INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
ACCREDITED BY NAAC WITH 'A' GRADE
Marching Beyond 25 Years Successfully

M.Sc. Environmental Science

Curriculum and Syllabus

Regulations 2023

(Based on Choice Based Credit System (CBCS) and Learning Outcomes based Curriculum Framework (LOCF))

Effective from the Academic year

2023-2024

Department of Chemistry

School of Basic Sciences

Vision and Mission of the Department

Vision

The **Vision** of the Department is to enhance our reputation as a world-class teaching and research institution reputed for its innovation, excellence and discovery, and to attract best students and staff worldwide.

Mission

- To actively promote and preserve higher values and ethics in education and research and will pursue excellence in all these areas
- To undertake research in emerging areas of Chemical Sciences & Nanotechnology and transform the findings for the benefit of society.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO 1	Postgraduate will have significant opportunities in various service domains at National and International level, and can work as scientist, analyst, quality controller, academics, chemist, wildlife biologist, ecological specialist, geologist, marine biologist, geographer.
PEO 2	On the basis of specialized knowledge and experience, postgraduate students will be able to do environmental analysis, computational design and development of new environmental safety techniques.
PEO 3	Post-graduates have leadership quality to handle all kind of circumstances in diversities by providing interdisciplinary and multidisciplinary learning environment.
PEO 4	To encourage leadership qualities in graduates with strong communication skills, mold them as good team players and managers so that they have the competence to function effectively in multi disciplinary orientation teams.
PEO 5	Postgraduate will be able to formulate, investigate and analyze scientifically real life problems along with ethical attitude which works in multidisciplinary team

PROGRAM OUTCOMES

PO1 **Problem analyze:** Identify, formulate, review research literature and analyze the chemical problems reaching substantiated conclusions using basics concepts of environmental chemistry.

PO2 **Design and development of solutions:** Design solutions for complex chemical problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO3 **Conduct investigations of complex problems:** Use research based knowledge and including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PO4 Indepth knowledge gaining in all topics and their relation with the industry application

PO5 Developing research attitude in frontier topics

PROGRAM SPECIFIC OUTCOMES
(PSO)

PSO1	To Job opportunities in wide sector of Consultant & Allied industries
PSO2	Competent to take challenging positions in industry, academics and government sectors by learning various analytical techniques, environmental
PSO3	To execute new ideas in the field of research and to develop principles and techniques of science through seminars and the project.

M.Sc. ENVIRONMENTAL SCIENCES CURRICULUM

Total number of credits: 90

			Hours/Week				Maximum Marks		
		SEMESTER I							
	Code No	Course	Lecture	Tutorial	Practical	Credits	CA	SEE	TOTAL
Core		Introduction to Environmental Sciences	4	0	0	4	40	60	100
Core		Environmental Chemistry and Toxicology	4	0	0	4	40	60	100
Core		Hydrology and water Resources	4	0	0	4	40	60	100
Core		Water analysis Practicals- Practical I	0	0	6	3	40	60	100
DSE		Discipline Specific Elective- 1	4	0	0	4	40	60	100
DSE		Discipline Specific Elective -2	4	0	0	4	40	60	100
SEC		Soft Skill 1/ Sector Skill Course	2	0	0	2	40	60	100
			22	**0**	6	**25**			
		SEMESTER II							
Core		Biodiversity and Conservation Biology	4	0	0	4	40	60	100
Core		Environmental Biotechnology	4	0	0	4	40	60	100
Core		Ecology and Environmental Microbiology	4	0	0	4	40	60	100
Core		Soil, Air and Noise pollution practicals- Practical II	0	0	6	3	40	60	100
Core		Environmental microbiology Practicals- Practical III	0	0	6	3	40	60	100
DSE		Discipline Specific Elective -3	4	0	0	4	40	60	100
SEC		Soft Skill 2/ Sector Skill Course	2	0	0	2	40	60	100
			18	**0**	**12**	**24**			
		SEMESTER III							
Core		Soil biology and Soil conservation management	4	0	0	4	40	60	100
Core		Atmosphere and Climatic change	4	0	0	4	40	60	100
Core		Non-conventional Technologies	4	0	0	4	40	60	100
Core		Environmental Biotechnology Practicals -Practical IV	0	0	6	3	40	60	100
DSE		Discipline Specific Elective- 4	4	0	0	4	40	60	100
DSE		Discipline Specific Elective -5	4	0	0	4	40	60	100
SI		Internship	0	0	4	2	40	60	100
SEC		Soft Skill 3/Sector Skill Course	2	0	0	2	40	60	100
			22	**0**	10	**27**			
		SEMESTER IV							
Core		Environmental impact and Risk Assesment	4	0	0	4	40	60	100
GE		Generic Elective	2	0	0	2	40	60	100
Core		Project Work	0	0	24	12	40	60	100
			6	**0**	**24**	**18**			

CA - Continuous Assessment, SEE - Semester End Examination

LIST OF DISCIPLINE SPECIFIC ELECTIVE COURSES

S.No.	Subject Title
1.	Aerobiology
2.	Urban Ecosystems
3.	Environment and Resource Economics
4.	Environmental Legislation and policy
5.	Solid Waste and E-Waste Management
6.	Environmental pollution and human health
7.	Natural Hazards and Disaster Management
8.	Climatology and Environmental modelling
9.	Industrial and Bio-medical Waste management
10.	Drinking water supply and Treatment
11.	Remote Sensing and GIS in Environmental Studies
12.	Systematics and Biogeography
13.	Natural Resources Management and Sustainability
14.	Geoinformatics
15.	Environment and Energy management
16.	Environmental Analysis: Techniques and Instrumentation

LIST OF SKILL ENHANCEMENT ELECTIVE COURSES (SEC)

S.No.	Subject Title
1.	Soft skill – I
2.	Soft skill – II
3.	Soft skill – III

LIST OF GENERIC ELECTIVE COURSES (GEC)

S.No.	Subject Title
1.	Green Chemistry
2.	Cheminformatics
3.	Food Chemistry and Adulteration

Syllabus

Core Courses

INTRODUCTION TO ENVIRONMENTAL SCIENCE 3 1 0 4

Course objective

To revive the fundamentals and basics of Environmental Science learned at school level with detailed explanation.

UNIT 1: Organisms and Environment: 12

Principle, definition and scope of environmental science. Structural, functional and evolutionary concepts. Holocoenotic nature of environment; abiotic and biotic environment. Ecological adaptations: Morphological and physiological responses of organisms to temperature and water. Earth, man and Environment. Origin of life and speciation.

UNIT 2: Ecosystem organization: 12

Ecosystem organization: Ecosystem structure and functions, primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways, ecological efficiencies); litter fall and decomposition; mineral cycles in terrestrial and aquatic ecosystems Ecosystem management: Concepts; sustainable development; sustainability indicators.

UNIT 3: Population Ecology: 12

Population Dynamics –density, natality, mortality, ecological mortality, Population ecology: Population characteristics, population growth, carrying capacity, population regulation, life history strategies (r and K selection), population interactions including Lotka – Volterra model, population differentiation

UNIT 4: Ecological Community: 12

Definition –Community dominance / Ecological dominance –Ecological succession and climax – classification –process –invasion, migration, competition, climax -hydrozere, xerozere. Succession – community organization: Ecological niche –interaction between species –competition –prey –predator relationship –parasitism –mutualism –symbiosis-commensalism

UNIT 5: Natural Resources: 12

Classification of land –Cultivable and non-cultivable lands, waste lands and their reclamation –Degradation of lands and Desertification: Causes, impact and control measures. Water resources: Manmade reservoirs, dams –uses and its environmental impacts –Marine and mangrove resources.

Total: 60 hours

Course Outcome

- Interrelate various factors in the environment.
- Interpret various types of ecosystems and their functioning.
- Justify different stages of development from bare land to full grown stage.
- Gain knowledge about the Ecological community.
- The biological, economic and social impacts of man-made reservoirs will be learnt

Text Books

1. Benny Joseph (2005)., Environmental Studies, New Delhi, Tata McGraw Hill Publishing co. Ltd
2. Erach Bharucha (2005)., Textbook of Environmental Studies, Hyderabad, Universities Press.
3. Brunner RC, 1989, Hazardous Waste Incineration, McGraw Hill Inc.

4. Clark RS, Marine Pollution, Clanderson Press, Oxofrd (TB).

Reference Books

1. Stanley E. Manohan, (2006), Environmental Science and Technology. A sustainable approach to green science and technology. Taylor & Francis CRC Press, Taylor & Francis group.
2. Anindita Basak, (2009), Text book on Environmental, Pearson Education, New Delhi
3. Odum, E. P. (1971), Fundamental and Environmental Ecology, III Edition, Prentice Hall.
4. Strahler, A. N. and Strahler A. H. (1973), Environmental Geosciences –Interaction with Natural Systems and Man, Hamilton Publishing Co, California.

Weblink

Environmental Science PDF book - AgriMoon
Introduction to Environmental Science, by Barbara Akre, Jean Brainard, Hugues Goosse, Michel: FREE Book Download (free-ebooks.net)
Environmental Studies Notes PDF Free Download [2021 Ed.] (theyuvas.com)

ENVIRONMENTAL CHEMISTRY AND TOXICOLOGY 3 1 0 4

Course Objective

To provide students with an understanding of the fundamental chemical processes occurred on environment. The course develops an understanding of basics of chemistry in relevance to environment such as, solutions preparation, chemical reactions and their effects on the environment,

UNIT 1: Concept and scope of Environmental Chemistry
12

Concept and scope of Environmental Chemistry; acid base reactions, Stochiometry, Gibb's energy, Chemical potential, Chemical equilibria, acid-base.reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radio nuclides.

UNIT 2: Chemistry of Elements **12**

Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere.

UNIT 3: Chemistry of Air **12**

Classification of elements, particles, ions and radicals in the atmosphere; Chemical process for formation of inorganic and organic particulate matters in air; PM_{10}, $PM_{2.5}$, Sulphur Oxides, Nitrogen Oxides, Carbon Oxides, Volatile Organic Compounds (VOCs), PAHs (Polycyclic Aromatic Hydrocarbons), Peroxy acetyl nitrate (PAN) and Photochemical smog; Ozone chemistry.

UNIT 4: Soil Chemistry **12**

Soil composition; relation between organic carbon and organic matter; inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium pathways in soil. Pb, Hg,Cd and As - Behavior of heavy metals and their compounds in environment.

UNIT 5: Toxicity in the Environment: **12**

Metals and Other inorganic contaminants; Organic contaminants; Fate of organic contaminants; Pesticides; Biochemical aspects of Arsenic, cadmium, lead, mercury, Selenium, carbon monoxide, ozone and PAN, Pesticides; Insecticides ,MIC, Photochemistry of Brominated Flame Retardants (BFR).

Total: 60 hours

Course Outcome

- To get knowledge of basic theories and problems of Environmental chemistry
- Describes important chemical reactions and cyclic processes of chemical species in the atmosphere, hydrosphere and in lithosphere
- Demonstrate knowledge of chemical principles of various fundamental environmental phenomena
- Apply basic chemical concepts in understanding the behavior of pollutants
- Know the different types of toxic and hazardous substances and analyze their toxicological information.

Text Books

1. Thomas Spiro, Kathleen Purvis-Roberts, William M. Stigliani, (2012) Chemistry of the Environment, Science Books Mill Valley, 3rd edition.
2. De AK, Environmental Chemistry, Wiley Eastern Ltd.
3. Girard, J. 2013. *Principles of Environmental Chemistry* (3rdedition). Jones & Bartlett.
4. Pani, B. 2007. *Textbook of Environmental Chemistry*. IK international Publishing House.

Reference Books:

1. Balram Pani, (2007) Text Book of Environmental Chemistry, I.K. International PublishingHouse PVT. Ltd.
2. Dara S, Mishra D.D (2006). A Textbook of Environmental Chemistry and Pollution Control. S.Chand Publication.
3. Boeker,E.&Grondelle,R.2011.EnvironmentalPhysics:SustainableEnergyandClimate Change. Wiley.
4. Julian E. Andrews, Peter Brimblecombe, Tim D. Jickells, Peter S. Liss, Brian Reid (2013).
   AnIntroduction to Environmental Chemistry, Wiley-Blackwell Publication.

