ES 402 EARTH RESOURCES AND PROCESSES CREDIT: (L-T-P) : 3 (3-0-0)

OBJECTIVE

To impart fundamental knowledge related to geosphere and geographic and geological processes

OUTCOME

The basic knowledge of geosphere would benefit learners in understanding Earth resources and natural and human-induced hazards and disasters

CONTENTS

Origin of the Earth, Earth resources – Soil, water and mineral resources, geo-thermal energy; Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere; Concept of minerals and rocks; Magma generation and formation of igneous, sedimentary and metamorphic rocks; Weathering including weathering reactions, erosion, transportation and deposition of Earth's materials (sediments) by running water, wind and glaciers; Formation of land forms; Plate tectonics - Sea floor spreading, mountain building, evolution of continents and structural deformation; Thermal, magnetic and gravitational fields of the Earth; Partitioning of elements during surficial geologic processes; Geochemical recycling of elements; Paleoclimate; Concepts of engineering geology

Distribution of water in Earth, hydrology and hydrogeology, major basins and groundwater provinces of India; Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity, groundwater tracers, Ghyben-Herzberg relation between fresh-saline water; Effects of excessive exploitation of ground water

SUGGESTED READINGS

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Valdiya, K.S. 2012. Environmental Geology, McGraw-Hill Education (India) P. Ltd., New Delhi.

Website - www.examrace.com

<u>COURSE STRUCTURE</u> <u>SEMESTER-I</u>

ES 403 ENVIRONMENTAL CHEMISTRY CREDIT: (L-T-P): 3 (3-0-0)

OBJECTIVE

To paraphrase basics of environmental chemistry, green chemistry and toxic chemicals

OUTCOME

The learners would be able to apply the knowledge in enhancing the quality of environment and sustainable use

CONTENTS

Fundamentals of Environmental Chemistry: Classification of elements, stoichimetry, Gibb's energy, Chemical Bonding, Chemical reactions and equations; Organic functional groups, classes of organic compounds; Free radical reactions, catalytic processes; Chemical equilibria, Acid base reaction, Solubility products, Solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes; Principles of green chemistry

Atmospheric Chemistry: Particles, ions reactive intermediates in atmosphere like hydroxyl radical, ozone and nitrate radical; Chemical speciation, chemical processes in the formation of inorganic and organic particulate matters, Thermo-chemical and photo-chemical reactions in atmosphere,Oxygen and ozone chemistry, photochemical smog

Aquatic Chemistry: Chemistry of natural waters (fresh water and marine), physico-chemical properties of water; Sedimentation, coagulation, flocculation, filtration, pH and redox potential, Water pollution: Deoxygenating substances, influence of chemical processes on DO, BOD and COD, solubility of CO₂; effect of pH, nitrogen and phosphorus transformations, salinity; Eutrophication, oxygen sag curve, seasonal variations and vertical profiles of dissolved oxygen **Chemistry of Toxic Products:** Pesticides-Classification and their effects, Bio-chemical aspects of

heavy metals (Hg, Cd, Pb, and Cr) and metalloids (As and Se), CO, O₃, PAN, VOC, and POP, Carcinogens in air

SUGGESTED READINGS

Baird, C. and Cann, M. 2005. Environmental Chemistry, Freeman Publishers, London.

Connell, D.W. 2005. Basic Concepts of Environmental Chemistry, CRC Press, New York.

Dara, S.S. and Mishra, D.D. 2010. A Text Book of Environmental Chemistry and Pollution Control, S. Chand and Co. Ltd., New Delhi, 522 p.

Manahan, S.E. 2010. Environmental Chemistry, Lewis Publishers, U.K.

- Masters, G.M. and Ela W.P. 2008. Introduction to Environmental Science and Engineering, PHI Learning, New Delhi.
- Stumm, W. and Morgan, J. J. 1996. *Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters*, Wiley Hoboken, New Jersey, USA.

