective courses : 14

Credits for the Project : 20

TOTAL : 80

FIRST SEMESTER

SES 504 B Lab course-I (Environmental Chemistry, geosciences and ecology)

Environmental Chemistry
Volumetric Analysis: Basic Principles
Acidimetry and Alkalimetry—Estimation of hydrochloric acid, sodium carbonate, oxalic acid
Permanganometry- Mohrs salt, potassium permanganate
Invetigatory projects: Available chlorine in bleaching powder, analysis of tea leaves, Analysis of fertilizers

Ecology
Biodiversity assessment : Quadrate method
Plankton analysis

Environmental Geosciences
Identification of rocks and minerals
Soil analysis- Physical (Texture, Bulk density, moisture content) and chemical parameters (pH, OC/OM, EC)
Wind rose
Measuring strike and dip of rock formations. Basic map reading.

Water quality
Colour, turbidity, conductivity, TDS, TSS,TS, pH, acidity, alkalinity, chloride, salinity, hardness, DO, BOD

Noise analysis

References

APHA (1995). Standard methods for the examination of water and wastewater. 19th edition American Public Health Association, Washington, DC
Maiti, S.K. (2003) Handbook of methods in environmental studies, Vol. 2: Air, noise, soil, overburden, solid waste and ecology. ABD Publishers, Japur.
Marc Pansu, Jacques Gautheyrou, Hand book of soil analysis- Minerological, organic and inorganic methods, Springer, New York
Maria Csuros and Csaba Csuros, Environmental Sampling and Analysis for Metals, Lewis Publishers

Miroslav Radojevic and Vladimir N Bashkin, Practical Environmental Analysis, RSC Publishing
Conklin Alfred R. Introduction to Soil chemistry, analysis and Instrumentation, Jhonwiley&Sons Newyork
NEERI , Air quality monitoring, A course manual (Photostat), NEERI Nagpur
Mamata Tomar, Quality Assessment of Water and Waste Water, Lewis Publishers London
Abbasi S A, Water quality sampling and analysis, Discovery Publishing New Delhi Christian Gary D, Analytical Chemistry, JhonWiley & Sons NewYork

SES 532 B Ecology & Environment

The course would enable the students to:

Understand the concepts of Ecology and Environment

Study the structure, organisation and processes in ecosystem

Understand the structural and functional aspects of a population as an ecological unit

Explain the concept of biological community, changes and interactions within community

1.1 Introduction

Basic concepts of Environment –
Multidisciplinary approach
Basic concepts - Science, Matter and Energy
Evolution of earth, origin of species, diversity and distribution of species
Global environmental issues – an introduction

1.2 Ecology

Definition, History of ecology, Subdivisions, Ecology and other subjects. Fundamental ecological variables

Ecosystems: Definition, Components, Structure and function, Size of Ecosystem, Classification of ecosystems

Comparative Ecosystem Ecology

1.3 Population Ecology

Definition, Structure and Measures

Population Growth, Population

regulation Strategies of species

survivability Population Genetics

Human Population

1.4 Community Ecology

Concepts, Community gradients, Characters of community

Ecological Succession and climax Community

Organization Interactions between species

Stress Ecology and Adaptation

1.5 Applied Ecology

Estimating Abundance Species diversity measures

Diversity indices

Mathematical ecology : Ecoinfomatics

Museology

Taxonomy and Biosystematics

Biomass productivity and estimation techniques

References

1. Brewer, R. (1994), The Science of Ecology, Saunders College Publishing, New York.

2. Chapman, J. L. And Reiss, M. J. (19920, Ecology: Principles and Application, Cambridge University Press, Cambridge.

3. Groombridge, B. (ed) 1992. Global Biodiversity: Status of the Earth's Living Resources, Chapman and Hall, London.

4. Hughes, J, D. 2001. An Environmental History of the World. Routledge, London.

5. Michael, P. 1990. Ecological methods for Laboratory and Field Investigations, Tata McGrew Hill Publishing Company Ltd, New Delhi.

6. Odum, E. P. 1971. Fundamentals of ecology

7. Sutherland, W. J. 2004. 1997. Ecological Census Techniques - A Handbook. Cambridge University Press. P336.

SES 533 Environmental Geosciences

Objective

1. To create the awareness that geology is a process-based unified field of science

2. To enable deciphering of processes through study of earth features3. To appreciate the concepts of geologic time and to view earth as a system

4. To build up the basic vocabulary of geology and the underlying concepts.

Unit 1 The Earth System

The Scientific Method – Earth as a System of Interacting Components - Geologic Time - The Geologic Record – Evolution of life

Plate Tectonics: Interior of the earth- – Plate mosaic – Rates of plate motion – Plate reconstruction – Mantle convection

Basic geological processes-Mountain building, volcanic eruption, seafloor spreading

Geological Time Scale, Stratigraphic time and absolute time. Origin of the solar system

Paleoenvironment and its significance

Tropical, Temperate and Polar systems –physical variations and significance

Unit 2 Materials of the earth

Minerals – Atomic structure of minerals – Rock-forming minerals – Physical properties of

Minerals

Rocks: igneous, metamorphic and sedimentary - Origin – The rock cycle

Characteristics of different types of rocks

Rock deformation: folds, faults and joints

Weathering and erosion: physical, chemical weathering of Soil.

Resources and reserves - Minerals and Population - Marine minerals-

Fossil fuels – formation and significance

Unit 3 Geomorphology

Geomorphology-basics

Geomorphology of India and Kerala: Brief description of different important units

Rivers & Streams: Valley, channel, floodplain, drainage network, drainage basin.

Glaciers– types and characteristics

River morphology –morphological parameters and its environmental significance; meanders, oxbow lake etc.

Sedimentary environment

Unit 4 Oceans and coasts

Origin and composition of sea water. Ocean and coastal ecosystems – Types and formationestuaries, backwaters, coral reefs, Islands , Fjords

Ocean currents and circulation, Shoreline process – wave erosion, deposition or accretion; modification of shorelines;

Unit 5 GROUND WATER IN THE ENVIRONMENT

Hydrological cycle-

Aquifers – types and properties, water table

Ground water recharge-recharge areas-discharge areas-

Ground water movement -base flow-measurement

Effect of pumping wells on ground water table-

Methods of ground water abstraction ---undesirable side effects of over exploitation-threats to groundwater system-physical destruction of aquifers-groundwater depletion-degradation of ground water quality-point source of contamination-diffuse source of contamination- aquifer vulnerability-aquifer over exploitation-

Sustainable groundwater development-ground water estimation-groundwater management-over exploited, critical and semi critical areas-ground water act in Kerala--artificial ground water recharge

Unit 6 Lithosphere and Atmosphere

Structure and composition of the atmosphere, hydrosphere, lithosphere.

Interaction between lithosphere and atmosphere: Winds, Precipitation etc.

Wind – types and formation, role in transportation, erosion, deposition

Precipitation – rainfall, snow fall.

Humidity and radiation

Monsoon, El Nino, Droughts, Tropical Cyclones

Atmospheric stability, inversions and mixing heights, wind rose

Unit 7 Resources and the Environment

Environmental impacts of mineral resource extraction and processing,

Sand mining – river and terrestrial ; Impacts on physical and biological systems

Quarrying, Clay mining and destruction of hillocks – impacts

Geological issues in the disposal of domestic waste and industrial waste

Shoreline activities and impacts

References

1. Grotzinger et al 2007 Understanding Earth WH Freeman New York 579 p

2. Soman K 2001 Geology of Kerala Geological Society of India Bangalore 430 p

3. Fetter CW 1990 Applied Hydrogeology CBS New Delhi 592 p

4. Krishnan MS 1976 Geology of India and Burma CBS New Delhi 433 p

5. Stewart RH 2007 Introduction to Physical Oceanography 353 p

(http://oceanworld.tamu.edu/home/course_book.htm) Accessed 13 Sept

SES 534 A : Environmental chemistry

Unit I

Definition. principles and scope of Environmental Science. Chemistry and the Environment, Earth. Man and Environment. Water and the hydrosphere, Air and the atmosphere, Energy and cycles of energy, Chemical fate and transport.

Unit-II

Mass and Energy transfer across the various interfaces, material balance. First and Second law of thermodynamics. heat transfer' processes, Fundamentals of Environmental Chemistry.; Stochiometry, Gibbs' energy. Chemical potential;. chemical equiilibria, acid· base reaction. solubility product, solubility of gases in water, the carbonate system. Unsaturated and saturated hydrocarbons" radionuclide’s.