Weblink:

Environmental Chemistry – Environmental Pollution, Atmospheric Pollution and Green Chemistry (vedantu.com)
Environmental Chemistry - Chemistry LibreTexts
Environmental chemistry - Wikipedia

HYDROLOGY AND WATER RESOURCES 3 1 0 4

Course Objective

The paper introduces students to the hydrological cycle, properties of water, physico- chemical and biological water quality assessment and indices, types of water resources, their use and management.

UNIT 1: Introduction **12**

Introduction: The hydrologic cycle; Structure and properties of water, Inventory of Earth's water, quality and quantity. Distribution of water - local, regional and global. Limits of cations and anions in portable water including fluoride and arsenic, phosphate, nitrate and heavy metals. Application of isotopes in hydrology. Hydrogeology of India.

UNIT 2: Surface water resources **12**

Surface water resources: precipitation, infiltration, water balance, Evapo-transpiration and runoff, Drainage basin. Stream discharge parameters and its measurement, River Hydrographs, Stage-discharge relationship and rating curves. Surface water and ground water interaction..

UNIT 3: Groundwater resources **12**

Groundwater resources: classification of formations according to their groundwater bearing properties. Vertical distribution of subsurface water: zone of aeration and saturation. Geologic formations as aquifers. Types of aquifer. Rock properties affecting ground water and aquifer parameters: porosity, permeability, hydraulic conductivity, transmissivity and storage coefficient. Darcy's law and the viscous character of groundwater flow. Ground water exploration

UNIT4:Environmental Influences on water resources **12**

Environmental Influences on water resources: surface and groundwater resources of arid and semiarid regions. Snowmelt hydrology from glaciers. Groundwater level fluctuations due to urbanization, evapotranspiration, meteorological phenomena and tides. Recent development in surface and groundwater resources monitoring and assessment. Salinity ingress in ground water. Water logging and soil salinity- conjunctive use of surface water and ground water

UNIT 5: Water resource management **12**

Water resource management: Flood and flood plain management; Water-shed management, water harvesting and artificial recharge to ground water; water pollution and water treatment. Wetland

and riparian management; forest management on water resources. Concept of the environmental flow of a River and environmental rejuvenation of a deteriorated River system. Water resources management in the perspective of possible climate change. Environmental issues: River linking debate.

Total: 60 hours

Course Outcomes

- Gains knowledge on water sources, their classification and properties.
- Understands the basic concept of water conservation and its significance
- Knowledge on wetlands and its conservation
- The students will be able to understand about the types of water resources and its management

Text Books

1. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.
2. Bansil, P.C. 2004. Water Management in India. Concept Publishing Company, India.
3. Vickers, A. 2001. Handbook of Water Use and Conservation. Water Plow Press.

Reference books

1. Brebbia, C.A. 2013. Water Resources Management VII. WIT Press.
2. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. Water Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.
3. Schward& Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.

Weblinks

Water - An Overview of Water, its Sources, and the Importance of Water (byjus.com) An Introduction to Water Resources (vedantu.com)

WATER ANALYSIS PRACTICALS- PRACTICAL I

0 0 6 3

Course Objective: (Entrepreneurship)

- Impart the practical knowledge about water quality parameters.
- Impart the knowledge to understand the degree of treatment based on water quality parameters.

List of Experiments

1. Preparation of Standard Solutions - Normality / Molarity / Molality / ppm.
2. Determination of pH, TDS and conductivity of a given water sample
3. Estimation of Temporary, Permanent and Total Hardness of water by EDTA method.
4. Determination of acidity and alkalinity of given water sample
5. Determination of nitrate of given water sample.
6. Determination of sulphate of given water sample.
7. Determination of residual chlorine by argentometric method
8. Determination of optimum lime soda dose for hardness removal
9. Determination of fluoride by CDTA method.

Total : 30 hours

Course Outcomes

1. Plan and conduct an experiment for physico-chemical properties of water
2. Understanding the role of water quality parameters for water supply and treatment.

Text books

1. Hand book of Water Analysis, Leo M.L. Nollet, Leen S. P. De Gelder by CRC Press
2. Industrial Water Analysis Handbook, Natarajan Manivasakam, Chemical Publishing Book.

Reference Books

1. Industrial Effluents - Origin, Characteristics, Effects, Analysis & Treatment, Natarajan Manivasakam,Chemical Publishing Book

BIODIVERSITY AND CONSERVATION BIOLOGY 3 1 0 4

Course Objective

Biodiversity describes the organisms in the natural environment, which provide the ecosystem services that form our natural capital: fresh water, clean air, soil fertility and biological pest control. Biodiversity is fundamental to the future sustainability of the world's natural resources.

UNIT 1: Levels of organization in living world 12

From genes to ecosystems; tree of life; organic evolution through geographic time scale; species concept; concept and types of speciation.

UNIT 2: Biodiversity patterns and Estimation 12

Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluctuations in biodiversity patterns; importance of biodiversity patterns in conservation. Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation

UNIT 3: Biodiversity in India 12

India as a mega diversity nation; phytogeographic and zoogeographic zones of the country; forest types and forest cover in India; fish and fisheries of India, status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.

UNIT 4: Threats to biodiversity 12

Natural and anthropogenic disturbances; habitat loss, habitat degradation, and habitat fragmentation; climate change; pollution; hunting; over-exploitation; deforestation; hydropower development; invasive species; land use changes; overgrazing; man wildlife conflicts; consequences of biodiversity loss; Intermediate Disturbance Hypothesis.

UNIT 5: Conservation of biodiversity 12

In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation (botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks), role of local communities and traditional knowledge in conservation; biodiversity hotspots; IUCN Red List categorization – guidelines, practice and application; Red Data book.

Total: 60 hours

Course Outcomes

- Gain knowledge on ecosystem, biodiversity and its components
- Provides information on diversity patterns
- Idea on national and international biodiversity datas can be obtained.
- Understands the concept of threats to biodiversity and its impact on the Environment species.
- Conservation of biodiversity, on economic grounds alone, needs to become core business in the management of our natural resources

Text Books

1. Chaudhuri, A. B. and D. D. Sarkar (2003), *Mega diversity Conservation, flora, Fauna and*

Medicinal Plants of India's hot spots, Daya Publishing House, Delhi.
2. Singh, M.P., B.S. Singh and Soma S. Dey (2004), *Conservation of Biodiversity and Natural Resources*. Daya Publishing House, Delhi
3. Dadhich L. K. and A.P. Sharma (2002), *Biodiversity –Strategies for Conservation*, APH Publishing Corporation, New Delhi.
4. Khan, T. I and Dhari N Al Ajmi (1999), *Global Biodiversity* – Conservation Measure, Pointer Publishers, Jaipur.

Reference Books

1. Krishnamurthy, K.V (2003), *An Advanced Textbook on Biodiversity* – Principles and Practice, Oxford and IBH Publishing, New Delhi.
2. Hall, BK. and Hallgrimsson, B., 2014. *Evolution*, 5th Edition, Johnes and Bartlett India Pvt. Ltd. New Delhi.
3. Ridley, M., , 2004, *Evolution*, 3rd Edition, Blackwell Science Ltd a Blackwell Publishing company, USA.

Weblinks

Conservation and sustainable use of biodiversity | UNESCO

Biodiversity and Conservation class 12 Notes Biology (mycbseguide.com)

(PDF) biodiversity conservation (researchgate.net)

ENVIRONMENTAL BIOTECHNOLOGY

3 1 0 4

Course Objective

The course is to introduce environmental biotechnology and focuses on the utilization of microbial processes in waste and water treatment and bioremediation.

UNIT-1Introduction 12

Scope–Branches of ecology–Abiotic factors–water–soil–temperature–light. Bioticfactors–Animal relationship–symbiosis–commensalisms–mutalism–Antagonism–Antibiosis–Parasitism–Predation–competition-Multiple interactions microbial populations-Microbial ecosystems and bio-geochemical cycles.

UNIT-2 Scope of environmental biotechnology: 12

Biodegradation, Bioconversion, Bioaccumulation, Biomagnifications, Bioremediation, Bioabsorption, Bioleaching, Xenobiotics, Biofeasibility, Bioreduction, Phytoremediation, bioconcentration, Denitrification and Methanogenesis, Biofuel-Biodiesel, Biogas, Bioplastics, Bioscouring. Biocontrolagents

UNIT-3 Environment Treatment: 12

Waste Water Treatment, Solid waste Management and disposal- landfilling, incineration, chemical degradation, heavy Metals. Treatment of wastes - Pulp industry, Tanning industry, Distilling industry, Dye industry, Pharmaceutical industry. Biotechniques for air pollution abatement and odour control.

UNIT-4 Bioresources: 12

Microorganisms in Agricultural Waste treatment, Composting, Vermiculture, Biofertilizers, Biopesticides. Biomedical waste management. Bioresource, Uses and types of biodiversity conservation.

UNIT-5 Environmental Management 12

Concept of health and sanitation, environmental diseases –infectious (soil, water and air borne) and pollution related, spread and control of these diseases. Disaster Management - Environmental Impact Assessment - GIS technology and remote sensing

Total: 60 hours

Course Outcome

- Basic knowledge of ecology and importance of microorganism role in ecology
- Understand the waste water and solid waste treatment.
- Analyse about scope of environmental biotechnology
- Identifying importance of Conservation and natural method adopting
- Determine the biotechnological approach for environmental management

Text Books

1. Dubey, R.C., A Textbook of Biotechnology–S. Chand and Co., New Delhi. 5th edition.2014
2. Sawyer,C.N., M cCarty,P.L., and Parkin,G.F., Chemistry for Environmental Engineering and Science, TMH Edition, Tata McGraw Hill Co. Ltd.,New Delhi. 5thEdition, 2003
3. Agarwal, K.M., Sikdar, P.K. and S. C. Deb, A Text Book of Environment. Mac Millan IndiaLtd,Kolkatta,India.2002.
4. Agarwal,S.K.,EnvironmentalBiotechnology.APHPublishingCorporation,NewDelhi,India.2002.

Reference Books

1. Paul.A, Rochelle, Environmental Molecular Biology, Horizon Press.2001.
2. Evans,G.M.andJ.C.Furlong, Environmental Biotechnology: Theory and Applications. JohnWiley & Sons Ltd,West Sussex, England.2003.
3. Jordening,H.J.andJ.Winter,EnvironmentalBiotechnology.Wiley-VCH VerlagGmbH&Co. KGaA, Weinheim, Germany. 2005.

Weblinks

Environmental biotechnology - Wikipedia

(PDF) Environmental Biotechnology: For Sustainable Future (researchgate.net)

Environmental Biotechnology: Meaning, Applications and Other Details (biologydiscussion.com)

ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY 3 1 0 4

Course Objective

This paper will introduce to the students the basic understanding of ecosystem and its structural and functional aspects. It will explore the interconnectedness among all the biotic and abiotic components of environment and the dynamic nature of the ecological processes in maintaining equilibrium in nature.

UNIT 1: Introduction **12**

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes, phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niche: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation; thermoregulation; strategies of adaptation in plants and animals.

UNIT 2: Ecology of populations **12**

Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth; deterministic and stochastic models of population dynamics; rudreal, competitive and stress-tolerance strategies.

UNIT 3: Ecology of communities **12**

Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, protocooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession: primary and secondary successions, models and types of successions, climax community concepts, examples of succession.