Website

https://www.epa.gov/2. *iitrindia.org/En/Index.aspx*

ES 408 ENVIRONMENTAL POLLUTION AND HUMAN HEALTH CREDIT: (L-T-P): 4 (4-0-0)

OBJECTIVE

To provide in-depth knowledge of environmental pollution, its causes, consequences (with focus on human health) and control measures

OUTCOME

The learners would be able to utilize the knowledge for protection of self and society from pollution, and maintaining quality environment

CONTENTS

Air Pollution: Concept, Sources and Types of air pollutants- Natural and anthropogenic sources, Primary and secondary air pollutants, Criteria air pollutants; Sampling and monitoring of air pollutants (gaseous and particulates), period, frequency and duration of sampling; Principles and instruments for measurements of ambient air pollutants concentration, and stack emissions. Indian National ambient Air Quality Standards, Comprehensive environmental pollution index; Impact of air pollutants on human health, plants, animals and materials; Dispersion of air pollutants, Mixing depth (mixing ratio, saturation mixing ratio), lapse rates (saturated, adiabatic and environmental), wind roses; Control devices for particulate matters: Principle and working of setting chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator; Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion; Indoor air pollution, Vehicular emissions and urban air quality, vehicular emissions in India, *e-riksha* and electric transport; Carbon sequestration and carbon credits

Noise Pollution: Sources, weighting networks, measurements of noise indices (L_{eq} , L_{10} , L_{90} , L_{50} , L_{DN} , TNI); Noise dose and noise pollution standards; Impact of noise and vibrations on human health; Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements

Water Pollution: Types and sources, ground water pollution, Eutrophication-concept, causes, effects and control measures; Impact of water pollution on humans, plants and animals; Water pollution: Vectors and diseases (e.g., Dengue); Indian standards for drinking water (IS: 10500:2012) and release of treated effluent in water bodies (IS: 2490:1981); Drinking water treatment-Coagulation and floccution, Sedimentation and Filtration, Disinfection and softening, Wastewater treatment- primary, secondary and advanced treatment methods. Common effluent treatment plant (CETP)

Marine Pollution: Sources and factors responsible for marine pollution, effects of marine pollution; major marine pollution episodes-Minnamata and Gulf war; Methods of abatement of marine pollution, coastal zone management

Soil Pollution: Sources (agricultural, industrial, mining and dumping) and factors causing soil pollution, Absorption of chemicals and toxic methods by soil; Industrial effluents and their interactions with soil components; Soil micro-organisms and their functions- degradation of pesticides and synthetic fertilizers; Effect of soil pollution; Pesticides and diseases, Incidences of fluorosis, arseniosis and goitre in India; Control of soil pollution

Radioactive Pollution: Sources, radioactive decay, biological effects and health hazards associated with radiation, radiation exposure and radiation standards, radiation protection; Radioactive waste disposal, Control of radiation pollution

Thermal Pollution: Sources, Heat islands-causes and consequences, Chemical and biological effects of thermal pollution, Thermal pollution standard and control of thermal pollution; Thermal pollution from power plants and its control

SUGGESTED READINGS

Able, P.D. 2002. Water Pollution Biology, Taylor and Francis, London.

- Gurjar, B. R., Ojha, C.S.P. and Molina, L.T. 2010. Air Pollution-Health and Environmental Impact, CRC Press, New York.
- Khopkar, S.M. 2004. *Environmental Pollution Monitoring and Control*, New Age International P. Ltd., New Delhi.
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ES 427 LABORATORY I CREDIT : L-T-P : 4 (0-0-8)

OBJECTIVE

Hands-on practice on monitoring of environmental attributes

OUTCOME

Learners would be able to develop practical skills of environmental analysis and monitoring as needed essentially for environmental management

