

DEPARTMENT OF ENVIRONMENTAL SCIENCES
CH. CHARAN SINGH UNIVERSITY,
MEERUT-250005 (U.P.)

COURSE/SYLLABUS OF M. Sc. ENVIRONMENTAL SCIENCES (w.e.f. 2015-16)

I SEMESTER				
PAPER CODE	COURSE	INTERNAL	EXTERNAL	MARKS
	Fundamental of Environmental Sciences	50	50	100
	Environmental Chemistry & Instrumentation	50	50	100
	Environmental Geosciences & Natural Disasters	50	50	100
	Natural Resource & Their Management	50	50	100
	Practical			100
II SEMESTER				
	Environmental Microbiology & Biotechnology	50	50	100
	Environmental Economics & Sociology	50	50	100
	Environmental Pollution & Monitoring	50	50	100
	Environmental Toxicology & Health	50	50	100
	Practical			100
III SEMESTER				
	Environmental Policies & Law	50	50	100
	Environmental Management & EIA	50	50	100
	Fundamentals of Remote Sensing & GIS	50	50	100
	Environmental Statistics & Computer Applications	50	50	100
	Practical			100
IV SEMESTER				
	Project Work/Dissertation			400
	TOTAL			1900

UNIT – I : Environment: Definition, scope and importance of Environmental Science; Interaction between man and environment; Components of environment (atmosphere, hydrosphere, lithosphere and biosphere).

UNIT – II: Ecosystem: Structure and components; Aquatic Ecosystems (Freshwater, Marine, Wetlands), Terrestrial ecosystem (Forest, Grassland, Agro & Desert); Energy flow in ecosystem; Biogeo- chemical cycles (Nitrogen, Carbon, Phosphorus, Water); Food Chain, Food Web and Ecological Pyramids.

UNIT – III: Population and Biotic Community: Characteristics of population; Population growth (vis-a-vis the concept of Carrying capacity); Concept and characteristics of Biotic-communities (concept of habitat, niche, keystone species, dominant species, flagship species, ecotones, edge effect).

UNIT – IV: Self Sustenance of Ecosystem: Homeostasis in natural ecosystems; Ecosystem stability and resilience; Biodiversity and ecosystem stability; Ecological succession (primary and secondary); Climax communities and trends in succession.

UNIT – V: Biodiversity and Conservation: Concept and value of biodiversity; Biodiversity at different levels (genetic, species and ecosystem); Threats to biodiversity; Hotspots of biodiversity; Biodiversity protection (a sustainable approach), Biodiversity Act. 2002.

RECOMMENDED BOOKS

1. Begon, M., Townsend, C. R., and Harper, J. L. (2005). *Ecology from Individuals to Ecosystems*. Wiley-Blackwell, USA.
2. Edwards, Andres R. (2005). *The Sustainability Revolution: Portrait of a Paradigm Shift*. New Society.
3. Gotelli, Nicholas J. (2008). *A Primer of Ecology*, 4th edition. Sinauer.
4. Kathleen C. Weathers (2012). *Fundamentals of Ecosystem Science*. Academic Press.
5. Krishnamurthy K.V. (2003). *Textbook of Biodiversity*. Science Publishers.
6. Michael L. Cain, William D. Bowman, and Saily D. Hacker (2014). *Ecology*, 3rd Edition. Sinauer Associates Inc. US, 648p.
7. Odum, Eugene P., and Gary W. Barrett. (2007). *Fundamentals of Ecology*, 5th edition. Thomson Brooks / Cole.
8. Primack, Richard B. (2010). *Essentials of Conservation Biology*, 5th edition. Sinauer.
9. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. (2007). *An Introduction to Sustainable Development*. Earthscan.
10. Stiling, Peter, (2001). *Ecology: Theories and Applications*, 4th edition. Prentice Hall.

UNIT - I :

Fundamentals of Environmental Chemistry: Concept and Scope of Environmental Chemistry, Fundamentals of chemical bonds, molecules and compounds, Organic functional groups and classes of organic compounds, Solubility of gases in water, Radio-nuclides.

Green Chemistry: Concept, Basic principles and tools of Green Chemistry, Zero waste technology.

UNIT - II: Water Chemistry: Acid-base equilibrium, The carbonate system, pH and buffers, Oxidation-reduction, Solution processes and solubility, Redox potential, Complexation and chelation reactions, Concept of salinity, Composition of sea water and physico-chemical, Characteristics of Sea Water.

UNIT - III: Soil Chemistry: Inorganic and Organic components of soil, mechanism of chemical wetting, soil pH, Nitrogen pathway, NPK in soil.

UNIT - IV: Atmospheric Chemistry: Chemical composition of atmosphere: particles, ions and radicals, Chemical processes for formation of inorganic and organic particulate matter, Chemical and photochemical reactions in the atmosphere, Photochemical smog, Acid rain and ozone chemistry.