UNIT 4: Introductory Microbiology **12**

Introductory microbiology; Microbiology- organisms in nature & their importance: Classification of microorganisms, Criteria for classification; nutritional types, Scope of Environmental Microbiology; microbial growth and metabolismMicrobial metabolism energy production, utilization of energy &
Biosynthesis. Role of microbes in human life and environment

UNIT 5: Environmental Microbiology **12**

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; interspecies microbial interactions, Ecological impacts of microbes, Symbiosis (Nitrogen fixation and ruminant symbiosis); microbial interactions in a biofilm, Plant – Microbe interaction (Beneficial and pathogenic), animal –microbe interactions (Beneficial and pathogenic) Role of Microorganism in Nutrient cycles.

Course Outcomes:

- Know the basic concepts of ecology and ecosystems, factors and its interactionalong with its succession processes
- Understands the concept of biodiversity, its types, values and its conservationmethods
- Learns about various environmental issues and environmental sustainability.
- Apply the knowledge of basic ecology in field studies.
- Understands the interrelation between the earth environment and man

Text Books

1. Fundamentals of Ecology (latest ed). Eugene P. Odum. WB Sunders Company, Philadelphia.
2. Fundamentals of Ecology- MC Dash. Tata-McGraw Hill, New Delhi.
3. Sharma P.D. (2012). *Ecology and Environment*. Rastogi Publications
4. Pratibha Singh, Anoop Singh & Piyush Malaviya (2009) Text Book of Environment & Ecology – Excel Publishers.

Reference Books

1. Eugene P. Odum (2017). *Ecology*. Oxford and IBH Publishing Co. Pvt. Ltd.
2. Manuel Molles (2015). *Ecology: Concepts and Applications*. 7th Edition. McGraw-HillEducation.
3. Microbiology - Michael J.Pelzer et.al., (latest ed.), Tata McGraw Hill, New Delhi.
4. Introduction to Environmental Engg. G.M.Masters. Prentice Hall of India

Weblinks

ami-journals.onlinelibrary.wiley.com/journal/14622920

https://ami-ournals.onlinelibrary.wiley.com/hub/journal/14622920/homepage/forauthors.html

SOIL, AIR AND NOISE POLLUTION PRACTICALS- PRACTICAL II **0 0 6 3**

Course Objective: (Entrepreneurship)

- Impart the practical knowledge about soil properties.
- Develop idea about culture media and staining techniques.
- Develop understanding about air, water and soil environment
- To learn assessment of ambient air and noise quality

List of Experiments:

1. Estimation of physical parameters of soil
2. Estimation of chemical parameters of soil
3. Estimation of heavy metals concentration from soil
4. Determination of SO2 in ambient air
5. Determination of NOx in ambient air
6. Determination of CO in ambient air.
7. Elementary analysis of Particulate matter for heavy metals
8. Determination of Ammonia in Ambient Air.
9. Construction of Wind rose diagram & Demonstration of Stack Monitoring Kit
10. Ambient noise monitoring
11. Frequency spectrum analysis of machine noise
12. Traffic noise monitoring
13. Audiometry survey for assessing hearing acuity

Total : 30 hours

Course Outcomes

- The students will learn various analytical and sampling protocols to monitor and analyze various ambient air andnoise quality parameter.

Text Books

1. Guidelines for measurement of Ambient air Pollutants, Volume 1, CPCB 2011.

Reference Books

1. Methods for Measurement of Air Pollution, Part 14: Guidelines for Planning theSampling of Atmosphere (Second Revision) by Bureau of Indian Standards (BIS).

ENVIRONMENTAL MICROBIOLOGY PRACTICALS-PRACTICAL III

0 0 6 3

Course Objective: (Entrepreneurship)

- To provide the practical knowledge about various microbiology techniques Course

List of Experiments:

1. Microbiology of water- Bacteriology of drinking water and sewage
2. MPN techniques for the determination of faecal coliform
3. Culture media preparation– Semi-synthetic and Synthetic media. Liquid and solid media (Nutrient agar and PDA media)
4. Gram staining techniques for detection of gram positive/gram negative bacteria.
5. Determination of total fungi count (medium – Rose Bengal agar).
6. Microbiology of Air: Enumeration of microbes by exposure plate method
7. Microbiology of soil: Isolation of microbes by serial dilution methods.
8. Lacto Phenol Cotton Blue staining technique for morphological identification of Fungi

Total : 30 hours

Course Outcome:

- Understand the importance and principle of sterilization
- Compare the types of culture for microorganism growth
- Learn about isolation and identification of microorganisms using different methods
- Determine the growth of microbes and the motility of Bacteria
- Identifying and differentiate the Gram positive, Gram negative Bacteria utilising biochemical test

Text Books

1. Bharucha, F.D. and A.I. Mehta, Handbook of Microbiological Methods and Media. Sevak Printers, Mumbai. 2000.
2. Cappuccino, J.G. and N. Sherman, Microbiology-A Lab Manual. Pearson Education, Singapore. 2004.
3. Dubey, R.B. and E. Maheswari, Practical Microbiology. S. Chand and Co. Publishers, New Delhi. 2004

Reference Books:

1. Goldman, E. and H. G. Lorrence, Practical Handbook of Microbiology. II Edition, CRC press, London. 2008.
2. Kannan, N., Laboratory Manual in General Microbiology. Palani Paramount Publishers, Palani, Tamil Nadu. 2002.

SOIL BIOLOGY AND SOIL CONSERVATION MANAGEMENT 3 1 0 4

Course Objective

This paper introduces students to the fundamentals of land and soil degradation. Each unit covers a range of topics, which will help students develop basic understanding of properties of soil and how the quality of land and soil degrades due to anthropogenic activities.

UNIT 1: Soil science **12**

Soil genesis and provenance, pedosphere, Soil organic matter: sources, composition, microbial decomposition of organic matter, Humus formation Taxonomy and biology of soil organisms. position and role of soil fauna in soil, ecological niche. Economic importance of soil microbes..

UNIT 2: Soil degradation **12**

Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, industrial and urban development, toxic organic chemicals, and organic contaminants in soils.

UNIT3:Land as a resource **12**

Land as a resource, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.

UNIT 4: Land Degradation
12

Biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors; drivers of land use and land cover change in major geographic zones

UNIT 5: Economic loss due to land degradation **12**

Loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles; future effects of soil degradation; emerging threats of soil degradation to developing countries. Brief account of bioremediation of contaminated soils and ground water, soil composting

Total: 60 hours

Course Outcomes

- Understands the environmental issues on soil, resources of land and management.
- Gains knowledge on soil sources, their classification and properties
- Obtain in-depth knowledge of need for soil conservation
- Understands the concept of land degradation and its impact

Text Books

1. Johnson, D.L. 2006. *Land Degradation* (2nd edition). Rowman& Littlefield Publishers.
2. Marsh, W. M. &Dozier,J. 1983. *Landscape Planning: Environmental Applications.* John Wiley and Sons.
3. Brady, N.C. & Well, R.R. 2007.*The Nature and Properties of Soils* (13th edition), Pearson Education Inc.

Reference Books

1. Environmental Land Use Planning and Management - John Randoloh (2003).
2. Landuse Planning for Sustainable Development – Jane Silberstein, M.A, Chris Maser.
3. Duff, P. M. D. and Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor & Francis

Weblinks

Sustainable soil and land management and climate change | Climate Smart Agriculture Sourcebook | Food and Agriculture Organization of the United Nations (fao.org)
Principles of Soil Conservation and Management | Request PDF (researchgate.net)

3 1 0 4

ATMOSPHERE AND CLIMATE CHANGE

Course Objectives

This paper introduces the student to the development of the Earth's atmosphere, its dynamic nature and variability in turns of the global energy balance. It also deals with elements of the climate, climate change and human impacts on climate initiative policies.

UNIT 1: Introduction **12**

Evolution and development of Earth's atmosphere; atmospheric structure and composition; the only biosphere; Milankovitch cycles. Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion;

UNIT 2: Atmospheric chemistry **12**

Chemistry of atmospheric particles and gases; smog– types and processes; photochemical processes; ions and radicals in atmosphere; acid-base reactions in atmosphere; atmospheric water; role of hydroxyl and hydroperoxyl radicals in atmosphere. plume behavior; Gaussian plume model.

UNIT 3: Global warming and climate change **12**

Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species

UNIT 4: Social connection to climatic change **12**

Climate change and Carbon credits- CDM- Initiatives in India. Climate justice, Immigration issues. Environmental movements; The classic case of earth day. Main climate change negotiations evolved over the past yearsand highlights of some key issues relevant to future climate change regime.

UNIT 5: Climatic change and Socio-economic implications **12**

Economic importance - drought and desertification- fishing and forestry-changes in monsoon pattern-industries-food productions-health care- tourism-transportation and energy consideration. Carbon tax and emission trading, Green fiscal policy

Total: 60 hours

Course outcomes:

- Understands the environmental issues, energy systems and management.
- Gains knowledge on movement of air masses and its impact on environment
- Obtain in-depth knowledge of effect of climatic change on global society
- Understands the concept of Earth's climate change and global warming

Text Books

1. Ranade, P. S. (2008). Climate Change and Biodiversity: Perspectives and Mitigation Strategies. ICFAI University press
2. Chasek, P. S. (2004), The Global Environment in the Twenty-First Century-Prospects for International Co-operation , Manas Publications, New Delhi.
3. Dash, S. K. (2007), Climate Change-An Indian Perspective, Cambridge University Press India Pvt Ltd., New Delhi.

Reference Books

1. Botkin, D. B. and Keller, E. A. (2007), *Environmental Science*: Earth as a Living Planet, 6th edition, John Wiley &Sons, USA
2. Burroughs, W.J. (2007).*Climate Change: A Multidisciplinary Approach*.2nd Edition.Cambridge University Press.
3. Climate Change: *A Multidisciplinary Approach*, 2nd edition, Cambridge University Press.

Weblinks

Climate change | Definition, Causes, Effects, & Facts | Britannica
ch8 (moef.gov.in)
Climate Change: Atmospheric Carbon Dioxide | NOAA Climate.gov

NON-CONVENTIONAL TECHNOLOGIES

3 1 0 4

Course Objective

This paper introduces students to the concept of green technology, its goals and advantages. It also highlights potential role of green technologies in realizing the goal of sustainable development and focuses on community participation to tap the economic benefits associated with switching to green technologies.

UNIT1:Introduction **12**

Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; encouraged use of public transport instead of private transport.

UNIT 2: Green technologies **12**

Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3R'sof green technology: recycle, renew and reduce; paradigm shift from 'cradle to cradle' to 'cradle to grave'

UNIT 3: **Green chemistry** **12**

Introduction to green chemistry; principles and recognition of green criteria in chemistry; bio- degradable and bio-accumulative products in environment; green nanotechnology photodegradable plastic bags.

UNIT 4: **Green infrastructure, planning**
12

Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification.

UNIT 5:Applications of greentechnologies **12**

Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats. Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, methane emissions reduction and/or reuse.

Total: 60 hours

Text Books

1. Arceivala, S.L. 2014. Green Technologies: For a Better Future. Mc-Graw Hill publications.
2. Baker, S. 2006. Sustainable Development. Routledge Press.

Reference Books:

1. Anastas, P.T. & Warner, J.C. 1998. Green Chemistry: Theory & Practice. Oxford university Press.

2. Woolley, T. & Kimmins, S. 2002.Green Building Handbook (Volume 1 and 2). Spon press

Weblinks:

https://www.energy.gov/eere/environmental-impacts-clean-energy

https://www.eia.gov/energyexplained/energy-and-the-environment/

ENVIRONMENTAL BIOTECHNOLOGY PRACTICALS- PRACTICAL- IV

0 0 6 3

Course Objective: (Skill development)

- To provide the knowledge about the uses of different microbes and their role in the environment.