CONTENTS

S. No.	Experiment
1.	To measure and record geographical location (latitude, longitude and altitude) and
	meteorological parameters using GPS and automatic weather station, respectively
2.	To prepare wind rose diagram using given meteorological data
3.	To determine PM 10 and PM 2.5 concentration in ambient air
4.	To determine sulphur di oxide concentration in ambient air
5.	To determine nitrogen di oxide concentration in ambient air
6.	To determine carbon mono-oxide concentration in ambient air
7.	To determine the level of noise at selected sites
8.	To determine Dissolved Oxygen (DO) in given water/wastewater samples
9.	To determine Biochemical Oxygen Demand (BOD) in given water/wastewater samples
10.	To determine Chemical Oxygen Demand (COD) in given water/wastewater samples
11.	To determine nitrate in given water/wastewater samples
12.	To determine phosphate in given water/wastewater samples
13.	To determine total Kjeldahl nitrogen in given soil samples
14.	To determine available phosphorus in given soil samples
15.	To determine available potassium in given soil samples
16.	To determine heavy metals (Pb, Hg, Zn, Cr, and Cd) in given water/wastewater/soil/plant
	samples
17.	To enumerate coliform bacteria in given water sample by MPN method
18.	To determine minimum size of quadrat for the study of plant biodiversity of the sample
	site
19.	To determine Importance Value Index (IVI) and species diversities of (herbaceous)
	species of the sample site
20.	To interpret remote sensing imagery using elements of image interpretation

SUGGESTED READINGS

- Aneja, K.R. 2018. Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology, 5th Edition, New Age International (P.) Ltd. Publishers, New Delhi
- APHA.1997. *Standard Methods for Examination of Water and Wastewater*, 21st Edition, American Public Health Association, American Water Works Association and Water Pollution Control Foundation, Washington, D.C.
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ES- 503 BIODIVERSITY AND ENVIRONMENTAL CONSERVATION CREDIT: (L-T-P): 4 (4-0-0)

OBJECTIVE

To familiarize learners about biological diversity in broader perspective as a basis for environmental suitability and sustainable human living on the Earth

OUTCOME

The learners would be able to develop understanding of biodiversity as a resource, causes of its loss, significance for conservation and initiatives for conservation of environment vis-à-vis biodiversity at a national (India) and global level

CONTENTS

Biodiversity- Concept, types, patterns (spatial and temporal), biodiversity for environmental and food security; National (Indian) and global status of biodiversity (natural flora including mangroves and corals, fauna and microbes; domesticated plants and animals, agriculturally-important microbes); Drivers of biodiversity (climate, geological and humans), Monitoring of biodiversity; threats to biodiversity

Biodiversity Hotspots- Definition and basis of identification, global occurrence; Characteristic flora and fauna of Indian biodiversity hotspots; Bio-geographic regions and agro-climatic zones of India, Endemic species, IUCN species categories of Red list, threatened and endangered species of plants and animals in India; Wildlife distribution India in and values of wildlife Species Invasion- Concept, importance, theories of invasion, major invasive species; Invasive species, environment and native biodiversity, regulation of introduction of invasive species and their management

Biodiversity and People- Socio-cultural value of biodiversity; Biodiversity in rural and urban landscape; The conservationist people, green consumerism, Biodiversity in different religions, Indigenous knowledge (traditional ecological knowledge) and biodiversity; Human-wildlife conflict; wildlife crime; Concept of gene pool, biopiracy, IPRs and bio-prospecting and Biodiversity and Environmental Conservation-Valuation of biodiversity for conservation planning; History of conservation, conservation ethics, deep ecology; World conservation strategy; Contemporary global biodiversity challenges (The 6th Mass extinction, The Red list and a catastrophic decline): Restoration ecology as a tool for conservation; Traditional conservation mechanisms (religious tree and animal, sacred landscape and sacred grove), Indigenous knowledge and people's biodiversity register; Conservation movements- Bishnoi movement, Chippko, Appiko, Gandhamardhan, Narmada and Silent valley movements Conservation in Practice- In-situ conservation practices-protected area network (Preservation plot, National park, Wildlife Sanctuary, Conservation reserve, Community reserve, On-farm conservation and Biosphere reserve); ex-situ conservation practices-Botanic garden, homestead garden, Arboratum, Bamboosetum, fernaria, Cacteria, herbarium, Zoo, Aquarium, and in-vitro conservation practices-gene bank, cryobank (pollen and spore bank) and DNA library; International initiatives for environmental protection