Unit III

The atmosphere and atmospheric chemistry, Energy transfer in atmosphere, Global climate and micrtoclimate, chemical and photochemical reactions in the atmosphere, reactions of atmospheric oxygen, composition of Air : Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Chemistry of air pol1utants, Photochemical smog.

Unit IV

Fundamentals of aquatic chemistry, The importance of water, The properties of water, gases in water, Calcium and other metals in water, Polyposhphates and phosphonates in water, concept of DO, BOD, COD, sedimentation, coagulation,· filtration, Redox potential.

Unit V

Soil Chemistry : Nature an dcomposition of soil, Inorganic and organic components of soil, acid base and ion exchange reactions in soils, macro and micronutrients in soil, Nitrogen pathways, NPK in soils.

Reference

Manahan Stanley E ., Environmental chemistry, Lewis Publishers London

Nyle C Brady, Nature and Properties of Soil, Macmillan

Air Pollution, M. N. Rao and H V N Rao, McGRAW HILL

Principles of Environmental Chemistry, James Girard

Green Engineering: Environmentally Conscious Design of Chemical Processes, David T. Allen

Chemistry Fundamentals: An Environmental Perspective (2nd Edition), Phyllis Buell

SES 535 A ENVIRONMENTAL POLLUTION AND CONTROL

The course would help the students to :

- *Understand the sources and impacts of pollution of various environmental matrices*
- *Explain the fate and transport of various pollutants*
- *Learn methods for the analysis of various pollutants*

- *Understand the environmental monitoring techniques and quality standards*
- *Understand the different pollution control measures*

Unit I : Air Pollution and management

Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Gas laws governing the *behavior* of pollutants in the atmosphere. Indoor air pollution, Methods of monitoring and control of air pollution S02 , NO, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate. Acid Rain. Smog, Air quality Standards, Air Sampling techniques.
Identification of aeroallergens. Air-borne diseases and allergies.

Unit II : Water Pollution and management

Types of water pollution-surface and ground water, Origin and Sources, Nutrients and Eutrophication, Organic matter - sources and degradation, Microbial pollution, Coastal and Marine pollution-Oil spills, Thermal pollution, Movements of contaminants in ground water , Impacts of water pollution, Heavy metals and other POPs in aquatic systems cycling and interactions, Water quality parameters-physical, chemical and biological, Management of point and non-point sources of water pollution, Monitoring of quality parameters, Sampling and analysis, Water quality standards, Tracers – dyes and isotopes in pollution monitoring, water pollution control.

Unit III: Soil Pollution and management

Soil quality parameters , sampling, Physico-chemical analysis of soil quality. Soil Pollution Control. Industrial waste effluents and heavy metals, their interactions with soil components. Soil micro-organisms and their functions, Degradation of different insecticides, fungicides and weedicides in soil. Different kinds of, synthetic fertilizers (NP & K) and their interactions with different components of soil.

Unit V: Noise Pollution and Management

Characterstics of noise, sources, Effects of noise, Standards, Measurement and control

Unit VI : Radioactive pollution

Radioactivity in the environment – natural and anthropogenic, Nuclear weapons, nuclear waste, Impacts on the environment, Management of radioactive waste

Reference

Abbasi S A , Environmental pollution and its control, Cogent international Pondichery

Cunningham William P Saigo Barbara Woodworth ., Environmental science, Mcgraw Hill London

Gaur G , Noise pollution and its management, Sarup & Sons New Delhi

Helmer Richard Hespanhol Ivanildo , Water pollution control, E and FN Spon London

Kearney Philip C Roberts Terry, Pesticide remediation in soils and water, JhonWiley & Sons NewYork

Lichtfouse Eric Schwarzbauer Jan Robert Didier, Environmental chemistry, green chemistry and pollutants in ecosystems, Springer Tokyo

Lippmann Morton, Environmental toxicants human exposures and their health effects, JhonWiley & Sons NewYork

Manahan Stanley E ., Environmental chemistry, Lewis Publishers London

Mc Bride Murray B., Environmental chemistry of soils, Oxford University Press New

York

Mishra P C., Soil pollution and soil organisms, Ashish Publishing New delhi

Nebel Bernard J Wright Richard T, Environmental science, Prentice Hall International New Jersey

Neill Peter O ONeill Peter, Environmental Chemistry, Blackie Academic London

Prabhakar V K, Toxic and Hazardous chemicals, Anmol NewDelhi

Prasad M N V, Metals in the Environment, Marcel Dekker Newyork

Rao CS, Environmental pollution control engineering, Newage Newdelhi

Sarkar Bibudhendra, Heavy metals in the Environment, Marcel Dekker Newyork

Sharma B K Kaur H , Water pollution, Krishna prakashan Meerut

Trivedi P R Gurdeep Raj , Noise pollution, Akash deep Publishing House New Delhi

Vanloon Gary W Duffy Stephen J., Environmental chemistry: a global perspective, University Press Oxford

SES 536: Research methodology and Statistics

I. RESEARCH METHODOLOGY

1.1 **Meaning**- Objectives- motivation- Significances of research, Types of research, Research methods and methodology, Research and Scientific Method, Criteria of Good research, Problems of researcher

1.2 **Selection of the problem**: Criteria for selection of problem and evaluating problems, Statement of problem formulation and definition.

1.3 **Research design**: Meaning, need for research design, Features and important concepts relating to research design, Different research design, Basic principles of experimental design.

1.4 **Survey of literature**: Different methods of surveying literature, different sources of information, internet, search engines, web sites, recording surveying information.

1.5 **Hypothesis**: Nature, types and sources of hypothesis, characteristics of a good hypothesis.

1.**6 Sampling**: Unit of sampling, population: techniques, characteristics of good samples, sampling errors and ways to reduce them.

1.7 **Collection and analysis and interpretation of data**: Procedure of data collection, scoring of data, tabulation, editing and analysis and interpretation of data.

1.8 **Research Report**: Composition, pagination, Title pages, Systems of indicating references, Bibliography, Appendices.

1.9. **Mini project** for data analysis

II. Statistics

Unit 2: Fundamental Statistics

2.1. **Introduction** – Importance and limitation.

2.2 **Classification and Tabulation** of data

2.3 **Graphical Representation**

2.4 **Measures of Central Tendencies** – Mean, Median and Mode

2.5 **Measures of Dispersion -** Range, Standard Deviation and Co-efficient of Variation

2.6 **Moments, Skewness and Kurtosis**

2.7 **Correlation and Regression** – Scatter diagrams – Karl Pearson's Coefficient of correlation – Rank correlation – Linear and Curvilinear regressions.

2.8 **Probability** – Frequency approach- Addition and multiplication theorems- Binomial, Poisson and Normal Distribution- Probit analysis (Graphic Method only)

2.9 **Testing of Hypothesis**: Null and Alternative Hypothesis – Two types of error – Level of significance Test based on t, Z, F ,Chi –square and Analysis of Variance – one-way, two-way, three-way analysis.

Unit 3 Application of Computer in Statistics

Data analysis using packages - SPSS

References

1. Ahuja Ram, Research Methods, Rawath Jaipur.

2. Babbie Earl, Research methods in sociology, Cengage Learning Australia.

3. Denscombe Martyn, The good research guide: for small scale social research projects, Viva Books New Delhi.

4. Devendra Thakur, Research methodology in social science, Deep & Deep Publications New Delhi

5. Gurumani N, Research methodology for Biological Sciences, MJP Publishers Chennai

6. Holmes Debbie Moody Peter Dine Diana, Research methods for the biosciences, Oxford Newyork.

7. Kothari C R, Research methodology: methods and techniques, Wiswa Prakashan New Delhi.

8. Mohankumar P S , Handbook on research methodology, Right Publishers Kudanechoor

9. Narwal S S Dahiya S S Singh J P, Research methods in Plant science, Allelopathy Vol 1, Soil analysis, Scientific Publishers Jodhpur.

10. Prabhakar V K, Research methodology and system analysis, Anmol NewDelhi

11. Santosh Gupta, Research methodology and statistical techniques, Deep & Deep Publications New Delhi

12. Barnett Vic, Environmental statistics, methods and applications. JhonWiley & Sons NewYork.

13. Gupta S P, Statistical methods, Sultan Chandh New Delhi

14. Jayaraman K, Handbook on statistical analysis in forestry research. Kerala Forest Research

Institute Peechi.

15. Kozak Antal Kozak Robert A Staudhammer Christina L Watts Susan B, Introductory Probability and Statistics, applications for forestry and the natural sciences, Cab International Wallingford.