List of Experiments:

1. Isolation of microorganisms from different waste (Effluent, Solid waste etc.,)
2. Estimation of TDS and TSS in industrial waste
3. Estimation of Chromium from soil
4. Screening of industrially important enzyme
5. Isolation of soil microbes Rhizobium sp.
6. Isolation and enumeration of phyllosphere Bacteria
7. Determination of Biological Oxygen Demand (BOD) of sewage sample
8. Determination of Chemical Oxygen Demand (COD) of sewage sample

Total : 30 hours

Course Outcome

- Knowledge on different types of wastes and their isolation methods
- Get an idea on heavy metals, their toxicity and determination

Text Books

1. Biotechnology Procedures and Experiments Handbook, S. Harisha, Infinity Science Press Llc Hingham, Massachusetts New Delhi, India.
2. Methods and Protocols: A Laboratory Manual for Biochemistry and Biotechnology First Edition, Publisher: INSC International Publishers

Reference Books

1. Laboratory manual for Biotechnology, Ashish S. Verma, S. Chand & Company Pvt. Ltd.

INTERNSHIP

Course Objective:

- To gain practical experience by working in a professional chemistry -relatedenvironment.
- To demonstrate an ability to work independently and utilize principles of chemistry tosolve real-world problems.

Course Requirements:

- Students wishing to receive credit for internship are required to find, apply for, and be selected for a chemistry or materials related internship position with an organization of their choice. They will then need to seek permission by the Department Chair to register for the appropriate internship course.

- The student must complete at least 90 hr of work during the semester for each hour of academic credit awarded, and these work hours must be completed during the term (odd oreven semester vacation) in which the student is registered for the internship course.

- After the student has completed the internship, the student must submit the final evaluation report of the internship experience and 20 minute presentation to department at conclusion of semester. The Department Chair and class instructor will allot the marks for the internship evaluation report.

Course Outcomes:

- To know the various types of industries.
- To learn the procedure of identifying, approaching, applying and getting approval ofinternship from a leading industry.
- To witness the entire work area of the industry.
- To understand the nature of job involved in the various sector of the industry.
- To adapt with the working people.

ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

3 1 0 4

Course Objective

This course talks about the need of industry and society to predict and include environmental concerns and risks while developing projects. The course also describes the modern tools and techniques to evaluate the environmental impacts and outlines various management options needed to mitigate these risks.

UNIT 1: Environmental impact assessment (EIA): **12**

Definitions, introduction and concepts; rationale and historical development of EIA; scope and methodologies of EIA; role of project proponents, project developers and consultants; Terms of Reference; impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP)

UNIT2: Rapid EIA; **12**

Strategic Environmental Assessment; Social Impact Assessment; Cost-Benefit analysis; Life cycle assessment; environmental appraisal; environmental management - principles, problems and strategies; environmental planning; environmental audit; introduction to ISO and ISO14000; sustainable development.

UNIT 3: EIA regulations in India; **12**

Status of EIA in India; current issues in EIA; case study of hydropower projects/ thermal projects.

UNIT 4: Risk assessment-I **12**

Introduction and scope; project planning; exposure assessment; toxicity assessment; hazard identification and assessment; risk characterization; risk communication; environmental monitoring; community involvement; legal and regulatory framework; human and ecological risk assessment.

UNIT 5: Risk Assessment-II **12**

Risk and Uncertainty in EIA. Documentation of EIA and EMP NABET accreditation aspects of EIA/EMP Preparation, Regional Environmental Impact Assessment (REIA), Strategic Environmental Assessment(SEA)

Total: 60 hours

Course Outcomes

- Understand the scope of EIA
- Learnt types and methods of EIA process and developed factors correlation skills
- Identify the role of EIA in sustainable environment management
- Improved the knowledge about EIA significance and magnitude

- Involved econometric values on level of impact
- Developed interaction matrix between variables
- Learnt national and international protocols on EI

Text Books

1. Suresh K.Dhameja, (2005), Environmental Science and Engineering, Published by SanjeevKumar Kataria, Delhi.
2. Judith, P. 1999. *Handbook of Environmental Impact Assessment*. Blackwell Science.
3. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, NewYork, USA.
4. Khandeshwar S.R, Raman N.S,Gajbhiye A.R (2019). Environmental Impact Assessment. Dreamtech Press

Reference Books

1. Bregmam J.I (1999), Environmental Impact Statements, Lewis Publishers, London.
2. Singleton R, Castle P and Sort D (1999), Environmental Assessment, Thomas TelfordPublishing London
3. Charles H. Eccleston (2011). *Environmental Impact Assessment: A Guide to Best ProfessionalPractices*. CRC Press
4. Eccleston C.H, (2000), Effective Environmental Assessment, Lewis Publishers, London.

Weblinks

(PDF) Environmental Impact Assessment and Environmental Risk Assessment: Review of Concepts, Steps and Significance (researchgate.net)

Environmental impact and risk assessment - ScienceDirect

PROJECT WORK/REVIEW 0 0 24 12

Course Objective:

- To learn about the basic concept of project work. To know about designing new experiments and carry out the experiments. To know about the various characterization techniques used to characterize the synthesized compounds. To know about the necessities of literature survey and to learn about writing dissertation of project work.

NOTE

1. Review of Chemical literature and documentation.

2. During the fourth semester the project work may be carried out either in industries/ National laboratories/R & D centers/in the university lab.

TOTAL: 24 h

Course Outcomes:

- To identify the topic with the consideration feasibility.
- To learn the procedure of literature survey of the concered topic.
- To derive a plan for executing the work in the stipulated time withmaximum efficiency and success.
- The intensive exposure to industry as a first time experience.
- Understanding different sectors of an industry and the functionaries of each sector.

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SYLLABUS

DISCIPLINE SPECIFIC ELECTIVE COURSES

AEROBIOLOGY

3 1 0 4

Course Objectives

- The knowledge on theoretical and practical skill in Aerobiology will be gained
- Principle and sampling of airborne bacteria, fungi and pollen grains can be learnt
- Environmental monitoring for industries like Pharma, Food and Cosmetics will be learnt.
- Importance of airborne pathogens and knowledge on disease forecasting can be gained.
- The medical importance of airborne virus, bacteria and fungi will be learnt
- The knowledge gained can be applied in the field of Medicine and Industries of different origin

UNIT 1: Introduction to Aerobiology: 12

Introduction and scope of Aerobiology – History of Aerobiology – special reference to Indian history – Aerobiologists of India – Classification of atmosphere – Components of Air spora – Aerobiology an Interdisciplinary Science – Aero bacteriology – Aeromycology – Aeropalynology – Aerophycology - Societies of Aerobiology – Journals in the field of Aerobiology.

UNIT 2: Air monitoring Principles and Methods: 12

Air Samplers – Principles of sampling – Passive sampling – Impaction – Suction samplers – Boehm's personal sampler – Durhams sampler – Tauber trap - Liquid impinger – Cascade impactor – Andersen sampler – Rotorod sampler – Tilak sampler – Burkard sampler.

UNIT 3: Environmental Aerobiology: 12

Environmental monitoring – Lung as particulate sampler – Impact of airborne microbes on human system, microbes and occupational environments – Indoor environments – sick building syndrome – Hospital infections - forecasting of hay fever season – Quality Assurance and Quality Control and Aerobiology – Pharmacopeia, FDA and CTFA regulations on Airborne microbes.

UNIT 4: Agricultural Aerobiology: 12

Aerobiology and Agriculture – Methods – Prediction models – Indian contributions – Disease forecasting – Tikka disease of groundnut – Bajra disease – Sorghum disease – Rice blast disease – Other crops – Forecasting timings – weather and aerobiology – Need for disease forecasting.

UNIT 5: Medical Aerobiology: 12

COVID-19 - Aerobiology and Allergy – Fungal spores and pollen grains – prevalence of fungal allergy – manifestations – clinical studies – airborne occurrence – Pollen studied in different regions of India – Pollen calendar.

Total: 60 hours

Course Outcomes

- To understand the basics and scope of Aerobiology
- Gains knowledge on different sampling techniques.
- To understand the importance of Environmental monitoring and its impacts in the human population.
- To understand the role of Aerobiology in agricultural and medicinal fields.

Reference Books

1. S.T. Tilak, 1998. Aerobiology, Student text series – Biology of the living organisms, Edt. J.G. Vaidya, Satyajeet Prakashan, Pune, Pp. 504.
2. N.K. Udaya Prakash, 2004, INDOOR MOLDS – Isolation and Identification, Marina Publishers, Chennai, Pp. 99.
3. **P. H. Gregory.** 1961. The Microbiology of the **Atmosphere**. London, Leonard Hill. (Books) Limited, 1961. Pp. 278.

Weblinks

Aerobiology - Wikipedia
Aerobiology - an overview | ScienceDirect Topics

3 1 0 4

URBAN ECOSYSTEMS

Course Objective

- The emerging importance of the urban setting as the locus of environmental conflict and governance in India, across a range of urban clusters including metros, cities and towns.
- Their importance for policy, community mobilization, law and governance are explored.

UNIT 1: Environment in an urban setting: 12

Man as the driver of urban ecosystem; commodification of nature; metros, cities and towns as sources and sinks of resources; resource consumption and its social, cultural, economic and ecological perspectives; urban transformation; increasing challenges posed by modernity for the environment.

UNIT 2: Urban dwelling: 12

Urban Sprawl; Housing scenario across a range of large-medium-small cities; poverty and slums in an urban context; Town planning Acts and their environmental aspects; energy consumption and waste disposal as well as accumulation; environmental costs of urban infrastructure.

UNIT 3: Urban interface with the environment: 12

Definition and concepts: green technology, green energy, green infrastructure, green economy, green chemistry; sustainable consumption of resources; individual and community level participation such assmall-scale composting pits for biodegradable waste, energy conservation;

UNIT 4: Green Technologies 12

Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3R's of green technology: recycle, renew and reduce.

UNIT 5: Natural spaces in a city: 12

Concept of 'controlled nature'; scope, importance and threats to nature in the city; organization and planning of green spaces such as parks, gardens and public spaces; concept of green belts; urban natural forest ecosystem as green lungs.

Total: 60 hours

Course outcomes

- To get knowledge on Green technologies and its environmental benefits
- Gain knowledge on the scope, threats and the biodiversity and ecosystem conservation

Text Books

1. Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.
2. Richter, M. & Weiland, U. (ed.). 2012. Applied Urban Ecology. Wiley-Blackwell, UK.

Reference Books

1. D'Monte, Darryl. 1985. Industry versus Environment Temples or Tombs. Three Controversies, Delhi, CSE.

Weblinks

Urban Ecosystems | Home (springer.com)
Urban ecosystem | Human Impact, Biodiversity & Pollution | Britannica
Urban Ecosystem - an overview | ScienceDirect Topics

3 1 0 4

ENVIRONMENT AND RESOURCE ECONOMICS

Course Objective

This course aims to provide a comprehensive introduction to the economic analysis of issues arising from the interactions between the natural environment and the human economy. It underscores the role of entropy laws in this process of interaction. It focusses on the ecosystem-services and discusses comprehensively the challenges arising due to externalities, public-good character and non-tradability of such services. In particular, it highlights the resulting nature of market failure along with issues for social welfare and distributive implications in determining human well-being.

UNIT 1: Economic solutions to environmental problems: 12

Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginalsocial cost of abatement; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards vs. emission charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.

UNIT 2: Natural resource economics: 12

Economics of non-renewable resources; economics of fuels and minerals; Hotelling's rule and extensions;taxation; economics of renewable resources; economics of water use, management of fisheries and forests; introduction to natural resource accounting.

UNIT 3: Tools for environmental economic policy 12

Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis, cost benefit analysis and adjusting and comparing environmental benefits and costs.

UNIT 4: Environmental Valuation Methods and Applications 12

Valuation of non-market goods and services-theory and practice; measurement methods; cost-benefit analysis of environmental policies and regulations.

UNIT 5: Statistical techniques applied to Environmental systems 12

Variables, population and Sampling, sampling methods, sampling error, frequency distribution, bar diagram, pie diagram, arithmetic and geometric mean, mode, median, measures of deviation, null and alternative hypothesis, probability distribution, t-test, χ^2 Test, correlation and regression.

Total: 60 hours

Course Outcomes

- Discuss the environmental issues in relation to the theory of externalities, public goods, and welfare.
- Illustrate and examine economic principles concerning the choice of instruments for controlling pollution and the relative strength and weaknesses of environmental policies based on command-and-control market-based instruments
- Discuss various approaches and methods developed for valuing environmental goods and services.
- Examine issues in the contemporary environmental discourse from an economists' point of view.