UNIT - V: Instrumentation Techniques:

- i. Instruments for Limnological analysis (pH meter, Turbidity meter, Conductivity meter, DO Analyzer)
- ii. Colorimetry
- iii. Spectrophotometry: Atomic absorption and Emission spectrophotometry
- iv. Flame photometry
- v. Chromatography- Paper Chromatography, TLC, GLC, HPLC
- vi. High Volume Air Sampler

RECOMMENDED BOOKS

1. Banerji, S. K. (1999). Environmental Chemistry. 2nd ed. Prentice-Hall, New Delhi.
2. Dara, S. S. (2008). A Text Book of Environmental Chemistry and Pollution Control. S. Chand Publications, New Delhi.
3. De, A. K. (2003). Environmental Chemistry. 5th Ed. New Age International (P) Ltd., New Delhi, India.
4. Down, R.D. & Lehr, J.H. (2005). Environmental Instrumentation and Analysis Handbook. John Wiley & Sons.
5. Girard J.E. (2005). Principles of Environmental Chemistry. Johns & Bartlett Publishers.
6. Gore, Michael G. (2000). Spectrophotometry and Spectrofluorimetry: A Practical Approach. Oxford University Press.
7. Manahan, S. E. (2001). Fundamentals of Environmental Chemistry. 2nd ed. CRC Press, Inc., USA.
8. Nelson, D.L. and Cox M.M. (2000). Lehninger Principle of Biochemistry. Worth Publishers.
9. Sodhi, G. S. (2006). Fundamental Concepts of Environmental Chemistry. Narosa Publishing House, New Delhi.
10. The Environment: Challenges for the Chemical Sciences in the 21st Century. National Academies Press (2003).

UNIT – I : Environmental Geology : Internal structure of earth-crust, mantle and core; surface features of the earth- landforms created by running water, underground water, wind, glacier, sea; types of rocks and rock cycle; erosion and weathering; soil formation, profile, types and conservation.

UNIT – II: Disaster types

Landslides – Types, causes, control and mitigation measures of landslide

Earthquakes – Seismology, causes, intensity and magnitude of earthquakes, geographic distribution of earthquakes zones, nature of destruction, earthquake mitigation for buildings and dams, Tsunami.

Volcanoes - Nature, types and extent of volcano, causes of volcanism, volcanic materials, geographic distribution of volcanoes.

UNIT – III: Floods – Type of floods, causes of floods, drainage basins, nature and frequency of flood, flood hydrographs, flood management and control, Cyclones, Tornadoes, typhoons.

Snow Avalanches: Cloud burst and their impacts.

Drought: Definition, types, assessment and mitigation; drought proofing.

Forest Fire: Causes, consequences, monitoring and mitigation.

UNIT – IV: Disaster Management in India: Disaster Management Cycle; preparedness, response, mitigation, rehabilitation, Disaster Management Act 2005; National Guidelines and Plans on Disaster Management; National Disaster Management Authority (NDMA); State Disaster Management Authorities, National Disaster Response Force; Institutional arrangement during disasters; International Agencies (International Space Charter, UNISDR); International Strategy for Disaster Reduction; Hyogo-Framework (2005-2015); Sendai Framework (2015-2030).

UNIT – V: Risk analysis and Environmental management: Definition of risk, environmental risk analysis, exposure and risk assessment, basic steps in risk assessment, dose response assessment, risk characterization, quantified risk assessment for industrial accidents, design of risk management programme, risk assessment application to environmental management problems.

RECOMMENDED BOOKS

1. Barbar W. Murk *et. al.*, (1996). Environmental Geology, John Wiley & Sons, New York.
2. Chamley, H. (2003). Geosciences, Environment and Man. Elsevier.
3. Dorothy Merritts, Kirsten Menking, Andrew DeWet (2014). Environmental Geology: An Earth Systems Approach. W. H. Freeman.
4. Egbort Bocker and Rienk Van Grondille (1996). Environmental Physics, John Wiley & Sons Ltd., 1999.
5. James Reichard (2013). Environmental Geology: Second Edition. McGraw-Hill Higher Education.
6. John M. Wallace and Peter V. Hobbs (1977). Atmospheric Science: An Introductory Survey, Academic Press, New York.
7. Roy, A.B. (2010). Fundamentals of Geology. Narosa Publishing House.
8. Singh Prabin (2010). Engineering and general geology. Kataria & Sons Publication.
9. Valdiya, K.S. (1982). Environmental Geology. Tata McGraw Hills Publication.
10. William H. Dennen and Bruce R. (1986). Moore, Geology and engineering. WCB Publishers, Iowa.

UNIT – I: Plants: natural resources: introduction, characteristics & classification; Concept of endemic, extinct and threatened species (endangered, rare, vulnerable & interminate species); Plants as a natural resource: a general account with reference to timber, food & medicines.

UNIT – II: Water & Animals: Water as a natural resource: as a medium for life and as a life support system; water resources of India; Animals as a natural resources: a general account with reference to game, wildlife & food; Depletion of Animal resources: Causes & consequences.