Conservation of wetlands, Ramsar sites in India; Species-specific wildlife conservation in India-Project Tiger, Project Elephant, Crocodile conservation, Sea turtle Project, Project rhinoceros; Ecodevelopment and eco-tourism as an instrument for conservation; Biotechnology and biodiversity (GMOs, Biopesticides, Bioremediation, Phytoremediation, Micro-propagation), Eco-friendly measures to mitigate impacts of linear infrastructure on wildlife

Institutions and Conventions for Conservation - IUCN, WWF, UNEP, IUBS, FAO, CITES, TRAFFIC, CBD, TRIPS, Green Peace, International Whaling Commission, IUCN Species Survival Commission, Ramsar Convention, Bonn Convention on (Migratory species) of Wild Animals, UN law of the Seas, International treaty on plant genetic resources for food and agriculture, Global Biodiversity Information Facility

Institution, Policy and Law for Conservation in India – Role of Government Institutions in Environmental Policies, Ministry of Environment Forest and Climate Change (GOI), National Biodiversity Authority, Protection of Plant Varieties and Farmers' Rights Authority, Wildlife Board, Wildlife Institute of India, Wildlife Crime Control Bureau; National Forest Policy 1988, National Environment Policy 2006; Wildlife (Protection) Act, 1972, Wildlife (Protection) Rules, 1995, The Wildlife (Protection)Amendment Act, 2002, 2013, Forest(Conservation) Act,1980, Biodiversity Act, 2002, Biodiversity Rules 2004, Protection of Plant Varieties and Farmers' Rights Act 2001, 2007; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; National Biodiversity Action Plan

SUGGESTED READINGS

Anathkrishnan, T. N.1982. Bioresources Ecology. Oxford and IBH Publishing Co. P. Ltd., New Delhi.

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ES 513: RESEARCH METHODOLOGY CREDIT: (L-T-P) : 3 (3-0-0)

OBJECTIVE

To explain the concept of research, steps in and methods of research, report writing, presentation and research ethics

OUTCOME

The knowledge of research and research methodology could be applied by the learners for doing research and presentation of research output in an ethical manner

CONTENTS

<u>Basics of Research</u> – Definition, Objectives, Motivation, Types, Approaches (Positivism and Post – positive approaches), Significance; Research methods vs Methodology; Research Planning – Characteristics of good research, What to do? How to do?, Problems encountered by a researcher in India; Hypothesis – Meaning, Types, Construction of hypothesis

<u>Research Formulation</u> – Definition, Sources of research problem, Considerations in selecting a research problem, Formulation of research objectives

<u>Review of Literature</u> – Importance, Primary and secondary sources, Web as a source of literature and searching the web; Organization of literature and identifying gap areas from review of literature; Writing research proposal or synopsis

<u>Research Design and Methods</u> – Meaning, Importance, Basic principles; Features of a good research design; Important concepts relating to research design; Different research designs; Basic principles of experimental designs, Developing a research plan

<u>Sampling Design</u> – Census and sample survey; Implications of sample design; Steps in sampling design; Criteria for selecting a sampling procedure; Characteristics of a good sample design; Different types of sample designs

<u>Measurement and Scaling Techniques</u> – Measurement in research, Measurement scales, Sources of error in measurement, Developing measurement tools; Scaling – Meaning, Classification and Techniques

<u>Data Collection</u> – Collection of primary data – Observation method, Interview method, Collection of data through instruments (questionnaires and schedules) and experimentation; Collection of secondary data; Selecting appropriate methods for data collection

<u>Sampling</u> – Need, Definition, Sampling theory; Concept of Standard Error, Estimation – Population mean and population proportion, Sample size and its determination

<u>Data Processing and Analysis</u> – Processing operations; Types of analysis; Statistics in research – Measures of central tendency, Dispersion, Skewness (Asymmetry), Correlation and Regression analysis; Statistical packages of data analysis

<u>Hypothesis Testing</u> – Basic concepts of hypothesis and hypothesis testing, Chi – square test, Analysis of variance and Co – variance, Non – parametric or Distribution – free tests, Multivariate analysis techniques

<u>Report Writing</u> – <u>Interpretation</u> – A pre-requisite for report writing, Meaning of interpretation, Techniques of interpretation, Precautions in interpretation