16. Levin Richard I Rubin David S, Statistics for Management, Edition 7, P H I NewDelhi

17. Miller Jane, Statistics for advanced level, Ed.2, University Press Cambridge.

SES 537: Natural and Anthropogenic Disasters

Unit 1 Disaster Management Concepts and Field of Study

2.1 Introduction to key concepts, terminologies and their complexities (Hazard, vulnerability, Exposure, Risk, Crisis, emergencies, Vulnerability, Disasters, Resilience) Types and classifications of disasters-Natural and Human made, Anthropogenic, Chemical, Biological etc., Impact of disasters,

2.1 Disaster management Spectrum and its components

2.3 Scope of DM and Disaster Management Cycle

Unit 2 Disasters and Development – Introduction

1.2 Relationship between disasters and development, implications. History of disaster

Response strategies

1.2 Disasters, Poverty and Development. Global challenges and trends of Disasters

1.3 Disaster Management: The interaction of Earth system and Human System

1.4 1.Disaster Risk Management - key concerns. Mainstreaming Disaster Risk Reduction to developmental efforts.

1.5 Geography and dimensions of Disasters- global out look.

Unit 3 Environment and Disasters

3.1 Science and Facts of Natural Hazards. Earth's processes as disasters: Internal and external Characteristics. Causal factors and characteristics of disasters.

3.2 Disaster typology and Classification.

3.3 Water and climate related disasters

3.4 Geologically related Disasters

3.5 Biologically related Disasters

3.6 Chemical, Industrial and Nuclear related Disasters

3.7Accident related Disasters

3.8 Climate change and Disasters

Unit 4 International Disaster management System

4.1 Organizations, bodies and Finance. International Strategies and functions. United Nations role in Disaster management.

4.2 International Disaster management support system. Unified response strategy

4.3 Mapping Disasters using global datasets. National and international information networks and inventories.

Unit 5 Disaster Management in Indian Context

5.1 Major Disasters in India. National Vulnerability profile

5.2 National Disaster management Hierarchy and Institutionalisation

5.3 National Disaster Decision support system. Technological applications. Role of Research Organisations.

5.4 Challenges of disasters in India

References

Coppola D. P., 2007. Introduction to International Disaster management. Elseiver. Butterworth-Heinemann

Peduzzi P., Dao H., and Herold C., 2005. Mapping Disastrous Natural Hazards Using Global Datasets Natural Hazards Volume 35, Number 2, 265-289,

Shaw R and Krishnamurthy R.R., (ed.)2009. Disaster management Global Challenges and Local solutions. University Press, India

Keller E.D., and Blodgett R. H, 2006. Natural Hazards. Pearson Printice Hall

Kapur A., Neeti, Meena, Deepthima, Roshani and Debanjali, Disastetrs in India Studies aof Grim Relaity. Rawat Publications, New Delhi

SES: 538 Energy Resources

Unit I: Introduction

1.1 Fundamentals of energy, work, power and units

1.2 Energy transformations – laws of thermodynamics

1.3 Flow of energy and cycle of matter in the human ecosystem: Energy for household, industrial and agricultural uses.

1.4 History and geography of energy development and energy related pollution

1.5 Concepts of Conventional, Non-conventional, Renewable, Non-renewable and Alternate energy resources.

Unit II: Non-renewable Energy Resources

2.1 Fossil fuels: Coal, Pete, Oil, Oil shale, Tar sands, Natural gas

2.2 Non-fossil fuels: Nuclear power

2.3 Ecological and social impacts (Advantages and Disadvantages) of major thermal and nuclear power plants

2.4 Management of energy projects and its environmental impacts

2.5 Environmental impacts of non-renewable energy resources

Unit III: Renewable Energy Resources

3.1 Solar Energy: Technique for harvesting solaer energy, direct utilization of solar energy by thermal convetsion thermo-mechanical conversion, Helio-electric conversion, Photo-voltaic conversion, indirect utilization through water powerOcean Thermal Energy Conversion (OTEC), Solar ponds.

3.2 Wind resources: Mapping of wind resources area, wind power stations, wind turbines – types, efficiency: Betz limit

3.3 Geothermal sources, Tidal energy and Ocean waves- Possibilities and limitations

3.4 Biomass based energy- Biogas systems, petro-plants, dendrothermal energy

3.5 Environmental impacts of renewable resources

Unit IV: Energy Resources in India

4.1 Fuel wood

4.2 Fossil fuel- coal, oil natural gas

4.3 Hydropower

4.4 Nuclear power

4.5 Renewable energy resources in India: Thermal energy, solar energy, wind energy, biomass based energy and other renewable energy sources (tidal, ocean waves and geothermal)

Unit V: Energy, Environment and Development

5.1 Environmental pollution associated with energy generation and consumption process

5.2 Energy pricing techniques for controlling environmental problems (air pollution)

Unit VI: Energy Auditing

6.1 Types of audits- walk through energy audit, intermediate energy audit, and comprehensive energy audit

6.2 Recommended practices

6.3 Performing the energy audit- details- computer simulation, developing the report

REFERENCE

1 Biomass Energy Systems (1997). Tata Energy Research Institute (TERI), New Delhi

2 **Goldemberg, J., Johnansson, T.B., Reddy, A.K.N.** and **Williams, R.H.** 1988. Energy for Sustainable World. Wiely Eastern Ltd. New Delhi

3 **Hill, R.**, **O'Keef, P.,** and **Snape, C.** 1996. The future Energy use. Earthscan publication Ltd. London

4 Looking back to think ahead: Green India 2047. (1998). Tata Energy Research Institute (TERI), New Delhi

5 **McKinney, M.** and **Schoch, R.M.** 1998. Environmental Sciences: System and solutions.
Johnes and Bartlett publishers, Massachusetts

6 **Mittal, K.M. 1997.** Non-Conventional Energy Systems: Principle, progress and prospectus

7 TERI Energy Data Directory & Year Book (TEDDY). (1997). Tata Energy Research Institute (TERI), New Delhi

SES 548: Introduction to Remote Sensing, GNSSs and GIS

Unit 1: Geodetical aspects, mapping concepts and surveying

Earth System – Geodesy: Datum/Spheroids and coordinate systems, map projection - different projections and their characteristics

Features on the earth's surface: their basic properties – discrete vs continuous and geometries of representation

Cartography: Maps – their characteristics and elements, types - Basic surveying principles and techniques: EDMs and GNSSs; GNSSs – segments, various constellations, errors, differential correction and precise positioning

Map reading and interpretation

Global, national and state mapping agencies and their authorized reference maps – general & thematic

Unit 2: Remote sensing: Introduction

Remote sensing system – components and principles – platforms, sensors, medium, target, interactions and their characteristics including various resolutions, concept of DN value, radiance, reflectance, emission

Electromagnetic spectrum - energy interaction with atmosphere and earth surface, atmospheric windows, spectral properties of various objects on the earth's surface and the concept of spectral signature, active and passive remote sensing

Space borne earth observation: various orbits and their characteristics, operations, image acquisition and various data products

Indian remote sensing programme & Other satellites and sensors like Landsat, SPOT, etc.

Unit 3 Digital Image Processing: Basics

Various image formats, loading and visualization – panchromatic and multispectral colour visualization – TCC and FCCs

Image restoration – geometric, radiometric – atmospheric errors and their correction

Image enhancements – single band, multiband operations – layer stacking, ratioing and various indices, PCT, TCT, resolution merging/image fusion

Image interpretation – visual and digital; visual interpretation elements and key

Digital image classification – unsupervised and supervised; accuracy assessment

Unit 4 Geographical Information System (GIS): Basics

Concepts, components and organisation of GIS

Representing & modelling spatial features and processes - vector and raster structures, relationship between features – topology; raster data compressions and storage formats

Non-spatial/attribute Database Management Systems (DBMS), significance of DBMS, principles, data types, models – RDBMS, data storage, query and retrieval

Basic GIS functions: data inputting methods & various data sources, data management, data manipulation and geographic analysis and output presentation

Unit 5 GIS: Geographic analysis and modelling

Exploration, query, vector spatial analysis & geoprocessing – extraction, proximity, overlay

Network analysis – route, trace, closest facility, allocation

Raster based spatial modeling and analysis – density, distance, map algebra – arithmetic & weighted overlay: multi-criteria decision making

Surface modeling and analysis: DEM creation – input sources, interpolation; slope, aspect, volume, profile, hillshade, viewshed, visibility, contouring

SECOND SEMESTER

SES 512 B Lab course- II (Environmental Chemistry, Environmental Microbiology, Biotechnology, Biotechnology, RS & GIS)

Water quality

Chemical parameters : COD, Sulphate, Sulphide, Potassium, Iron, Nutrients (Nitrite, Nitrate, TN, Phosphate), metals