Text Books

1. Ecott J. Callan and Janet M. Thomas, 2013, Environmental Economics and Management: Theory, Policy and Applications, Cengage Learning, Delhi.
2. Ramprasad Sengupta, 2013, Ecological Limits and Economic Development, Oxford University Press, New Delhi
3. Per-Olov Johansson, 1987, The Economic Theory and Measurement of Environmental benefits, Cambridge University Press.

Reference Books

1. Peter Bartelmus, Ernst Lutz and Jan Van Tongeren, 2001, 'Environmental Accounting: An Operational Perspective', in Ulanganathan Sankar (ed.) Environmental Economics, Oxford University Press, New Delhi.

Weblinks

Environmental and Resource Economics | Volumes and issues (springer.com)
Environmental & Resource Economics - Course (nptel.ac.in)

ENVIRONMENTAL LEGISLATION AND POLICY 3 1 0 4

Course Objective

To impart knowledge about environmental laws, regulations and policies of India and international environmental laws.

UNIT 1: Introduction: 12

Constitution of India; fundamental rights; fundamental duties; Union of India; union list, state list, concurrent list; legislature; state assemblies; judiciary; panchayats and municipal bodies; National Green Tribunal.

UNIT 2: History of environmental legislation and policy: 12

Ancient period: worship of water, air, trees; Mauryan period: Kautilya's Arthashastra, Yajnavalkyasmriti and Charaksamhita; Medieval period: forests as woodland and hunting resourcesduring Mughal reign; British India: Indian Penal Code 1860, Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, Orissa River pollution and prevention Act 1953.

UNIT 3: Environmental legislation: 12

Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002

UNIT 4: Government institutions: 12

Role of Ministry of Environment, Forests & Climate Changin environmental law and policy making; role of central and state pollution control boards in environmental law and policy making, National Green Tribunal: Aditya N Prasad vs. Union of India & Others; Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988; environmental education case: M.C. Mehta vs. Union of India, WP 860/1991.

UNIT 5: International laws and policy: 12

Stockholm Conference 1972; united Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention.

Total: 60 hour

Course Outcomes

- Understand environmental legislation and policies of national and internationalregime.
- Have an insight into major acts and rules applicable for pollution control and natural resource conservation

Text Books

1. Gurudeep Singh (2005) *Environmental law in India* –Mc Millan, New Delhi.
2. Shyam Diwan and Armin Rosencrany, 2001, *Environmental law and policy in India*, Oxford University Press, New Delhi

Reference Books

1. Nath B., Hens, L., Compton, P and D. Devuyst (1998), *Environmental Management inPractice*, Vol I, Routledge, London and New York.

Weblinks

Major Environment Policies and Legislations : iCED (cag.gov.in)

https://moef.gov.in/wp-content/uploads/wssd/doc2/ch2.html

3 1 0 4

SOLID WASTE AND E-WASTE MANAGEMENT

Course objective

This paper throws light on the current scenario of solid waste generation and problem in its handling and management. It also deals with the different governmental policies that explain proper transportation, handling and disposal of solid waste to minimize its effect on environment.

UNIT 1: Introduction: **12**

Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.Impact of solid waste on environment, human and plant health; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

UNIT 2: Solid waste Management: **12**

Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques.

UNIT 3: Resource Recovery: **12**

4R - reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobictreatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment. Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.

UNIT 4: Integrated waste management and policies: **12**

Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management. Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Plastic Waste (Management and Handling) Rules, 2011; E-Waste (Management) Rules, 2016

UNIT 5: E-Wastes: **12**

E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management.

Total: 60 hours

Course Outcome

- Understand the fundamental principles of existing and emerging technologies for the treatment of waste andrecovery of materials and energy from waste.
- Gains knowledge on the overview of the Indian and international waste management regulations and guidelines for the design,construction, operation and management of waste treatment facilities.
- Describes the overview of management of waste from industrial and agricultural sector.

Text Book

1. Tchobanoglous, G., Theisen, H., and Vigil, S. A. (2014). Integrated Solid Waste Management: Engineering Principles and Management Issues. New Delhi: McGraw-Hill Education (India) Private Limited.
2. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2010). Environmental Engineering. New York:McGraw-Hill.
3. Khan, I. H., and Ahsan, N. (2012). Textbook of solid waste management. New Delhi: Satish Kumar Jain forCBS Publisher and Distributors.

Reference Books

1. Tchobanoglous, G., and Kreith, F. (2002). Handbook of Solid Waste Management-Second Edition. NewYork: McGraw-Hill.
2. CPHEEO (2000). Manual on Municipal Solid Waste Management, Central Public Health and EnvironmentalEngineering Organisation, Ministry of Urban Development, Govt. of India, New Delhi.
3. Williams, P. T. (2005). Waste treatment and disposal-Second Edition. London: John Wiley and Sons.

Weblinks:

Solid-waste management | Definition, Methods, Importance, & Facts | Britannica
Municipal Solid Waste Management — Vikaspedia

ENVIRONMENTAL POLLUTION AND HUMAN HEALTH 3 1 0 4

Course objectives

This paper deals with different aspects of environmental contamination, which have adverse effects on human health. It will lay emphasis on understanding mechanisms of pollutants impacting human health by developing an understanding of different types of pollutants, their sources and mitigation measures. The students will also be introduced to the concept of permissible limits.

UNIT 1: Introduction: **12**

Definition of pollution; pollutants; classification of pollutants.

UNIT 2: Air pollution: **12**

Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NO_x, SO_x, PM, CO, CO_2, hydrocarbons and VOCs) and control measures; indoor air pollution: sources and effects on human health.

UNIT 3: Water pollution: **12**

Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).

UNIT 4: Soil pollution: **12**

Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies.

UNIT 5: Noise pollution: **12**

Noise pollution – sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures.

Total: 60 hours

Course Outcomes

- The students will be able to understand the basic principles and fundamentals of Air/Soil/Water pollutants and their impact on environment.
- Students will be able to gain detailed knowledge on local and global environmental issues and analyze chemical processes involved in different environmental problems.

Text Books

1. Avinash Chauhan (2020) *Environmental Pollution and Management*. IK International Publishers Ltd
2. Ahluwalia V.K (2014). *Environmental Pollution and Health*. The Energy and ResourcesInstitute, TERI
3. Gupta O.P (2019). *Elements of Environmental Pollution Control*. Khanna Publication.

Reference Books

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. *Air Pollution: Health and Environmental Impacts*. CRC Press, Taylor & Francis.
2. Hester, R.E. & Harrison, R.M. 1998. *Air Pollution and Health*. The Royal Society of Chemistry, UK.
3. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. *Environmental Pollution and Control*. Butterworth-Heinemann, USA.

Weblinks

Environmental pollutants and their effects on human health - ScienceDirect
Environmental and Health Impacts of Air Pollution: A Review - PMC (nih.gov)

NATURAL HAZARDS AND DISASTER MANAGEMENT 3 1 0 4

Course objectives

This paper introduces the students to various aspects of environmental hazards, their causes, classifications, and impacts. It also focuses on the management strategies and governmental action plan to mitigate and prepare for such hazards.

UNIT 1: Introduction: 12

Definition of hazard; natural, technological, and context hazards; concept of risk and vulnerability; reasons of vulnerability - rapid population growth, urban expansion, environmental pollution, epidemics, industrial accidents, inadequate government policies.

UNIT 2: Natural hazards: 12

Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought - meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF); tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

UNIT 3: Risk and vulnerability assessment: 12

Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk & vulnerability assessment

UNIT 4: Mitigation and preparedness: 12

Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept of preparedness; importance of planning, exercise, and training in preparedness; role of public, education and media in hazard preparedness.

UNIT 5: Disaster management in India: 12

Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster, and Bhopal tragedy; National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study of efficient disaster management during cyclone '*Phailin*' in 2013.

Total: 60 hours

Course Outcomes

- Understand the basics of Environmental hazards, causes, classification and impacts.
- Gets idea on risk and vulnerability assessment
- Understand the Emergency/Disaster Management Cycle.
- Develop a basic understanding of Prevention, Mitigation, Preparedness, Response and Recovery

Text book

1. Schneid, T.D. & Collins, L. 2001. *Disaster Management and Preparedness*. Lewis Publishers, New York, NY.
2. Smith, K. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge Press.
3. Wallace, J.M. & Hobbs, P.V. 1977. *Atmospheric Science: An Introductory Survey*. Academic Press, New York.

Reference Books

1. Sharma, R.K. & Sharma, G. (2005) (ed) Natural Disaster, APH Publishing Corporation, New Delhi
2. Gautam Ashutosh 1994. *Earthquake: A Natural Disaster*. Ashok Publishing House. New Delhi.
3. Singh R.B. 2006 *Natural Hazards and Disaster Management*; Vulnerability and Mitigation. Rawat Publications.

Weblinks

Natural Hazards & Disaster Management (cbseacademic.nic.in)

Ch-13.pdf (nios.ac.in)

CLIMATOLOGY AND ENVIRONMENTAL MODELLING

3 1 0 4

Course Objective

The objective of the course is to provide basic knowledge on mathematical model construction and analyze environmental problems mathematically.

UNIT 1: Introduction: **12**

Water Quality, Development of Mathematical Models,Reaction Kinetics, Mass Balance, Steady state solutions, Types of loadings, Types of Reactors, incompletely mixed systems, Advection, Diffusion, Dispersion, Distributed systems (steady state and Time variable), Control Volume approach (Steady state solutions).

UNIT 2: River Quality modelling: **12**

Streeter Phelps model, Fate and transport of pollutants in rivers and streams, Pulse and step inputs, transport in estuaries, Fate and transport of pollutants in lakes, Fate and transport of pollutants in subsurface systems.

UNIT 3: Meteorological modelling: **12**

Comparison of boundary layer (BL) and free atmosphere characteristics, diurnal cycle of the ABL, convective BL, potential temperature, degree of turbulence, variance of the vertical and horizontal velocity, comparison between day time and night time BL, prediction of CBL height and Monin-Obukhov length (L).

UNIT 4: Air quality modelling (AQM): **12**

Major AQM types & scales, steps in model formulation, types of input required for dispersion modelling, Preparation of meteorological data for air quality models (surface and upper air data). Emission quantification for point, area and line sources. The box model, Gaussian plume and puff model, Receptor Models such as Chemical Mass Balance (CMB) and Positive Matrix Factorization (PMF).

UNIT 5: Performance evaluation of models: **12**

Model parameterization, calibration and validation, sensitivity analysis and its role, errors and uncertainty analysis.Application of commonly used regulatory models (AERMOD, CALPUFF and CALRoads) and their applications to industrial problems

Total: 60 hours

Course Outcome

- Describe the transport of water and air contaminants.
- Description of naturally occurring process to released pollutants in mathematical form to develop models.
- Use of regulatory models for the purpose of impact study and to device control management plan.

Text Book

1. Stull, R. “Practical Meteorology: An algebra-based survey of atmospheric science” – version 1.02b.Univ. of British Columbia. 940 pages.
2. Surface Water-Quality Modelling by Steven C. Chapra, Medtech.

Reference Books

1. First principles of meteorology and air pollution by Mihalis Lazaridis . Springer.
2. Air pollution modelling by Zannetti paolo, 2013,Springer.
3. A Basic Introduction to Pollutant Fate and Transport by Frank M. Dunnivant and Elliot Anders, JohnWiley & Sons, NY.

Weblinks

Introduction to Environmental Modelling | SpringerLink
Ecological modelling | Nature Climate Change

INDUSTRIAL AND BIOMEDICAL WASTE MANAGEMENT

3 1 0 4

Course objective

To provide in depth understanding of Hazardous and Biomedical Waste characteristics and management. The course covers the planning and engineering principles needed to address the Hazardous and Biomedical Waste Management.