<u>Research Report</u> – Significance of report, Types of report – Technical report and thesis, Popular report; Structure and components of a scientific report; Steps in report writing; Layout of a typical report – Structure, language, illustrations, tables, bibliographic entries, referencing and footnotes; Writing research papers; Making presentations – oral and poster

<u>Research Ethics and Standards</u> – Commercialization and research; Research ethics – Definition and importance; Research ethics in practice – Intellectual Property Rights, Professional values and qualities of a researcher and sponsoring organization; Detecting unethical research – Plagiarism, paraphrasing and copyright violation; Tools for detecting unethical research; Consequences of plagiarism, Reproducibility and accountability; Valuing research – Citation counting and impact factor, Scientific citation index (SCI), SCI – expanded (SCI – E), H – index

SUGGESTED READINGS

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- Wadehra, B.L. 2000. Law Relating to Patents, Trade-marks, Copyright, Designs and Geographical indications. Universal Law Publishing, New Delhi.

ES 427 LABORATORY I CREDIT : L-T-P : 4 (0-0-8)

OBJECTIVE

Hands-on practice on monitoring of environmental attributes

OUTCOME

Learners would be able to develop practical skills of environmental analysis and monitoring as needed essentially for environmental management

CONTENTS

S. No.	Experiment
1.	To measure and record geographical location (latitude, longitude and altitude) and
	meteorological parameters using GPS and automatic weather station, respectively
2.	To prepare wind rose diagram using given meteorological data
3.	To determine PM 10 and PM 2.5 concentration in ambient air
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7.	To determine the level of noise at selected sites
8.	To determine Dissolved Oxygen (DO) in given water/wastewater samples
9.	To determine Biochemical Oxygen Demand (BOD) in given water/wastewater samples
10.	To determine Chemical Oxygen Demand (COD) in given water/wastewater samples
11.	To determine nitrate in given water/wastewater samples
12.	To determine phosphate in given water/wastewater samples
13.	To determine total Kjeldahl nitrogen in given soil samples
14.	To determine available phosphorus in given soil samples
15.	To determine available potassium in given soil samples
16.	To determine heavy metals (Pb, Hg, Zn, Cr, and Cd) in given water/wastewater/soil/plant
	samples
17.	To enumerate coliform bacteria in given water sample by MPN method
18.	To determine minimum size of quadrat for the study of plant biodiversity of the sample
	site
19.	To determine Importance Value Index (IVI) and species diversities of (herbaceous)
	species of the sample site
20.	To interpret remote sensing imagery using elements of image interpretation

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- Aneja, K.R. 2018. Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology, 5th Edition, New Age International (P.) Ltd. Publishers, New Delhi
- APHA.1997. *Standard Methods for Examination of Water and Wastewater*, 21st Edition, American Public Health Association, American Water Works Association and Water Pollution Control Foundation, Washington, D.C.
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DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE-II)

ES 416 ENVIRONMENTAL PLANNING, POLICY AND LEGISLATION CREDIT: (L-T-P): 3 (3-0-0)

OBJECTIVE

To develop broad understanding of institutional aspect of environmental conservation and management

OUTCOME

To learners would be able to utilize scientific and technological skills, and institutional understanding in policy planning and decision-making to achieve environmental security, biodiversity conservation and sustainable development

CONTENTS

Environmental Planning: Definition, need of policy, law and ethics for environmental conservation and sustainable use of resources, policy frameworks for environment in India; Environmental economics-Concept, significance for environmental planning, valuation methods and case studies, role of NGOs in environmental management

Environmental Ethics: Concept, importance for quality environment and living, ethical theories (homocentric, biocentric and ecocentric), animal rights, deep ecology, land ethics and ecofeminism **International Environmental Institutions:** UNEP, IUCN, WWF, UNESCO (MAB, IGBP), IUBS (DIVERSITAS), IPCC, WRI, World Commission on Sustainable Development