Environmental microbiology

- Preparation and sterilisation of bacteriological media – use of autoclave and hot air oven for sterilisation
- Isolation and enumeration of microorganisms in environmental samples (soil and water)
- Pure culture techniques – quadrant streaking, continuous streaking methods
- Use of compound microscope
- Staining techniques – Simple stain, Gram stain
- Endospore staining
- Detection of bacterial motility – hanging drop method, use of semi solid agar
- Basic biochemical test for characterisation of bacteria – Oxidase test and catalase test and oxidation/ fermentation (O/F) test
- Water quality testing – MPN method to detect total coliforms, faecal coliforms and faecal streptococci
- Membrane filter technique to detect faecal coliforms in water and Escherichia coli
- Indole, Methyl Red (MR), Voges-Proskauer and Citrate (IMViC)

tests for the characterisation of E. coli

Soil/sediment quality

Available Nitrogen, Total Nitrogen, Available Phosphorous, Available potassium, metals

Air quality

SOx, NOx, CO, SPM, RPM

Remote sensing & GIS

1. Map reading and interpretation
2. Surveying and map making using various EDMs including GNSSs receivers
3. In-situ spectral data collection using the hand-held spectro-radiometer
4. Introduction to various proprietary and open source free software packages: ERDAS Imagine, IDRISI, ENVI, ILWIS, ArcGIS, QGIS
5. Inputting spatial data through scanning (existing conventional maps) – various resolutions (DPI) and saving in different image formats
6. Importing satellite images and scanned raster images
7. Subset creation: spatial & spectral
8. Georeferencing using GCPs
9. Projection and datum transformations

10. Image visualizations: panchromatic and creation of various colour composites – Std. FCC, FCCs, TCC

11. DN to radiance, surface reflectance and TOA reflectance conversions

12. Radiometric corrections: haze removal, dark pixel subtraction, pixel filling, de-striping

13. Atmospheric correction using FLAASH in ENVI

14. Geometric correction – georeferencing

15. Image enhancements: contrast stretching, spatial filtering, band ratioing/band math and indices, PCT, TCT

16. Resolution merging/ image fusion

17. Visual interpretation of images using Std. FCC and interpretation elements through on-screen vectorisation

18. Database design, Vectorization & editing and attribute encoding

19. Topology creation and error identification

20. Error correction through topological and common editing

21. Exploration of the database using find, identify, hyperlink tools

22. Querying the database using various selection tools including Boolean logic.

Complex queries using various logical connectors such as OR, NOR, XOR, NOT, AND

23. Proximity analysis: BUFFER, NEAR, POINTDISTANCE

24. Overlay analysis: UNION, IDENTITY, INTERSECT, SYMDIFF,

CLIP, ERASE, SPLIT

25. Management operations: DISSOLVE, ELIMINATE, MERGE, MOSAIC

26. Network analysis: ND creation including multimodal, Routing, Tracing, Allocation, Closest facility

27. Interpolation & surface model generation: IDW, Kriging, Spline etc., DEM/DTM, Terrain creation using TIN or GRID interpolation

28. Surface visualisation and visual analysis: Draping, Colour relief, Hillshade, ViewShed, Visibility

29. Surface analysis using DEM/DTM: Slope, Aspect, Volume – Cut/Fill, Profile, Contouring

30. Hydrological analysis: Flow Direction, Flow Accumulation, Stream, Basin

31. Density analysis: point, line

32. Multi-criteria decision making: reclassification, map/raster algebra – arithmetic & weighted overlay

33. Distance analysis: Straight-line Euclidean, Cost Weighted Distance

34. Least Cost Path analysis

35. Importing and collecting data, satellite images from various open source web GIS platforms: Bhuvan, IndiaWRIS, NSDI-IndiaGeoportal, NNRMS portal, BhooSampada, IBIN, BIS, Sahyadri, GoogleEarth, NOEDA, UN Spider, WorldClim etc.

References

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Maiti, S.K. (2003) Handbook of methods in environmental studies, Vol. 2: Air, noise, soil, overburden, solid waste and ecology. ABD Publishers, Japur.

Marc Pansu, Jacques Gautheyrou, Hand book of soil analysis- Minerological, organic and inorganic methods, Springer, New York

Maria Csuros and Csaba Csuros, Environmental Sampling and Analysis for Metals, Lewis Publishers

Miroslav Radojevic and Vladimir N Bashkin, Practical Environmental Analysis, RSC Publishing

Conklin Alfred R. Introduction to Soil chemistry, analysis and Instrumentation, Jhonwiley&Sons Newyork

NEERI , Air quality monitoring, A course manual (Photostat), NEERI Nagpur

Mamata Tomar, Quality Assessment of Water and Waste Water, Lewis Publishers London

Abbasi S A, Water quality sampling and analysis, Discovery Publishing New Delhi

Christian Gary D, Analytical Chemistry, JhonWiley & Sons NewYork

SES 513A: Environmental Microbiology

Unit I: Microorganisms in the environment (10 Hrs)

Ubiquity of microorganisms in the environment – general account of microorganisms in the environment – bacteria, fungi, protists, algae and viruses - characteristic features and their role in the environment.

Morphology and ultrastructure of bacteria – plasma membrane, cell wall, flagella , pili, capsule, slime layer, glycolcalyx, nucleoid, ribosomes, cytoplasmic inclusions. Basis of Gram staining.

Unit II: Isolation and characterisation of bacteria from the environment (Hrs.)

Isolation of bacteria from the environment – pour plate and streak plate method. Use of different media and culture techniques.

Pure culture techniques – streak plate method – quadrant streak and continuous streak methods. Maintenance of bacteria on agar slants and long term preservation as glycerol stock.

Outline of microbial taxonomy – phenetic and phylogenetic classification. Bergey's manual of determinative bacteriology

Unit III – Microbial nutrition and growth (Hrs.)

Nutritional diversity among prokaryotes – various types of autotrophy and heterotrophy among bacteria. Nutritional requirements – macronutrients, micronutrients and trace elements in microbial nutrition. Culture media – complex and synthetic media. Use off specialized media (selective media, selective and differential media) for the isolation of specific microorganisms.

Microbial growth – cytological and population growth – factors affecting growth of bacteria. Characteristic features of bacteria growth curve. Continuous culture systems – chemostat and turbidostat.

Physical and chemical control of bacterial growth – disinfectants, antibacterial agents, antibiotics and chemotherapeutic agents

Unit IV: Microorganisms and the environment

Microbial community and important microorganisms in soil, fresh water and marine environments - Role of microorganisms in biogeochemical cycles with special reference to carbon, nitrogen, phosphorus and sulphur cycles

Foreign derived microorganisms in the environment – fate and survival. Genetically modified microorganisms in the environment – fate and effects.

Microorganisms in extreme environments – Archaebacteria – Psychrophiles, Thermophiles, Halophiles, Barophiles, Methanogenes etc.

Water borne pathogens – diseases caused and symptoms – routes of infection and control measures. Microbial indicators of water quality – coliforms, faecal coliforms, Escherichia coli and faecal streptococci. Waste water treatment

Soil microbial communities and their association with plants – bipartite and tripartite associations - rhizosphere microflora, mycorrhizae – ecto and endomycorrhizae – VAM – actinorrhizae

Unit V: Genetically engineered microorganisms and their applications in the environment

Prokaryotic DNA and its characteristic features - Recombinant DNA techniques – restriction endonucleases and cloning vectors – plasmids, cosmids, phagemids etc. Polymerase chain reaction (PCR) technique for amplification and detection of specific genes

Application of genetically engineered organisms in the clean-up of the environment – bioremediation strategies for polluted soil and water ecosystems.

References

1. Claus, W.G. 1989. Understanding microbes: A Laboratory Text book for Microbiology. W. H. Freeman and Co., New York.

2. Eweis, J.B., Ergas, S.J., Chang, D.P. Y. and Schroeder, E.D. 1998. Bioremediation Principles, McGrawHill Publ.

3. Freifelder, D. 1987. Microbial Genetics. Johns and Barlett Publishers Inc.

4. Hawkins, J.D. 1996. Gene Structure and Expression, Third edition. Cambridge University Press, Oxford.

5. Lewin, B. 1998. Genes VI. Oxford University Press, Oxford.

6. Lynch, M. and Hobbie, J.E. 1988. Microorganisms in Action - Concepts and applications of Microbial Ecology. Blackwell Scientific Publications.