UNIT:1 Hazardous Wastes: 12

Definition, Sources and Classification;Characteristics of Hazardous wastes: Ignitability, Corrosivity, Reactivity, Toxicity, Generation of Hazardous Waste, Guidelinesof Hazardous Waste Management, Basel Convention, Regulatory frame work: Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016; Monitoring of critical parameters/risk-analysis. HAZAN, HAZOP; Environmental Impacts of Hazardous Wastes; Emergency Management: Indian and foreign legislation in respect of the above.

UNIT:2 Storage, Collection and Transport of Hazardous Waste: 12

Collection of Hazardous Wastes; Treatment, Storage and Disposal Facility and safety measures.

UNIT:3 Hazardous Chemicals: 12

Toxic chemicals, Flammable Chemicals, Pesticides, Explosives, Reactive Substances, Cyanide Wastes,Water-soluble Chemical Compounds of Heavy Metals, & Toxic Metals; Hydrocarbons, Point Pigment Dyes, Oil Emulsion Tars, Phenols, Asbestos, Acid/Alkaline Slurry, Physical Properties, Chemical Composition; Lethal Dose and Concentration on Human Life, Flora and Fauna; Case studies, Leakages, Explosion, Oil-spills, Fire of Hazardous Chemical Storage.

UNIT:4 Biomedical Waste: 12

Definition, Characteristics and Categorization; Handling and Storage, Treatment and Disposal; Biomedical Waste Management; Biomedical Waste ManagementRules, 2016. Radioactive wastes, Generation and Processing of Atomic Minerals, Disposal of Fuel rods, Leakage in atomic reactor plants, Remediation of contaminated sites.

UNIT:5 Hazardous Waste Reduction: 12

Hazardous Waste Reduction; Hazardous Waste Treatment, Physical and Chemical Treatment, Thermal Treatment, Incineration, Combustion Calculation and Air requirements, Environmental Control Measures, Pyrolysis, Biological Treatment, Hazardous Waste Landfills, Secure Landfill, Site Selection, Component of Landfill, Landfill Design and Operation, Deep Well Injection

Total: 60 hours

Course Outcomes

- A comprehensive overview of hazardous and biomedical wastes management from both scientific and engineering principles point of view.
- Understanding of the fundamental principles of existing and emerging technologies for the treatment of hazardous and biomedical wastes.
- Understanding of the legislative and regulatory framework related to the generation, treatment, storage, and disposal of hazardous and biomedical wastes.

Text Books

1. Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous and Industrial. CRC Press NewYork: 2nd Edition.
2. VanGuilder, C. (2008). Hazardous Waste Management: An Introduction. New Delhi: Mercury Learning andInformation (Second Edition).
3. Rao, M. N., Sultana, R., & Kota, S. H. (2017). Solid and Hazardous Waste Management: Science andEngineering. India: BS Publications.

Reference Books

1. Tchobanoglous, G., Theisen, H., & Vigil, S. A. (2014). Integrated Solid Waste Management: EngineeringPrinciples and Management Issues. New Delhi: McGraw-Hill Education (India) Private Limited.
2. CPHEEO (2000). Manual on Municipal Solid Waste Management, Central Public Health and EnvironmentalEngineering Organisation, Ministry of Urban Development, Govt. of India, New Delhi.

Weblinks

Biomedical Waste Management in India - Types & Segregation (byjus.com)
(PDF) Latest Biomedical Waste Management Guidelines (researchgate.net)

DRINKING WATER SUPPLY AND TREATMENT 3 1 0 4

Course objectives

The objective of the course is to understand the water chemistry and principles of water treatment processes and its design and transportation and to study the microbial characteristics of the potable water.

UNIT 1: Drinking Water chemistry: 12

Acids and Bases, titrations, buffers, buffer intensity, chemical equilibrium calculations, Langelier index, Oxidation and reduction reaction, stoichiometry, Redox couples, pE-pH diagrams. Basic concepts of organic chemistry, behavior and fate of organics in the environment.

UNIT 2: Water requirements: 12

Types of water demands, Water demandforecasting, Surface water and ground water sources, Water quality and drinking water standards, conventional contaminants and emerging contaminants; Water treatment: Source selection process, selection of treatment chain, plant citing.

UNIT 3: Physico-chemical processes (Process, Mechanism and Design): 12

Sedimentation, Coagulation and Flocculation processes, Granularmedia filtration, Disinfection, Water softening, Adsorption and ion exchange processes, Desalination, Membrane filtration, Reverse osmosis, electrodialysis, Treatment of specific contaminants: Fluoride, Nitrate, Iron, Manganese and Arsenic etc.

UNIT 4: Determination of reservoir capacity: 12

Gravitational, pumping and combined water supply schemes, Water-lifting arrangements, Distribution reservoirs and service storage, Pumping and design considerations for pumps, Design and hydraulic analysis of waterdistribution system.

UNIT 5: Microbiology of Water: 12

Potability of water: microbial assessment of water quality (presumptive test/MPN test, confirmed test and completed test, membrane filter technique), Biological waste water treatment: Waste water characteristics, BOD, COD, Secondary treatment (Activated Sludge, Oxidation Pond, Trickling filter). Brief account of water borne diseases and preventive measures.

Total: 60 hours

Course Outcome

- An insight into the structure of drinking water supply systems, water collection, water purification and water supply scheme for drinking water.
- An understanding of water quality criteria and standards, and their relation to public health.
- Student can apply knowledge of basic water chemistry to solve problems associated with drinking water treatment**.**

Text Books

1. Environmental Engineering (2013 ed.)-Peavy and Rowe, McGraw Hill India.
2. Chemistry for Environmental Engineering and Science, (2003)-Sawyer, Clair N., Perry L. McCarty, and Gene F. Parkin. Boston: McGraw-Hill.

Reference Books

1. Environmental Engineering-I, (33rd ed.)- S K Garg, Khanna Publishers Delhi.
2. Theory and practice of water and wastewater treatment (2009)-Textbook by Ronald L. Droste, Willey.

Weblinks

Water Treatment Notes: Process, Methods, Importance and Purpose (testbook.com)
Overview of Drinking Water Treatment Technologies | US EPA

REMOTE SENSING AND GIS IN ENVIRONMENTAL STUDIES 3 1 0 4

Course Objective

This course introduces the students to various computer-based and statistical methods used for study and management of natural resources and the environment. The students are expected to learn about remote-sensing techniques, physical principles, sampling, statistics and image-analysis methods.

UNIT 1: Remote Sensing: **12**

Definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation.

UNIT 2: Application of remote sensing: **12**

Application of remote sensing in EIA, Application of remote sensing in groundwater, Applications of remote sensing in mining, Application of remote sensing in forest management, Application of remote sensing in characterization and monitoring of biodiversity, Application of remote sensing in mapping of wetlands

UNIT 3: Geographical Information Systems: **12**

Definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.

UNIT 4: Application of GIS: **12**
Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.

UNIT 5: Basic elements of statistical analyses: **12**
sampling; types of distribution – normal, binomial, poisson; measurements of central tendency and dispersion; skewness; kurtosis; hypothesis testing; parametric and non-parametric tests; correlation and regression; curve fitting; analysis of variance; ordination.

Total: 60 hours

Course Outcome

- Analyze the energy interactions in the atmosphere and earth surface features
- Identify the earth surface features from satellite images
- Apply remote sensing techniques in the fields of Geology, Agriculture, Urban, Forestry, Water resources etc.
- Classify the maps, coordinate systems and projections
- Process spatial and attribute data and prepare thematic maps
- Identify and rectify mapping inaccuracies

Text Books

1. Zar, J.H. 2010. Biostatistical Analysis (5th edition). Prentice Hall Publications
2. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.

Reference Books

1. Edmondson, A. & Druce, D.1996.Advanced Biology Statistics. Oxford University Press.
2. Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.
3. Richards, J. A. & Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer

Weblinks

Remote sensing and GIS applications in earth and environmental systems sciences | SN Applied Sciences (springer.com)

Applications in Remote Sensing to Forest Ecology and Management - ScienceDirect

SYSTEMATICS AND BIOGEOGRAPHY 3 1 0 4

Course Objective

This course discuss the principles and applications of classical and modern day systematic to classification of living organisms, develop understanding of historical and contemporary patterns of distributions of organisms, and design effective conservation strategies using biogeographic theories in an era of global change and large scale human induced degradation.

UNIT 1: Concept and systematics approaches: 12

Definition of systematics; taxonomic identification; field inventory; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; numerical and molecular methods. Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept of species (taxonomic, typological, biological, evolutionary, phylogenetic); categories and taxonomic hierarchy.

UNIT 2: Nomenclature and systems of classification: 12

Principles and rules (International Code of Botanical and Zoological Nomenclature); ranks and names; types and typification; author citation; valid publication; rejection of names; principle of priority and itslimitations; names of hybrids.

UNIT 3: Historical Biogeography: 12

Earth's history; paleo-records of diversity and diversification; continental drift and plate tectonics and their role in biogeographic patterns - past and present; biogeographical dynamics of climate change and Ice Age.

UNIT 4: Conservation Biogeography: 12

Application of biogeographical rules in design of protected area and biosphere reserves; use of remote sensing in conservational planning. Biogeographical rules - Gloger's rule, Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare, exotic, cosmopolitan species.

UNIT 5: Speciation and extinction: 12

Types and processes of speciation - allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers
to dispersal; extinction.

Total: 60 hours

Course outcome

- To understand the concepts and systematic approach in the taxonomic identification of species
- Discuss the geographical distribution of plants and animals in relation to physical and human environment
- Gain knowledge in understanding the nomenclature and the classification of taxonomical species.
- Illustrates the historical importance of biogeography and its conservation
- To understand the concepts of speciation, distribution and extinction.

Text Books

1. Hanks S.L.B.: Ecology & the Biosphere, Principle & Problems, Vanity Bok, Delhi.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.
3. Sarkar, D. (2003): Fundamentals and Applications of Pedology, Kalyani Publishers, New Delhi

Reference Books

1. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. 2010. Biogeography (4th edition). Sinauer Associates, Sunderland.
2. Wheeler, Q.D. & Meier R. 2000. Species Concepts and Phylogenetic Theory: A Debate. Columbia University Press, New York.
3. Wilkins, J. S. 2009. Species: A History of the Idea (Vol. 1). University of California Press
4. Barry, C : Biogeography, Blackwell Scientific Publication, Oxford, London, 1993.

Weblinks

Systematics and Biogeography: Cladistics and Vicariance | Systematic Biology | Oxford Academic (oup.com)

Foundations of Systematics and Biogeography | SpringerLink

NATURAL RESOURCES MANAGEMENT AND SUSTAINABILITY

3 1 0 4

Course Objective

This paper takes an objective view of the nature of Earth's resources, their generation, extraction and impact of human activities on earth's environment. It aims to provide an idea of effective management strategies and a critical insight of the major sustainability issues.

UNIT 1: Introduction: 12

Resource and reserves; classification of natural resources; renewable and non-renewable resources; resource degradation; resource conservation; resource availability and factors influencing its availability; land resources; water resources; fisheries and other marine resources; energy resources; mineral resources; human impact on natural resources; ecological, social and economic dimension of resource management.

UNIT 2: Natural resources and conservation: 12

Forest resources: economic and ecological importance of forests, forest management strategies, sustainable forestry; water resources: supply, renewal, and use of water resources, freshwater shortages, strategies of water conservation; soil resources: importance of soil, soil conservation strategies.

UNIT 3: Mineral resources: 12

Mineral resources and the rock cycle; identified resources; undiscovered resources; reserves; types of mining: surface, subsurface, open-pit, dredging, strip; reserve-to-production ratio; global consumption patterns of mineral resources techniques to increase mineral resource supplies; ocean mining for mineral resources; environmental effects of extracting and using mineral resources.

UNIT 4: Non-renewable energy resources: 12

Oil: formation, exploration, extraction and processing, oil shale, tar sands; natural gas: exploration, liquefied petroleum gas, liquefied natural gas; coal: reserves, classification, formation, extraction, processing, coal gasification; environmental impacts of non renewable energy consumption; impact of energy consumption on global economy; application of green technology; future energy options and challenges.