International Environmental Conventions and Agreements: Stockholm Declaration, Ramsar Convention, Vienna Convention and Montreal Protocol, Basel convention, CITES, Convention to Combat Desertification (CCD), Earth Summit-1992, CBD, Earth Summit at Johannesberg 2002, Rio⁺20, GEF, Conventions related to climate change (UNFCCC, Kyoto Protocol, CoPs, CDM, Paris Agreement 2015), UN Summit on Millennium Development Goals 2000 and Sustainable Development Goals 2015, Copenhagen Summit 2009

Environmental Policies in India- Constitution provisions-Article 48 A and Article 51 A, National Forest Policy 1988, National Water Policy 2002, National Landuse Policy 2019., National Environment Policy 2006, National action Plan on Climate Change 2009, National Green Tribunal Act 2010, National Electric Mobility Mission Plan-2020, 2013

Environmental Legislations in India:

(a) Related to Forest, Wildlife and Biodiversity-Wildlife Protection Act 1972, amendments 1992, 2013, Forest Conservation Act 1980, Indian Forest Act (revised) 1982, Biological Diversity Act 2002 and Rules 2004, Protection of Plant Varieties and Farmers Rights Act 2002

(b) Related to Water, Air and Environment- Air (Prevention and Control of Pollution) Act 1981 amended 1987 and Rules 1982, Environment (Protection) Act 1986 and Rules 1986, Noise Pollution (Regulation and Control) Rules 2000, Coastal Regulation Zones (CRZ) Act 1991 amended from time to time, The Public Liability Insurance Act 1991 and Rules 1991

(c) Related to Wastes- The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules 2000, The Hazardous and other Wastes (Management and Transboundary Movement) Rules 2016, The Solid Waste Management Rules 2016, The Plastic Waste Management Rules 2016, The Bio-medical Waste Management Rules 2016, The e-Waste Management Rules 2016, The Construction and Demolition Waste Management Rules 2016

(d) Related to Vehicular Emission-Motor Vehicle Act 1988, The Batteries (Management and Handling) Rules 2010 and amendments

Environmental Management Standards- ISO 14000 series, Eco-labeling (ecomark) schemes

SUGGESTED READINGS

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- Sankar, R.N. 2015. Environmental Management, Oxford University Press, New Delhi, 588 p.
- Selman, P. 1992. *Environmental Planning*, Paul Chapman Publishing Ltd., London, 191p.
- Sulphey, M.M. and Safeer, M.M. 2017. Introduction to Environment Management, PHI Learning P.Ltd., Delhi, 408 p.
- WCED. 1987. *Our Common Future*, (World Commission on Environment and Sustainable Development, WCED), Oxford University Press, Oxford.

GENERIC ELECTIVE (GE)

MB 561 PROJECT MANAGEMENT CREDIT: (L-T-P): 3 (3-0-0)

OBJECTIVE

To impart knowledge on principles and practices of managing projects

OUTCOME

Learners would be able to apply the knowledge of managing projects in a time and cost effective manner in real-life situations

CONTENTS

Introduction: Project management- An overview; Forms of project organization; Project planning Project control

Project Identification and Presentation: Socio-economic considerations in project formulation; Social infrastructure projects for sustainable development; Investment opportunities; Project screening and presentation of projects for decision- making; Expansion of capacity; Diversification

Market and Technical Analysis: Market and demand analysis- Market survey, Demand forecasting, Uncertainties in demand forecasting; Technical Analysis-Product mix, Plant capacity, Materials and inputs, Machinery and equipment

Project Costing and Finance: Cost of project; Cost of production; Break even analysis; Means of financing project; Tax aspects in project finance; Role of financial institution in project finance

Project Appraisal: Time value of money; Project appraisal techniques- Payback period Accounting rate of return, Net present value, Internal rate of return, Benefit-cost; Social costbenefit analysis; Effective rate of protection

Risk Analysis: Measures of risk; Sensitivity analysis; Simulation analysis; Decision tree analysis

Project Scheduling/Network Techniques in Project Management: CPM and PERT analysis; Float times; Crashing of activities; Contraction of network for coast optimisation, updating; Cost analysis of resources allocation

Multiple Project: Project dependence; Capital rationing; Ranking methods of projects; Mathematical programming approach; Linear programming model; Post project Evaluation

SUGGESTED READINGS

Bhavesh, M. and Patel, B.M. 2000. *Project Management: Strategic Financial Planning Evaluation and Control*, Vikas Publishing House Pvt. Ltd., New Delhi.