7. Pelcazr, M.J., Reid, R. and Chan, E.C.S. 1996. Microbiology. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.

8. Prescott, L.M., Harley, J.P. and Klein, D.A. 2006. Microbiology. WCB Publishers. (Latest editions available)

9. Salle, A.J. 1961. Laboratory Manual of Fundamental Principles of Bacteriology. Mc Graw Hill Book C, New York.

10. David C Sigee 2005. Freshwater Microbiology - Biodiversity and dynamic interactions of microorganisms in the aquatic environment. John Wiley and Sons Ltd. England.

11. Abigail A Salyers and Dixie D Whitt 2001. Microbiology - Diversity, disease and the environment. Fitzgerald Science Press, Maryland, USA.

12. Jacquelyn G Black 2005. Microbiology - Prinicipes and Explorations - 6th Edition. John Wiley and Sons, USA

SES 540 ANALYTICAL TECHNIQUES AND INSTRUMENTATION (3 credits)

UNIT-1

Significant figures, Accuracy and precision, Types of errors- random and systematic errors, Standard deviation

UNIT-2

Gravimetric methods: Mechanism of formation of precipitates, Characteristics of ideal precipitate, Methods to improve filterability and minimizing adsorbed impurities, Precipitation from homogeneous solutions, Organic and inorganic precipitating agents, Application of gravimetric methods.

UNIT-3

Volumetric methods: Molarity, Normality, Standard solutions, End point, Acid-base titrations – titration curves, theory of indicators, Complexometric titrations-EDTA titrations-applications, Iodometry, Iodimetry, Colorimetric titrations.

UNIT-4

Spectrochemical methods: Micrwave, IR, Electronic, Raman, NMR and ESR spectroscopy-principle; AAS, SEM,TEM- instrumentation and applications,

Wavelength selectors: Filters and Monochromators, Radiation detectors and Transducers

UNIT-5

Radiation detectors: Dosimetry, Geiger Muller Counter, Scintillation Counter; Electrochemical Methods: pH meter- Glass and reference electrodes, Conductivity meter

UNIT-6

Chromatographic Techniques: Paper Chromatography, Thin Layer Chromatography, Column Chromatography, Gas-Liquid Chromatography (GC), High Performance Liquid Chromatography (HPLC), GC-MS, LC-MS, LC-MS/MS.

References

1. APHA (1998), Standard Methods for the Examination of Water and Waste water, 20th edition, Washington DC

2. McBride, M.B. (1994), Environmental Chemistry of Soils, Oxford University Press, New York

3. Skoog, D.A. and Leary, J.J. (1992), Principles of Instrumental Analysis, 4th edition, Saunder's

College Publishing, Fortworth

4. Suchla, G (Ed.) (1987) Vogel's Qualitative Inorganic Chemistry, ELBS.

5. Willard, H.H., Merrit, L.L., Deen, J.A. and Settle, F.A. (1986), Instrumental Methods of Analysis, (Indian Reprint), CBS Publishers and Distributors, New Delhi

6. Skoog, West, Holler Crouch, Fundamentals of Analytical Chemistry, 8th edition, Cengage Learning

7. J.Throck Watson, Introduction to Mass Spectrometry, 3rd edition, Lippincott-Raven publishers, Philadelphia, New York

8. Gary D. Christian. Analytical Chemistry, 5 th edition, John Wiley and Sons.

SES 541: Environmental Economics and Sustainable Development

UNIT I Environmental Economics

1.1 From economics to Environmental Economics

1.2 Definition and scope of Environmental Economics

1.3 Externalities- types and importance problem of second best and solution to Externality - Market failure - Solution.

1.4 Properties of public goods - Coase theorem-Common pool resources Tragedy of commons.

1.5 Basic theories of EE - Material Balance Approach and law of entropy.

1.6 Welfare aspects of Environmental Economics - Principle of maximum social welfare

- Pareto Criterion

1.7 Environment Cost- Benefit Analysis (CBA)

UNIT II Sustainable Development

2.1 From problems to crises- Depletion of resources and degradation of environment

2.2 From modern development to Sustainable Development **-** WCED

2.3 Strategies and Policies for SD.

2.4 Sustainable human development index, Sustainability pillars

2.5 Gandhian model of SD

2.6 Definition, Importance of sustainable production and consumption

UNIT III Sustainable Consumption

3.1 Definition, importance, relevance for developing countries Difference between Sustainable Consumption from Sustainable Development and Sustainable Production - key issues -UN Guidelines Sustainable Consumption

3.2 Sustainable Consumption Tools

3.3 Sustainable living and values

UNIT IV Education for Environment and Sustainable Development

4.1 Environmental education

4.2 Education for Sustainable Development

4.3 Education for sustainable consumption

4.4 Eco – School

4.5 Mini project on resource consumption and conservation

REFERENCES

1. **Savitha Singh,** Global Concern with Environmental crisis and Gandhi's Vision (1999),APH Publishing Corporation,Delhi.
2. **Bowers, J.** (1997). Sustainability and Environmental Economics. Longman, Singapore.
3. **Brown, L. R.** (2001). Eco-Economy. Earth Scan Publications, London.
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9. **Schumacher, E. F.** (1990). Small is Beautiful. Rupai & Co. Pub., New Delhi
10. **Titanberg, T.** (1998). Environmental Economics and Policy (2nd Edn.). Addison Wesley Publishers.
11. **Trivedi, P. R.** and **Singh, V. K.** (1994). Environmental Protection and Law. Commonwealth Publishers.
12. **World Commission on Environment and Development**. (1987). Our Common Future.
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14. **Muralivallabhan T. V**., Dimensions of Sustainable Economic Development, Unma Pub., 2005

15. **Rajyalakshmi V .,** Environment and sustainable development ,A.P.H Pub, New Delhi
16. **Natalia Mirovitskaya and William Ascher.,** Guide to Sustainable Development and Environmental policy., Duke University Press, London, 2001.

SES 542: Environmental Laws, Ethics, Education and Policy

Unit I Introduction

1.1 Brief History of Environmental Regulations in the World up to 1990.

1.2 Role of UN Environmental Policies and Laws, Stockholm Declaration – 1972:

Hague Declaration – 1989; Rio Declaration – 1992.

1.3 Fundamental Principles of International environmental Laws.

Unit 2 Environmental Policy in India

2.1 Environmental Legislation Protection Laws in India – Ancient and Pre- Independence.

2.2 Forest policies and Legislation in Pre – independence Period.

2.3 Environmental Legislation in Post – Independence Period.

2.4 Constitutional and Legislative Provisions in India.

- Fundamental principle; 42nd Amendment Act; Direct Principles
- Fundamental Rights,
- Environmental Legislations (General)
- Environmental Protection Act of 1986

2.5 Judicial Remedies and Procedures.

· Tort Law, Public Nuisance , Public Interest Litigation, Freedom of information 2.6 Forest Law, Public Nuisance, Public interest Litigations, Freedom of Information **Unit 3 Laws Relating to control of Pollution and Environment in India.**

3.1 Water Act and Related Acts, Rules and Regulations.

3.2 Air Act – Related Acts, Rules and Regulations

3.3 Noise and Land Pollution Rules and Regulations

3.4 Rules and Notification made under Environmental (Protect) Act 1986 – Rules of Hazardous Microorganisms. Bio–medical waste, Recycled Plastics, Ozone Depleting Substances, Solid Waste Management, etc.

3.5 Forest and Wild Life Protection Act and Rules.

Unit 4 International Organisation, Conservations and Protocols

4.1 United Nations, GEMS, UNEP, GEF, WCN etc.

4.2 Antarctica Convention, Stockholm Convention, Rio Conference and Conventions, Ramsar Conevention, Kyoto Protocol, Rio+10 earth Watch Green Peace etc.

Unit 5 Information, Education and Communication

5.1 Environmental education/awareness, lifestyle changes and consumerism. Values and ethics, Gaia hypothesis

5.2 Information Networks – ENVIS Centers – INFOTERA etc.

5.3 Role of NGO's in the Implementation of Environmental Policies. Communication and Management.

REFERENCES

1. Rosencrans, A., and divan, S. (2002), Environmental Law and Policy in India cases, Materials and Statutes, Oxford University Press.

2. Santhakumar, S., (2001), Environmental Law, Surya Publication, Chennai

3. Titanberg, T., (1998), Environmental Economics and Policy (2nd Edn.) Addison Wesley Publishers.

4. Trivedi P.R. (1996) International Environmental Law, ABH Publishing Corporation

5. Nagore, A.P., (1996) Biological Diversity & International Environmental Law ABH Publishing Corporation New Delhi.

6. Chakrabarti N.K., (1994) Environmental Protection and the Lawn Ashish Publishing House, New Delhi.

7. Simon Bill and Stuart Bill (1995) Environmental Law, Blackstone Press Ltd, London.

8. United Nations International Environmental Law (1993) Emerging Trends & Implications for Transnational Corporations, United Nations, New York.