UNIT 5: Resource management 12

Approaches in resource management: ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies; concept of sustainability science: different approach towards sustainable development and its different constituents; sustainability of society, resources and framework; sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.

Total: 60 hours

Course outcomes

- Gain knowledge on Various Natural Resources like water, land, plants, animals, air, space, forest etc.
- Gains idea on Renewable and non-renewable energy resources and its conservation
- will bring over all understanding and knowledge about concepts of Sustainable Development.
- Environmental pollution and deterioration of natural resources and its ill effects on society.
- learn to use critical thinking skills to perceives natural resource management

Text Books

1. Owen, O.S, Chiras, D.D, & Reganold, J.P. 1998. Natural Resource Conservation – Management for Sustainable Future (7thedition). Prentice Hall.
2. Ramade, F. 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
3. Tiwari, G.N. & Ghosal. M. K. 2005. Renewable Energy Resources: Basic Principles and Application. Narosa Publishing House.
4. Ginley, D.S. & Cahen, D. 2011. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press.

Reference Books

1. Craig, J.R., Vaughan. D.J. & Skinner. B.J. 1996. Resources of the Earth: Origin, Use, and Environmental Impacts (2nd edition). Prentice Hall, New Jersey.
2. Freeman, A.M. 2001. Measures of value and Resources: Resources for the Future. Washington DC.
3. Freeman, A.M. 2003. Millennium Ecosystem Assessment: Conceptual Framework. Island Press.
4. Klee, G.A. 1991. Conservation of Natural Resources. Prentice Hall Publication.
5. Miller, T.G. 2012. Environmental Science. Wadsworth Publishing Co.

Weblinks

Natural resource management - Conservation, Sustainability, Stewardship | Britannica Money
The Sustainable Use of Natural Resources: The Governance Challenge | International Institute for Sustainable Development (iisd.org)

GEOINFORMATICS 3 1 0 4

Course Objective

Understanding of the fundamental concepts of Remote Sensing and Geographic Information System and the understanding of the wide applications of Remote Sensing and GIS in Environmental Management.

UNIT 1: Introduction: 12

Types of Remote Sensing, Application and importance of Remote Sensing; Physics of Remote Sensing; The Electromagnetic spectrum; Spectral Reflectance Curves; Spectral Signatures; Types of Resolution. Remote Sensing Platforms: Ground, air borne and satellite-based platforms; Some important Remote Sensing Satellites.

UNIT 2: Aerial Photography and Photogrammetry: 12

Aerial and terrestrial photogrammetry, applications of photogrammetry, types and geometry of aerial photograph, flying height and scale, relief (elevation) displacement, Stereoscopy and Orthophotography, Aerial Photo Interpretation, LiDAR.

UNIT 3: Digital Image Processing: 12

Pixels and Digital Number; Digital Image Structure; Format of Remote Sensing Data; Concept of False Color and True Color Imagery; Image Processing functions: Image Restoration, Image Enhancement, Image Transformation, Image Fusion,Image Classification and Analysis; Image interpretation strategies.

UNIT 4: Geographic Information System: 12

Introduction; Preparation of thematic map from remote sensing data; Co-ordinatesystems; Concept of Datum; GIS components: Hardware, software and infrastructures; GIS data types: Data Inputand Data Processing; DEM/ DTM generation. Integration of GIS and Remote Sensing.

UNIT 5: Concepts of GPS: 12

Spherical trigonometry, History, Types, Navigation Systems and Applications, Introduction to IRNSS

Total: 60 hours

Course Outcome

- Understanding of the fundamental concepts of Remote Sensing and Geographic Information System.
- Understanding of the wide applications of Remote Sensing and GIS in Environmental Management

Text Books

1. Remote Sensing & GIS - by Basudeb Bhatta, Oxford University Press (OUP) Higher Education Division, (Second Edition), 2011.
2. Introduction to Remote Sensing - by James B. Campbell and Randolph H.Wynne, (Fifth Edition), The Guiford Press, 2011
3. Concepts and Techniques of Geographic Information Systems by Chor Pang Lo, Albert K. W. Yeung, Prentice Hall, 2002.

Reference Books

1. Principles of Geographical Information Systems - P A Burrough and R. A. McDonnell, OUP, Oxford 1998.
2. Geographic Information System- Kang Tsung Chang, Tata Mc Graw Hill, Publication Edition, 2007.

Weblinks

Geoinformatics - Wikipedia
MGY-001B1E.p65 (egyankosh.ac.in)
Geoinformatics - an overview | ScienceDirect Topics

ENVIRONMENT AND ENERGY MANAGEMENT 3 1 0 4

Course Objective

This course aims to provide students with a broad understanding of the existing energy resources, issues related to energy and the environment, challenges and possible paths to sustainable energy generation and use.

UNIT 1: Introduction **12**

Defining energy; forms and importance; energy use from a historical perspective: discovery of fire, discovery of locomotive engine and fossil fuels, electrification of cities, oil wars in the Middle East, advent of nuclear energy; sources and sinks of energy; energy over-consumption in urban setting.

UNIT 2: Energy resources **12**

Global energy resources; renewable and non-renewable resources: distribution and availability; past, present, and future technologies for capturing and integrating these resources into our energy infrastructure; energy-use scenarios in rural and urban setups; energy conservation.

UNIT 3: Energy, environment and society **12**

Nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, greenhouse effect, global warming and urban heat island effect; nuclear energy and related issues such as radioactive waste, spent fuel; social inequalities related to energy production, distribution and use.

UNIT 4: Future Energy Sources **12**

Current and future energy use patterns in the world and in India; evolution of energy use over time; alternative sources as green energy (biofuels, wind energy, solar energy, geothermal energy; ocean energy); need for energy efficiency; energy conservation and sustainability; action strategies for sustainable energy mix and management from a future perspective.

UNIT: 5 Energy management **12**

Energy conservation in industrial systems: boilers, furnaces, pumps, fans and blowers, steam system, motors and transformers, power factor, load management, The Electrical System Audit , The Mechanical System Audit, Verification of System Performance , The Physical Plant Audit and case studies, Retrofit Considerations , Audits to Industrial Assessments: energy conservation opportunities, waste minimization opportunities, process improvement opportunities, Renewable energy system audit.

Total: 60 hours

Course Outcomes

- An overview of different energy sources, their environmental impact with respect to development.
- Gains knowledge laterally and originally to conceptualize and solve environmental problems due to energy use
- Knowledge to evaluate a wide range of potential solutions for problems and to arrive at feasible, optimal solutions on energy generation after considering public health and safety

Text Books

1. Energy and the Challenge of Sustainability, World energy assessment, UNDP New York, 2000.
2. Nebojsa Nakicenovic, Arnulf Grubler and Alan McDonald Global energy perspectives, Cambridge University Press, 1998
3. Guide to Energy management, by Barney L.Capehart, Wayne C.Turner, and William J.Kennedy, The fairmont press, INC. Fourth edition

Reference Books

1. Fowler, J.M., Energy and the environment, 2nd Edn., McGraw Hill, New York, 1984
2. AKN Reddy, RH Williams, TB Johansson, Energy after Rio, Prospects and challenges, UNDP, United Nations Publications, New York, 1997

Weblinks

Master Environmental & Energy Management (MEEM course) | MSc University of Twente (Leeuwarden) (utwente.nl)
Energy management - Wikipedia

ENVIRONMENTAL ANALYSIS: TECHNIQUES AND INSTRUMENTATION 3 1 0 4

Course Objective

To upgrade the students with knowledge on instrumental techniques of chemical analysis, practical work with the realistic samples from the environment so that they could become familiar with the instrumentation this is inevitable for contemporary investigations of environmental pollution.

UNIT 1: Introduction: 12

Concept of accuracy (standard reference material, certified reference material), precision and error, Types of errors (determinate, indeterminate, absolute, relative), significant figures, Sample preservations, handling and storage of samples and chemical in lab, Solvent partitioning, Calibration Curves, Standard Curves, Quality Control and Quality Assurance

UNIT 2: Instrumentation and analytical methods-1 12

Instrumentation and analytical methods involved in the following techniques and their applications in environment, Infrared spectrometry, Atomic Absorption Spectroscopy, ICPMS, ICP-AES, UV-VIS, NMR, Concept of Titrimetry and Gravimetry.

UNIT 3: Instrumentation and analytical methods-2 12

Chromatography, Paper Chromatography, Gas Chromatography, GC-MS HPLC, Electrophoresis: Capillary, X-ray diffraction, X-ray fluorescence, FTIR, Bomb colorimetrry, Mass Spectroscopy. SEM, TEM.

UNIT:4 Handling of hazardous samples 12

Handling of radioactive and hazardous samples: Utilization of different techniques for analysis of Polycyclic Aromatic Hydrocarbons (PAHs), Pesticide residues, Polychlorinate Biphenyls in the Environment

UNIT5: Operating procedure for labs 12

Standard Operating procedure for labs, good laboratory practices, Chemical labeling and safety, Emergency and incident/accident reporting Management of chemicals and other waste generated in labs, safety measures while handling chemicals and instruments, Accreditation and certification of lab.

Total: 60 hours

Course Outcomes

- Understanding the environmental aspects and impacts of each unit operations of the polluting industries.
- The students will be able to understand and orient themselves with the industry before they undergo summer training, internship, interview or job.
- The students will be able to conceive and prepare Environmental Management Plan of these industries

Text Books

1. Sustainable Mining Practices: A global Perspective (2005) V.Rajaram, S.Dutta, K Parameswaran. A.A. Balkema Publishers.
2. Environmental Management in Mining Areas - NC Saxena, Gurdeep Singh and R Ghosh (Ed.), Scientific Publishers (India), Jodhpur 2003.
3. Environmental Control in Petroleum Engineering, John C Reis, Elsevier Science & Technology Books, 1996.

Reference Books

1. R.C Gupta (2012), Energy and Environmental Management in Metallurgical Industries, PHI Learning Pvt. Ltd.
2. Environmental Impact of Mining - CG Down & J Stocks, Applied Sc. Pub, London, 1978.
3. Environmental Impacts of Mining: Monitoring, Restoration and Control – M Sengupta, Lewis Publishers, Boca Raton, 1993.

Weblinks

https://onlinelibrary.wiley.com/doi/book/10.1002/0471473332

(PDF) INTRODUCTION TO INSTRUMENTATION MEASUREMENTS AND FIELD METHODS IN ENVIRONMENTAL SCIENCE (researchgate.net)

Syllabus

Skill Enhancement Courses

SOFTSKILLS – I - 2 0 0 2

Course Objective:

- To enable participants Business Communication Skills
- To enhance participants E-mail writing skills
- To impart Leadership and Team Bonding skills

Credit Hours

1. READING COMPREHENSION AND VOCABULARY 06

Filling the blanks – Cloze Exercise – Vocabulary building – Reading and answering Questions.

2. LISTENING AND ANSWERING QUESTIONS. 06

Listening and writing – Listening and sequencing sentences – Filling in the blanks – Listening and answering questions.

3. GROUP DISCUSSIONS 06

Why GD part of a selection process – Structure of a GD – strategies in GD – Team Work – Body Language

4. CONVERSATION. 06

Face to face Conversation and Telephone conversation.