Kahnkonen, K. (Editor).1997. Managing Risk in Project, E. & F.N. Spon, London, U.K.

Wysochi, R. K., Bick, R. and Crane, D. B. 2000. *Effective Project Management*, John Wiley and Sons, USA.

<u>COURSE STRUCTURE</u> <u>SEMESTER-I</u>

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE-I)

ES 421 URBAN GREEN SPACE MANGEMENT CREDIT: (L-T-P): 3 (3-0-0)

OBJECTIVE

To develop an understanding of importance of green spaces in urban ecosystems and technomanagerial issues associated with them

OUTCOME

The learners would be able to apply the concepts and practices of urban green space management for conserving environment and biodiversity, and promoting livelihood options in urban habitat

CONTENTS

The Urban Green Spaces: Introduction, The Urban habitats, Environmental issues in urbanizing world, urban greens (landscapes, urban forestry and biodiversity) – Uniqueness, national (Indian) and global perspective, Concept of smart cities and sustainable cities

Biodiversity in Urban Green Spaces: Species composition in green belts. avenue plantations, urban forest, vertical and horizontal gardens and amenity grasslands; Threats to urban biodiversity; Biodiversity conservation in urban landscapes; Biodiversity parks, Botanical gardens, Zoological parks and Aquaria, Green campuses and Green habitats

Management of Green Spaces and Aesthetic Landscapes: Urban landscape elements, Types of plantation and amenity grasslands, Tree/plant architecture and urban landscaping, Technical aspects of tree other plant species maintenance, soil and water conservation, control of pests and diseases

Green Space Planning: Integration of urban forestry and urban gardens in city planning, Social issues and institutional policy, Role of government, corporate, academia and research, financial institutions, NGOs, media, civil societies and citizens in urban green space development and management, case studies

SUGGESTED READINGS

Grey, G.W. and Denke, F.W. 1986. Urban Forestry, John Wiley and Sons, New York.

Miller, R.W. 1997. Urban Forestry: Planning and Managing Urban Green Spaces, 2nd Edition, Prentice-Hall India P. Ltd., New Delhi.

ES 505 REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM CREDIT: (L-T-P): 3 (3-0-0)

OBJECTIVE

To provide fundamental knowledge of remote sensing and GIS, and their application in environmental monitoring, forecasting and resource management

OUTCOME

The learners would be able to apply the knowledge so acquired for environment and natural resource management, and urban planning

CONTENTS

Introduction to Remote Sensing – Definition, principles, history and elements of remote sensing; Electromagnetic radiation and its sources, EMR spectrum, radiation laws; Atmospheric windows, Interaction of EMR with atmosphere and Earth surface, Spectral signatures; Application of remote sensing, Advantages and disadvantages of remote sensing, supervised and unsupervised classifications, ground control points (GCP)

Remote Sensing Systems (Active and Passive; Imagining and Non-imaging), Orbit and platforms of Earth observation, sensors and scanners; Types of Resolution – spatial, spectral, radiometric, temporal; Photogrammetry, Elements of image interpretation, Ground truth collection, Global Positioning System (GPS)

Introduction to Geographic Information System (GIS) – Definition, attributes, functions and process; Remote sensing and GIS applications in land cover/land use planning and management, urban sprawling, vegetation study, forestry, natural resources, waste management and climate change

Remote sensing and GIS software use in solving environmental problems including groundwater exploration, Rainwater harvesting, Biomass analysis; Applications of Remote sensing and GIS in disaster management such as, early warning of Tsunami, Earthquake, Snowfall, Forest fire, Landslide, and subsidence

SUGGESTED READINGS

Bhatta, B. 2011. Remote Sensing and GIS. Oxford University Press, 2nd Edition, New Delhi.

Jensen, J.R. 2007. *Remote Sensing of the Environment: An Earth Resource Perspective*, 2nd Edition, Prentice Hall, New Jersey.

Joseph, G. 2005. Fundamentals of Remote Sensing, University Press, Hyderabad.