SES 544 A ECOTOXICOLOGY

Unit I Toxicants and ecosystem

Toxicants – organic and inorganic,

Toxicants – entry into the environment, cycles and residence time

Transboundary movement of pollutants- factors affecting

Global environmental pollutants

Routes of exposure to humans – food, occupation, environment

Unit II Toxicants and their effects

Effects of toxicants on populations and communities

Toxicity of pesticides, metals, radioactive minerals, fluorides, chemical fertilizers and air pollutants – cellular and molecular level

Damage process and action of toxicants – exposure, uptake, transport, storage, mechanism of action in plants and mammals

Toxicants in the food chain- Accumulation and magnification

Multilevel trophic interactions and non-trophic interactions

Acute and chronic effects

Occupational hazards and diseases

Toxicity of biohazards

Unit III Toxicity testing and indicators

Principles of toxicity testing, Factors to be considered in toxicity testing

Methods of toxicity evaluation at cellular and molecular level by in vitro and in vivo methods

Ecotoxicological testing methods – single species testing, microcosms etc.

Bioindicators , lacustrine communities as indicators of ecosystem stress

Biosensors– concept and approach

Biomarkers- classification, relationship of biomarkers to adverse effects

Unit IV Sanitation, Health and Hygiene

Sanitation and Health- introduction and Current situation

Water and sanitation related diseases, respiratory infections, under nutrition

Successful approaches to sanitation-strategies

Role of health sector

Global experience in improving sanitation and hygiene

Climate change and diseases

Epidemiology and health ecology

Epidemiological diseases due to pollution problems

Health effects of cosmetics and drugs

Health risk assessment of toxic chemicals

Ecological risk assessment

Unit V Food Security

Concept of food security, food systems and public health, interrelation between diet, food production, the environment, population and resources, Toxicants in food

REFERENCES

Ballantyne, B., Marris, T. and Turner, P. (Ed.). 1995. General and applied toxicology (Abridged edition), Macmillan Press

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Cralley, L.V., Atkins, P.R., Cralley L.J. and Clayton (Ed.). Industrial environmental healththe worker and the community

Freedman B (Ed.). 1995. Environmental ecology – the ecological effects of pollution, disturbances and other stresses.

Levy B.S. and Wegman D.H. (Ed.). 1995. Occupational health- recognizing and preventing work related disease. Little Brown and Co.

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Ramada F., (Ed.) 1997. Ecotoxicology, John Wiley & Sons

Richardson M. 1995. Environmental Toxicity assessment. Taylor and Francis Ltd.

Stine K.E. and Brown T.M. 1996. Principles of toxicology

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Wright D.A. and Welbourm P. 2002. Environmental Toxicology, Cambridge University Press.

SES 545 A : Green Chemistry and NanoTechnology [Elective : 2 Credits]

Unit 1

Introduction and need for green chemistry; Principles of green chemistry; percentage atom utilization and percentage atom economy; rearrangement, addition, substitution and elimination reactions; examples of catalytic reactions.

Unit 2

Planning green synthesis; evaluation of rearrangement, addition, substitution, elimination and pericyclic reactions for green reactions; selection of solvents; selection of starting materials; use of protecting groups; use of catalyst and low energy reactions.

Unit 3

Alternate approach to solvent chemistry; solvent free reactions; microwave assisted synthesis; ionic liquids as an ecofriendly solvent; supercritical fluid extraction as a cleaner technology.

Unit 4

Green technologies: catalytic reactions; alternate waste treatment technologies:

Advanced Oxidation Technologies for waste water treatment , Phycoremediation, Sustainable sanitation

Unit 5

Introduction to nanotechnology – particle size, surface area and quantum dots ; synthesis and fabrication – nano scale metal oxides, Carbon nanotubes , nanocomposites., Green nanosynthesis- types , methods and advantages; nanotechnology as a tool for sustainability, health and safety.

Unit 6

Characterization of nano particles for structural and chemical nature. Environmental applications of nano materials –ground water remediation, water purification, absorbent, membrance process, nano sensors, detection of pesticides and trace metal ions, environmental monitoring, social implications of nanoscience and technology.

References

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Srivastava M M (2007) Chemistry for Green Environment

Lichitouse Eric et al (2009) Environment Chemistry, Green Chemistry and pollutants in ecosystem

Ahluwalia V K (2009) Green Chemistry Environmentally benign reactions

Anastas Paul T (2000) Green Chemistry theory and practice

Sanghi Rashmi (2006) Green Chemistry, Environment friendly alternatives

Lancaster Mike (2010) Green Chemistry : An introductory text

Prasad T. (2007) Nano: The Essential understanding of Nanoscience and nanotechnology. McGraw Hill.

Hornyak, Moore and Tibbals Dutta (2007). Fundamentals of Nanotechnology ,CRC press

Wiesner M.R., Jean-Yves Bottero (2007). Environmental Nanotechnology applications and impacts of Nanomaterials. McGraw Hill.

Savage N (2009). Nanotechnology Applications for Clean water. William Andrew Inc..

John (2013). Role of natural products in Green synthesis of Nanoparticles.

SES 549: Biodiversity and Conservation Biology

The course would enable the students to:

Understand the concepts of Biodiversity and conservation biology

Study the structure, significance and threat of biodiversity

Understand the various initiatives for biodiversity conservation

Explain the concept of human ecology, natural history, legal and policy aspects of conservation science

Unit 1 Biodiversity - An introduction

- The evolution of biodiversity
- Theories and Concepts of Biodiversity

- Origin of species/speciation
- The distribution of biodiversity in macroscale
- Species interactions and biodiversity

Unit 2 Biodiversity

- Levels of Biodiversity
- Genetic diversity, species diversity, Eco-system diversity, alpha, beta, gamma
- Global and Regional biodiversity
- Threats to Biological Diversity – Habitat Degradation, Fragmentation, Global Climate Change, over extraction, over abundance, alien and invasive species, diseases, pollution
- Endangered and Threatened species, IUCN, Red Data Book

Unit 3 Biodiversity Conservation in Practice

- Global Conservation initiatives – Biodiversity hot spots, Conservation in South and Southeast Asia,
- National Conservation Action Plan,
- Landscape-level Conservation
- Conservation Strategies
- In situ and ex situ conservation

Unit 4 Introduction to Conservation Biology

- History, Concepts and

Background

- Biogeography of India
- Western Ghats
- Wild life biology
- Restoration biology

Unit 5 Natural History

- Natural History in India
- Animal Behaviour
- General Entomology, Ornithology, Mamma logy, Ichthyology, Herpetology
- Basic understanding of common flora in Southern Western Ghats

Unit 6 Human Ecology

- Environmental History and Conservation Movements
- People and Nature: Ecosystem services
- Indigenous communities and Ethnobiology
- Human-wildlife Conflict

Unit 7 : Conservation – Legal and policy framework

- International treaties - Convention on Biological diversity, CITES, TRAFFIC - Legal aspects of conservation in India.
- Biopiracy – causes and effects

References

1. Sutherland, W. J. 2004. The Conservation Handbook, Research, Management and Policy, Blackwell Science ltd. P278.

2. Nair, S. C. Southern Western Ghats: A biodiversity conservation Plan, INTACH, NewDelhi. P92.

3. Michael E. Soule and Bruce Wilcox, 1980. Conservation Biology: An Evolutionary- Ecological Perspective.

4. Lewis, M. 2003. Inventing Global Ecology: Tracking the biodiversity ideal in India, Orient Longman. P369.

5. Martin, G.J. 1995. Ethnobotany - A methods manual. Chapman & Hall. Madras.

6. Maxted, N., B. V. Ford-Lloyd and J. G. Hawkes. 1997. Plant Genetic conservation- the insitu approach. Chapman & Hall, Madras.

7. Ahmadullah, M and Nayar, M. P. 1987. Endemic plants of the Indian Region. Vol. I Botanical Survey of India.

8. Heywood, V. H. (ed) 1995. Global Biodiversity Assessment (UNEP), Cambridge University Press, Cambridge.

SES 510 A: ENVIRONMENTAL BIOTECHNOLOGY AND WASTE MANAGEMENT [3 credits]

Unit I : Cell Technology and Biotechnology

1.1 Cell : Structure and function – Prokaryotes and Eukaryotes. Nucleic Acids, Central dogma - Protein synthesis, rDNA technology. Fermentation Technology.

1.2 Plant tissue culture techniques

1.3 Environmental Biotechnology: an overview.

Unit II : Biotechnological Methods in Pollution Control

2.1 Air pollution control : Bio-desulphurisation of coal, Green belts.

2.2 Water pollution control : Aerobic and Anaerobic wastewater treatment

Systems.