5. SELF- INTRODUCTION AND ROLE PLAY 06

Total: 30 Hours

Course Outcome

At the end of this course the students will be able to,

CO 1 Prioritize power of understanding and aids assimilation of vocables. Vocabulary to charge communication with educated words

CO 2 Develop comprehensive knowledge through listening leading to answering questions

CO 3 Build observation power and infuse self-confidence through group discussions

CO 4 Identify methodology for befitting constructional ability

CO 5 Experiments with inward looking and visualization of the 'otherness' of situations

Books Recommended

- Barun K. Mitra. Personality Development and Soft Skills. Oxford University Press. New Delhi.2011.
- S.P. Sharma. Personality Development. Pustaq Mahal. New Delhi. 2010.Meenakshi Raman and Sangeetha Sharma. Technical Communication. Oxford University Press. New Delhi. 2009.
- Tiko, Champa & Jaya Sasikumar. Writing with a Purpose.OUP. New Delhi. 1979

Web Source:

- https://www.skillsyouneed.com/ips/communication-skills.html
- https://blog.smarp.com/top-5-communication-skills-and-how-to-improve-them
- https://blog.hubspot.com/service/phone-etiquette

SOFT SKILLS – II **- 2 0 0 2**

Course Objective:

- To enable students to develop their communication skills effectively
- To enhance students Reading, Writing, Listening and Speaking skills
- To develop their self-confidence through communication

Credit Hours

1. PRESENTATION SKILLS **06**

Elements of an effective presentation – structure of presentation – voice modulation – Audience analysis – Body language

2. SOFT SKILLS **06**

Time Management – Articulateness – Assertiveness – Stress management

3. RESUME / REPORT PREPARATION / LETTER WRITING **06**

Structuring the resume / Report – Business letters – E-Mail Communication

4. INTERVIEW SKILLS **06**

Kinds of Interviews – Required by Skills – Corporate Culture – Mock Interviews

5. 30 FREQUENTLY ASKED QUESTIONS **06**

Total **30 Hours**

Course Outcome

At the end of this course the students will be able to,

CO1 Illustrate the essential of presentation skills, thoughts, structure, voice modulation, audience analysis and body language

CO2 Utilize the psychological skills pertaining to time management, articulation, assertion and stress management

CO3 Construct methodology for preparation of resume, reports, business letters and email communication

CO4 Appraise learners with varied skills needed for expose to interviews

CO5 Categorize the nature of questions asked usually in interviews

Books Recommended

- Barun K.Mitra. Personality Development and soft skills. Oxford University Press. New Delhi. 2011.
- S P Sharma. Personality Development. Pustaq Mahal. New Delhi. 2010.
- Meenakshi Raman and Sangeetha Sharma. Technical Communication. Oxford University Press. New Delhi. 2009.

Web Sources:

- https://www.skillsyouneed.com/ips/communication-skills.html
- https://www.businessnewsdaily.com/5836-top-interviewing-skills.html
- https://gdpi.hitbullseye.com/Group-Discussion.php

SOFT SKILLS III **2 0 0 2**

Course Objective:

- To enable students to develop their soft skills and Body Language
- To enhance students Reading, Writing, Listening and Speaking skills
- To develop their self-confidence to excel at Interviews

	Credit Hours
UNIT–I	**06**
Powerful Presentation	
UNIT–II	**06**
Reinforcement	
UNIT–III	**06**
Using visual aids	
UNIT–IV	**06**
Types and Methods of Presentations	
UNIT–V	**06**
Obstacles to Presentation	
Total	**30 Hours**

Course Outcome:

CO1 To develop participants social and professional skills CO2 To help participants manage time effectively

CO3 To build a strong resume to suit corporate requirements

CO4 To face interviews confidently

CO5 To enhance their aptitude abilities

Books Recommended:

- Roz Townsend: Presentation Skills for the Upwardly Mobile, Emerald, Chennai.
- Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw- Hill Publishing Company Limited, 2001.
- Pease, Allan. Body Language. Delhi: Sudha Publications, 1998.

Web Sources:

- https://www.skillsyouneed.com/ips/communication-skills.html
- https://venngage.com/blog/presentation-skills/
- https://gdpi.hitbullseye.com/Group-Discussion.php

Syllabus

Generic Elective Courses

GREEN CHEMISTRY **2 0 0 2**

Course Objective:

- To train the students to use eco-friendly approaches in synthesizing agro-based chemicals viz. insecticides, fungicides, herbicides, bactericides acaricides, weedicides
- To emphasize green chemistry approach in crop protection which help to reduce global warming.

UNIT- I Introduction **06**

Current status of chemistry and the Environment-Evolution of the Environmental movement: Public awareness - Dilution is the solution to pollution-Pollution prevention

UNIT- II Green Chemistry **06**

Definition –Principles of Green Chemistry - Why is this new area of Chemistry getting to much attention - Why should chemist pursue the Goals of Green Chemistry - The roots of innovation – Limitations

UNIT- III Green Chemistry using Bio Catalytic Reactions **06**

Introduction - Fermentation and Bio transformations - Production of Bulk and fine chemicals by microbial fermentation- Antibiotics – Vitamins - Bio catalyses synthesis of industrial chemicals by bacterial constructs - Future Tends.

UNIT-IV Green House Effect and Global Warming **06**

Introduction - How the green house effect is produced - Major sources of green house gases - Emissions of CO_2 - Impact of green house effect on global climate - Control and remedial measures of green house effect - Global warming a serious threat - Important points

UNIT-V Future Trends in Green Chemistry **06**

Green analytical methods, Redox reagents, Green catalysts; Green nano-synthesis, Green polymer chemistry, Exploring nature, Biomimetic, Proliferation of solvent-less reactions; Non-covalent derivatization, Biomass conversion, emission control.

TOTAL: 30h

Course Outcomes:

- To understand the connection between common atoms and complex molecules
- To explain and analysing simple chemical reactions
- To distinguishing between recyclable and non-recyclable materials
- To assessing the potential impact of chemical reactions to environment andhuman health
- To understand the connection at the chemical level between all matter and will develop your inquiry based activities to explore best practices related to organic farming and resource management.

TEXT BOOKS:

1. M. Lancaster, Green Chemistry: an Introductory Text, RSC. 2002
2. Sheldon, Arends, Hanefeld, Green Chemistry and Catalysis , Wiley, New York. 2007.

REFERENCE BOOKS:

1. Anastas & Warner, Green Chemistry : Theory & Practice ,Oxford Univ. Press, New York, 1998.
2. S. E. Park, J. S. Chang, S. H. Jhung, The Role of Catalyst for Green Chemistry, Chemworld, Vol. 44 (8), 38, 2004.

WEBSITES:

1. https://www.nrdc.org/stories/greenhouse-effect-101

WEB SOURCES:

1. https://fscimage.fishersci.com/cmsassets/downloads/segment/ScienceEducation/pdf/green_12PrinciplesGreenChem.pdf
2. https://nptel.ac.in/content/storage2/courses/108108078/pdf/chap1/student_slides02.p df

CHEMINFORMATICS 2 0 0 2

Course Objective:

- Students completing this paper should be able to understand concepts of molecular chemistry that are basic to cheminformatics.
- This course will train the students to use QSAR, docking etc.

UNIT- I Mathematics Process 06

Graph theory and molecular numerology; Logic, sets and functions; Algorithms, integers and matrices; Mathematical reasoning, induction and recursion; Counting; graphs, trees and sets, basic probability and statistics; Markov processes

UNIT- II Basics of Stereochemistry 06

Basic Stereochemistry, Amino acids and Proteins and Properties; pKa, pH and ionization of acids and bases; Protein structure - Primary structure, Secondary structure - helix & sheet; Tertiary structure; Quaternary structure; covalent and non-covalent forces that maintain structures.

UNIT- III Chem Information 06

History of scientific information communication-chemical literature-chemical information-chemical information search-chemical information sources-chemical name and formula searching-analytical chemistry-chemical history-biography-directories and industry sources

UNIT- IV Biological Databases 06

Introduction; Experimental sources of biological data; Publicly available databases; Gene expression monitoring; Genomics and Proteomics; Metabolomics; Visualisation of sequence data; Visualization of structures using Rasmol or SPDB Viewer or CHIME; Genetic basis of disease; Personalised medicine and gene-based diagnostics.

UNIT- V Drug Design 06

Introduction to drugs, structure-based drug design. QSAR and 3D-QSAR Methods. Pharmacophore Design, Ligand-Based Design and *De Novo* Drug Design Virtual screening/docking of ligands. Protein structure, Drug action & enzymes. Drug action & receptors. Prediction of Binding Modes, Protein–Ligand binding free energies, Fragment- Based Drug Design, ADMET prediction.

TOTAL: 30 h

Course Outcome:

- To understand basis of group theory and its applications
- To study Logics, sets and functions
- To get a clear idea on the principles and theories of algorithms, induction Basics and process of photosynthesis
- To understand the Basics of stereochemistry and structure of proteins
- To study History of science and chemical information

TEXT BOOKS:

1. P. Shanmughavel, Principles of Bioinformatics, Pointer publishers. 2005.
2. Arfken, Mathematical Methods for Physicists, Academic Press. 1985

REFERENCE BOOKS:

1. P. Shanmughavel, Trends in Bioinformatics, Pointer publishers, 2006.
2. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry-Part A & B, 3rd Edition, 1990.

WEBSITES:

1. https://en.wikipedia.org/wiki/Cheminformatics
2. https://en.wikipedia.org/wiki/Drug_design

WEB SOURCES:

1. https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod15.pdf

FOOD CHEMISTRY AND ADULTERATION 2 0 0 2

Course Objective:

- To understand the basic information of food chemistry and adulteration.
- To appreciate the importance of food additives and pesticide control.
- To provide an information about food preservatives

UNIT-I Introduction 06

Food: source, functions of food – food groups – food guide – basic five food groups, usage of the food guide – food in relation to health – objectives of cooking.

Water: Purification processes – Ion exchangers, reverse osmosis, activated charcoal treatment - Use of chlorination, ozone, and UV light disinfection. Specification of drinking water.

UNIT-II Constituents of Foods 06

Carbohydrates: Classification, Principles involved in the analysis of carbohydrates – estimation of carbohydrates.

Proteins: amino acids – peptides - Analysis of proteins – Separation of amino acids by paper chromatography.

Minerals and vitamins: Sources, functions, deficiency of the following minerals (calcium, iron, iodine, fluorine, sodium and potassium (elementary treatment). Vitamins - classification, sources, Vitamins – A, D, E and K, C, B Complex, - B6 & B12.

UNIT-III Food Additives 06

Artificial sweeteners – saccharin, cyclomate, asparatame – food flavours – esters, aldehydes and heterocyclic compounds. Antioxidants. Food colours – changes in cooking..Restricted use. Spurious colours. Emulsifying agents, preservatives –leavening agents. Baking powder –Yeast. Taste enhancers – MSG-vinegar

UNIT-IV Pesticides Control 06

Spoilage of foods by insects and pests, loss in food quantity and quality Various pesticides used in agriculture and post-harvest storage, uses of pesticides for food grain application.

UNIT-V Food Adulteration 06

Common adulterants in different foods – milk and milk products, vegetable oils, and fats, spices and condiments, cereals, pulses, sweetening agents and beverages. Contamination with toxic chemicals – pesticides andinsecticides. .

TOTAL: 30h

Course Outcomes:

- To know about the basic criteria of food and water standards for consumption
- To get a basic idea about the chemical constituents of food
- To learn about the various food additives, their chemical composition and their permissible level of usage in foods.
- To know about the various organisms which spoil the crops pre and post harvest and their control using pesticides
- To know about the various food adulterants for different types of food and methods to detect those adulteration.

TEXT BOOKS:

1. Owen.R. Fennema, Food Chemistry, Marcel Decker Inc., New York. 1996.
2. M. Swaminathan, Text Book on Food chemistry, Printing and Publishing CO. Ltd. 1993.

REFERENCE BOOKS:

1. B. Siva Sankar, Food Processing and Preservation, Prentice – Hall of India Pvt. Ltd. New Delhi. 2002.
2. S. Ramakrishnan, K. G. Prasannam, R. Rajan, Principles - Text book of medical biochemistry, Orient Longman Ltd. 3rd Edition, 2001.

WEBSITES:

1. https://nptel.ac.in/courses/103/107/103107088/
2. https://nptel.ac.in/courses/126/104/126104003/

WEB SOURCES:

1. https://www.bitmesra.ac.in/UploadedDocuments/admince/files/IMSc_%20Food%20Technology.pdf
2. https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes/Week-1_02-Relationship%20between%20Food,%20Nutrition%20and%20Health%201-A.pdf