- Lillesand, T.M., Kiefer, R.W. and Chapman, J.W. 2007. *Remote Sensing and Image Interpretation*, 5th Edition, John Wiley and Sons, Inc. New Jersey.
- Richards, J.A. and Jia, X. 2006. *Remote Sensing Digital Image Analysis: An Introduction*, 4th Edition, Springer Verlag, Berlin.

Website - www.nptel.ac.in/courses/105108077/

ES 507 WASTE MANAGEMENT CREDIT: (L-T-P): 3 (3-0-0)

OBJECTIVE

To sensitize learners about different wastes, waste-specific environmental concerns and waste management

OUTCOME

The knowledge so obtained could be utilized for waste utilization and zero waste living

CONTENTS

Waste - Definition and categories; Solid waste - Definition, types, sources, characteristics, proximate and ultimate analysis of solid waste and impact on environmental health; Waste generation rates and scenario, Urbanization and waste generation

Waste Management - Concepts of waste reduction, 3R and 5R concept, recycling and reuse; Solid waste collection and transportation - Waste segregation, container systems, transfer stations and transportation, Decentralized solid waste management system, *Swachha Bharat Abhiyan*, Composite waste management index

Waste Processing and Treatment Technologies - Mechanical and thermal volume reduction; Electrical energy from solid waste – Fuel pellets and Refuse Derived Fuel (RDF), Thermal Techniques – Incineration, Pyrolysis and Gasification; Chemical techniques – Biomethanation, Bioethanol and Biodiesel; Energy and resource recovery from waste - Composting, Vermicomposting, Incineration of solid wastes, Waste disposal in landfills: Site selection, design, and operation of sanitary landfills, secure landfills and landfill bioreactors, leachate and landfill gas management, landfill closure and post-closure environmental monitoring; landfill remediation, case studies

Hazardous Wastes - Definition, sources and characteristics; Hazardous waste treatment methods – Neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal; Hazardous waste management and disposal; Legislation on management and handling of municipal solid wastes and hazardous wastes

Neo-wastes and their Management

e-waste - Classification, sources, methods of handling and disposal

Fly ash - Sources, composition and utilization

Plastic waste - Sources, consequences and management

SUGGESTED READINGS

Buckingham, P.L. and Evans, J.C. 2010. *Hazardous Waste Management*, Waveland Press Inc., USA.

Cheremisinoff, N.P. 2002. Handbook of Solid Waste Management and Waste Minimization Technologies, Elsevier Scientific Publishers, Woburn.

Khan, I. H. and Ahsan, N. 2003. *Textbook of Solid Wastes Management*, CBS Publishers, New Delhi.

Masters, G.M. 2008. *Introduction to Environmental Engineering and Science*, Prentice Hall, India P. Ltd. New Delhi.

Tchobanoglous, G. 2002. Handbook of Solid Waste Management, McGraw-Hill, New York.

Website - www.swayam.gov.in/

CH 503: PATENT LAWS AND IPR ISSUES

(Credits: 02, Lectures: 30)

UNIT-I

Drug & Cosmetics Act with special reference to schedule Y and M, schedule of medical devices. **UNIT-II**

Concept of total quality management, requirements of GMP, GLP, GCP, Regulatory requirements of drugs and Pharmaceutical (USFD-NDA/ ANDA)

UNIT-III

Documentation and Maintenance of records.

UNIT-IV

Intellectual property rights patents, Trademarks, Copyrights, Patents Act.

UNIT-V

Environment protection Act, Pollution Control, Factories Act.

Reference Books

Bansol, IPR Guidelines for Pharm students and Researchers.

Consumer Protection Act.

Drug & Cosmetic Act.

Environmental Protection Act.

Federal Food, Drug & Cosmetic Act.

Guarino, R.A., New Drug Approval Process, Marcel Dekker, New York.

Patents Act.

Phillip W. Grubb, Patents for Chemicals, Pharmaceuticals and Biotechnology

Pisano-FDA Regulatory Affairs.

Willing, S.W., & Stoker, Good Manufacturing Practices for Pharmaceuticals, Marcel Dekker, New York.