2.3 Bioremediation : Soil / land contaminated with oil spills, PCBs, PAHs;

Bioremediation technology; Phytoremediation

2.4 Biosensors : Concept and principle ,Biosensors for environmental monitoring

Unit III : Emerging Trends in Environmental Biotechnology

3.1 Agrobiotechnology : Plant genetic engineering – role of rDNA technique;

transgenic plants - GM crops, Biopesticides and Biofertilizers

3.2 Ecological Engineering : Constructed / Artificial wetlands, Nutrient Film

Technique (NFT).

3.2 Biodegradable plastics – PHBs and PHAs

Unit IV : Solid Waste Management

4.1 Municipal Solid Waste : Types, sources , properties and impacts

4.2 Techniques for treatment / processing : Concept of three ' R ' s, Thermal

processes – incineration, Pyrolysis, RDF. Biological processes – Anaerobic

digestion, Composting and vermicomposting.

4.3 Disposal techniques : Landfills – design , operation and management.

4.4 Hazardous waste management.

4.5 Concept of Zero waste

Unit V : Ecological Sanitation

5.1 Conventional sanitation : a linear flow system – its limitations

5.2 Eco San –Circular flow and closing the loop : concept, goals and advantages

5.3 Eco San for human night soil management : Dry Toilets, Composting Toilets UDDT,UDFT.

5.4 Grey water management

5.5 Eco San - Human Health and Food Security

REFERENCES

1. **Abbasi**, **S.A. 1998**. Environmental Pollution and its Control ,C*ogent Internationa*l , Pondicherry

2. **Abbasi, S.A., Ramasamy, E.V., 1999.** Biotechnological Methods of Pollution Control. *Orient Longman*,

(*Universities Press of India Ltd.)* India, 168.

3. **Abbasi, S.A., Ramasamy, E.V., 2001.** Solid Waste Management with Earthworms. *Discovery*

Publishing house, New Delhi.

4. **Davis, M.L. and Cornwell,D.A. 1991.** Introduction to Environmental Engineering, *Mc Graw Hill*

International Edition

5. **Edwards, C.A. 2004.** Earthworm Ecology, *CRC Press*, London.

6. **Freeman, .H.M. 1998.** Standard book of Hazardous Waste Treatment and Disposal, *Mc Graw Hill*,

New York.

7. **Hill, M.K. 2004**. Understanding Environmental Pollution, *Cambridge University Press*, Cambridge,U.K.

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10. **Odum, E.P. 1971.** Fundamentals of Ecology, *W.B.Sounders Company*, Philadelphia.

11 **Peavy, H.S., Rowe,D.R., and Tchobanolous,G. 1985.**Environmental Engineering, *Mc Graw Hill*

International Edition, Singapore.

12. **Scragg, A. 1999.** Environmental Biotechnology. *Addison Wesley Longman*, Singapore.

13. **Tchobanoglaus, G., Theisen, H and Vigil, S.A. 1993.** Integrated Solid Waste Management :

Engineering Principles and Management issues*, Mc Graw Hill* International Edition, Singapore.

14. **Winblad U and Simpson-Hébert M** (editors) **2004:** Ecological sanitation –revised and enlarged edition. *SEI,* Stockholm, Sweden.

Third Semester

SES: 522A ENVIRONMENTAL ENGINEERING

Unit I: Introduction

1.1 Environmental Engineering and Environmental Systems

1.1.1 Water resource management

1.1.2 Air resource management

1.2 Solid waste management systems

1.3 Mass-balance approach to problem solving.

Unit II: Water Resource Management: Water and Wastewater Treatment

2.1 Water quality studies

2.1.1 Sampling technique

2.1.2 Sampling devices

2.1.3 Sample preservation

2.1.4 Physical – Chemical and biological examination of water

2.1.5 Water quality standards

2.2 Water treatment

2.2.1 Filter plants

2.2.1.1 Mixing and flocculation, Coagulation, Jar test

2.2.1.2 Softening – lime soda and ion exchange process

2.2.1.3 Filtration – slow, rapid and high – rate sand filters

2.2.1.4 Disinfection – Chlorination, Ozonation and UV application

2.3 Wastewater treatment

2.3.1 Municipal sewage treatment

2.3.1.1 Basic treatment processes and flow- sheets

2.3.1.2 Waste flow rates and their assessment

2.3.2 Unit operations of pre-treatment and primary treatment

2.3.2.1 Bar racks, grit chambers, communitors, equalization and sedimentation

2.3.2.2 Design concepts

2.3.3 Secondary treatment: Biological unit processes

2.3.3.1 Nature and kinetics of biological growth

2.3.3.2 Aerobic activated sludge process and its various modification.

2.3.3.3 Oxidation ponds

2.3.3.4 Attached growth systems – trickling filters

2.3.3.5 Rotating biological contactors (RBCs)

2.3.4 Anaerobic waste =water treatment systems

2.3.4.1 Evolution of high – rate anaerobic reactors – CSTRs

2.3.4.2 Up flow anaerobic filters (UAFs)

2.3.4.3 UASBs, Expanded / Fluidised bed reactors

2.3.5 Chemical unit process

2.3.5.1 Precipitation

2.3.5.2 Coagulation

2.3.5.3 Disinfection

2.3.6 Tertiary / Advanced treatment system

2.3.6.1 Filtration

2.3.6.2 Adsorption

2.3.6.3 Nitrogen and phosphorous removal

2.3.6.4 Biological nutrient removal (BNR) system

2.3.7 Land treatment – Slow rate, overland flow, rapid infiltration

Unit III: Air Resource Management: Air quality studies

3.1 Air quality standards

3.1.1 Micro and macro air pollution

3.1.2 Indoor air pollution

3.1.3 Acid rain

3.1.4 Ozone depletion

3.1.5 Greenhouse effect

3.2 Air pollution meterilogy

3.2.1 The atmospheric engine

3.2.2 Turbulence, stability, laps rate, plume behavior, terrain effects

3.2.3 Factors affecting dispersion of air pollutants

3.2.4 Dispersion modeling – Gaussian dispersion model

Unit IV: Air Resource Management: Air Pollution Control

4.1 Control of particulate matter

4.1.1 Gravitational

4.1.2 Centrifugal

4.1.3 Electrostatic, fabric and wet collectors

4.2 Control of gaseous contaminants

4.2.1 Adsorption

4.2.2 Absorption

4.2.3 Condensation

4.2.4 Combustion

4.3 Automobile emission control

Unit V: Solid Waste Management: Municipal Solid Waste

5.1 Types, sources and properties

5.2 Techniques for treatment / processing of solid waste

5.2.1 Recovery, reclamation, recycle and reuse of resources

5.3 Disposal methods for the solid waste residues

5.3.1 Incineration

5.3.2 Sanitary land fills

5.4 Hazardous waste management

Unit VI: Noise Pollution and Risk Assessment

6.1 Noise pollution

6.2 Noise levels, measurements and noise limits

6.3 Noise attenuation and control measures

6.4 Risk assessment and disaster management for industries

6.4.1 Case histories of major chemical disasters

6.4.2 Basic components of hazard control system

6.4.3 Technique of risk assessment – PHA, HAZOP, MAXCRED

6.4.4 Emergency control and disaster plan

REFERENCE

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SES 550: Climate Change and Governance

Unit 1: Basic definitions - Climate and weather; climate change;greenhouse gases; radiative forcing; warming potential;climate modelling; global and regional circulation models; IPCC modelling scenarios.

Unit 2: Observed andprojected changes in the climate system – land surface temperature; ocean surface temperature; precipitation;cryosphere;sea level;greenhouse gas concentrations (CO_2 and Non CO_2 gases);and extreme climatic events.

Unit 3: Drivers of climate change – natural and anthropogenic radiative forcings; solar irradiance; aerosols, water vapour and clouds; volcanic eruption; GHG emissions from energy, industries, and transport; and gross and net emissions from agriculture, forestry and other land use.

Unit 4: Impacts of climate change–on physical systems (Glaciers, snow, iceand/or permafrost;Rivers, lakes, floodsand/or drought; Coastal erosion and/or sea level effects); biological systems (Terrestrial ecosystems; aquatic ecosystems); Human and managed systems (Food production; Livelihoods, healthand/or economics)

Unit 5: Greenhouse gas inventorying – IPCC guidelines on national greenhouse gas inventorying; general guidance and reporting; guidance specific to energy, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU), and waste; activity data; emission factors; key categories; tiered approach; stock-difference and gain-loss methods; principles of reporting; measurement, reporting and verification (MRV) system.

Unit 6: Climate change mitigation–decarbonizing energy production; use of clean energy and enhancing the energy efficiency in industries, transport, and buildings; carbon dioxide storage and capture; bioeconomy or low carbon economy; enhancing the carbon sequestration capacity of forests and land use; climate smart agriculture; REDD+, long term mitigation pathways.

Unit 7: Climate change adaptation - social, ecological asset and infrastructure development;technological process optimization;integrated natural resources management;institutional, educational and behavioural change or reinforcement;financial services including risk transfer;information systems to support early warning and proactive planning.

Unit 8: Climate change institutions and governance - UNFCCC - Conference of Parties (COP); International Climate Agreement;Policy approaches for adaptation andmitigation, technology and finance; National Communications; Biennial Update Report; Intended Nationally Determined Contributions; Funding streams – Green Climate Fund, Forest Carbon Partnership Facility, Global Environment Facility, Adaptation fund, Bilateral and multilateral funds, and official development assistance fund, voluntary and compliance markets; global think tanks in climate change.

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IPCC(2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of theIntergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

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SES 506 B: ENVIRONMENTAL IMPACT ASSESSMENT

Unit 1: Sustainable development

1.1. Significance of developmental activities in the past and present, participants in development activities

Environment Management Techniques for Sustainable Development

Unit 2: Environmental Impact Assessment

2.1 Introduction

2.1.1 Definition, aim, history, principles and concepts and scope

2.1.2 EIA steps, Types of EIA,

2.1.3 Public participation in EIA- significance

2.2 EIA Methods and their functions

2.2.1 Adhoc method, Checklist Method, Sectoral guidelines, Systematic sequential approach, Simulation modelling workshops, Spatial analysis methods, Rapid assessment techniques

2.2.2 Interaction Matrices- Network and Overlays Approach, Moore Impact matrix

Unit 3: EIA Process

3.1 Methods for preparing EIA

3.1.1 Socio-economic aspects

3.1.2 Making Inventories

3.1.3 Sampling and Data Process

3.2 Impact Prediction

3.2.1 Positive and negative impacts

3.2.2 Primary and Secondary impacts

3.2.3 Impact on physical, social and biotic environments **Unit 4: EIA for different environmental programmes**

4.1 Industries

4.2 Urban development

4.3 land use

4.4 Energy projects : Hydel , Thermal, Nuclear, Oil and gas, Solar, Wind

4.5 Resource Management : Agriculture, Irrigation, Water, Wildlife, Forest, Biodiversity, Mineral

4.6 Coastal zone

4.7 EIA case studies

Unit 5 : Environment Audit

Introduction to environment audit-types; Environment auditor-auditing skills

Environment audit procedure – pre audit, site visit and post audit

Environmental auditing standards

Unit 6 : Life Cycle Assessment (LCA) and EMS

LCA – introduction , basics, objectives

Life cycle stages, LCA components

Global and regional impact categories

LCA applications – case studies

LCA and standards

Environment Management System (EMS)- introduction, structure, Procedure

Case studies

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SES 519 B: Advanced Geoinformatics and applications

Unit 1: Applications in Ecology & Environment Management - Basics

Sampling and ecological survey design

Mapping of natural resources – minerals, soil, water and bio-resources

Modelling and analysis of ecosystems and ecological processes – marine, forest, mountain, rivers & streams, coastal areas and wetlands – global ecosystem dynamics, climate change monitoring and modelling

Detailed vegetation and built environment characterization using high spatial and spectral resolution remote sensing images and in-situ hyper-spectral data

Unit 2: Advanced Remote Sensing techniques and their applications

Active remote sensing techniques: a) LIDAR – terrestrial, airborne: available datasets and software packages b) Microwave RS: SAR principles, processing techniques, interferometric DEM – eg: SRTM, available datasets and software packages and special applications

Basics & Applications of hyper-spectral RS: principles, processing methods, use of hyperspectral indices

Thermal RS: principles and processing techniques, available datasets and applications

Photogrammetry – stereoscopy, 3D measurements and stereo DEM – eg. CartoDEM, AsterDEM; Introduction to various image processing and photogrammetric software packages.

Unit 3: Applications in Ecology & Environment Management - Advanced

Landscape level biodiversity characterization, disturbance analysis including forest fire vulnerability analysis and conservation planning

Applications in EIA and Cost-Benefit Analysis: quantifying impacts and use in the preparation of EMP

Applications in hydrological modeling and analysis: ground water prospecting, watershed characterisation and conservation treatment planning

Applications in community health (epidemiologic) assessment and management;

Urban Ecology: heat island mapping & monitoring, sprawl assessment and monitoring;

Land use / land cover dynamics – monitoring, cause-consequence analysis & modelling

Pollution dispersion modelling: water, air & soil – various quality indices

Soil erosion estimation, zonation and modelling

Environmental suitability analysis – ecosensitive area zonation – multiple criteria decision making

Preparation of land use / activity regulatory zoning using geospatial tools

Unit 4: Participatory/crowd sourced mapping and information sharing

Web/Internet and mobile Geoservices: crowd sourced mapping, data collection and information sharing. Case studies – MANU, Bhuvan Panchayat

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Computers, Environment and Urban Systems

Environment and Planning

GeoJournal

International Journal of Geographical Information Systems

International Journal of Remote Sensing

Remote sensing of Environment

SES: 518-A ENVIRONMENT MANAGEMENT

Unit 1: Introduction

Basic Principles of Environment Management

Environment management – tools and techniques

Environment Management Systems (EMS)

Introduction to environmental quality models- input and output models, linear programming models of environmental quality management

Natural resources and their management

Unit 2: Ecosystem management

Grassland and forest management

Wetland Management

Management of Coastal and marine ecosystems

People's participation in ecosystem management

Case studies

Unit 3: Water resource management

Global Water Budget, global water availability, depletion of water resources , Interrelation of water resources with other natural resources and the environment

Dams and water resources

Basic Techniques for Water Analyses

Watershed management

Irrigation water management

Integrated Water Resources Management (IWRM)

Concept of sustainable water resources development

Global Efforts - water resource management, Local water organisations; World water organisations; UN, GWP, WWC, etc

Unit 4: Physical Resources

Soil and mineral resources- status and significance, problems facing

Soil quality management – engineering and ecological solutions

Control of soil erosion

Eco-restoration of degraded land

Soil Management in Kerala

Radioactive minerals and their management

Metals and other minerals – management strategies

Unit 5: Biological Resources

Forest resource management – NTFPs, biodiversity, medicinal plants

Integrated management of wild life population

Sustainable Management of biological resources of Kerala

Unit 6: Environmental Planning and Management

Principles of EPM

Principles, concepts and scope of environmental planning

Ecological aspects of EPM

Steps in Environmental planning

Identification and formulation of strategies of EPM

Environmental analysis and EPM

Physical planning in relation to environmental and land use classification

EPM for Town and urban lands, Rural and agricultural lands, Waste lands, Lands reclaimed, Wetlands, Mining areas, Industrial areas, Transportation and urban planning

Unit 7: EPM for Environmental Hazards

Environmental hazards in Environmental Planning and Management

Types of environmental hazards- Food, drought, landslides, earthquakes, cyclones etc.

Significance and characteristics of hazards in environmental planning and development

Opportunities and regional planning for hazard management

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SES 523 B. ADVANCED ANALYTICAL INSTRUMENTATION

UNIT-1

Electromagnetic spectrum, Interaction of light with matter/molecule

Fundamentals of molecular spectroscopy

Wavelength selectors: Filters and Monochromators,

Unit-2

Spectroscopic Techniques: Micrwave, IR, Electronic, Raman, NMR and ESR spectroscopy-principle and Instrumentation

Atomic Absorption spectroscopy (AAS), Inductively coupled plasma mass spectrometry (ICP-MS)

Unit 3

Advanced Microscopic techniques / principle and instrumentation

Scanning Electron Microscopy (SEM, SEM-EDX)

Transmission Electron Microscopy (TEM)

Unit 5

Advanced chromatographic techniques: Gas-Liquid Chromatography (GC), High Performance Liquid Chromatography (HPLC, UPLC), High Pressure Thin Layer Chromatography (HPTLC), Ion Chromatography (IC)

Chromatography connected with mass spectrometry: GC-MS, GC-MS/MS, LC-MS, LC-MS/MS, LC-Q-ToF-MS

Unit 6

Environmental Applications of spectroscopic and mass spectrometric techniques, Hand-on training in Advanced Analytical Instrumentation (UV, IR, GC, GC-MS, LC-MS, LC-Q-ToF-MS, ICP-MS etc)