UNIT – III: Soil & Minerals: Soil as a natural resource: a general account with reference to nutrients & soil biota; Role of agricultural practices in soil degradation; distribution & uses of economic minerals; Exploitation of mineral resources from oceans with special reference to India; Impact of exploitation of economic minerals on environment.

UNIT – IV: Energy: Energy: scenario in India, conservation measures used; Coal, oil & natural gas; Hydro energy, wind energy, tidal energy; Solar energy, Nuclear energy; Biogas, fire wood, Petroplants.

UNIT – V: Resource Management: Ecosystems based management.

Management of common International Resources: Ocean, climate, International fisheries and management commissions; Antarctica: the evolution of an international resource management regime.

RECOMMENDED BOOKS

1. Bandhu, Desh (1987). Env. Education for conservation & Development. Indian Environment Society, New Delhi.
2. Chaturvedi, A.N. (1994). Management of India's forest resources. Khanna Bandhu, Dehradun.
3. Dar, G.h., Bhagat, R.C., Khan, M.A. (2002). Biodiversity of the Kashmir Himalaya. Anmol Publication, Pvt. Ltd., New Delhi.
4. Frankle, O.H. & Hawkel, J.G. (1975). Plant genetic resources. International Biological Programme-2, Cambridge University Press London.
5. Gautam, A. & Rastogi, S. (2003). Resource Geography. International Publishing House, Meerut.
6. Gupta, K.C. (2002). Energy & Environment in India- A study of Energy management, Gyan Publishing House, New Delhi.
7. Heywood, V.H. (1995). Global Biodiversity Assessment. Cambridge Univ. Press, UK.
8. Jadhav, H.V. (1997). Energy & Environment. Himalaya Publishing House, Delhi.
9. Jairajpuri, M.S. (1991). Animal resources of India-Protozoa to mammalian- State of the Art Zoological survey of India. XI-XXVII.
10. Singh, M.P. (2004). Natural Resources and Renewable Energy. Daya Publishing House, Delhi.

UNIT – I: Environmental Biotechnology & Biotechnological processes - Definition, history and scope of biotechnology, Bioconversion, bioaccumulation, biodegradation, Fermentation as a biotechnological process, Concept of bioreactors, Types of bioreactors.

UNIT – II: Biofertilizers, Biopesticides & Biofuels: Bacterial biofertilizers algal biofertilizers, aquatic fungi biofertilizers, vermiculture technology, biopesticides, and integrated pest management, Biofuels (Energy from biomass, biodisel, biofilters, biosensors and biochips, biofuel cells, endorphins).

UNIT – III: Biotechnology and biodiversity- Biotechnology and biodiversity conservation Cryopreservation, seed banks, DNA banks, other types of gene banks, micro-propagation. GMOs (transgenic animals, plants & fish), Stress tolerant plants and their significance.

UNIT – IV: Environmental Microbiology: Introduction, history and scope of Environmental Microbiology; Microbial diversity: Major groups of microbes; Microbiology of Soil, water and air; Microbes of extreme environment; Microbial pathogens.

UNIT – V: Applied Microbiology: Biodegradation of organic and inorganic pollutants and pesticides; microbial treatment of oil pollution; production of vinegar, lactic acid, citric acid, antibiotics, vitamins and vaccines; microorganism in bioassays.

RECOMMENDED BOOKS

1. Alan Scragg (2005). Environmental Biotechnology, 2nd Ed., Oxford University Press.
2. Alcano (2001). Fundamentals of Microbiology. Jones & Bartlett Publishers.
3. Atlas, R.M. & R. Bartha (2000). Microbial Ecology: Fundamentals & applications. 4th Ed. Pearson Int.
4. Black, Jacquelyn G. (2008). Microbiology: Principles and Explorations. Wiley.
5. Chaterji, A.K. (2002). Introduction to Environmental Biotechnology. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Gabriel Bitton (1999). Wastewater Microbiology, 2nd Ed., Wiley-Liss, New York.
7. Gary W. Vanloon and Stephen J. Duffy (2000). Environmental Chemistry: A global perspective. Oxford University Press.
8. Gupta, P.K. (2008). Molecular Biology and Genetic Engineering. Global Medical Publication.
9. Mark Coyne (2001). Soil Microbiology: An Exploratory Approach. Thomson Business Information.
10. Mitchell R. & Ji Dong Gu. (2010). Environmental Microbiology. Wiley Blackwell.
11. Mohapatra P.K. (2008). Textbook of Environmental Microbiology, I.K. International Pvt. Ltd.
12. Nester, Roberts. (2009). Microbiology. McGraw Hill.
13. Rai, M.K. (2006). Handbook of Microbial Biofertilizers. Taylor & Francis.
14. Raina M. Maier (2008). Environmental Microbiology. Academic Press.
15. Ratledge, C. & Krisansen, B. Basic Biotechnology. 3rd Edition. Cambridge University Press.

UNIT – I : Fundamentals of Environmental Economics: Definition, concepts, issues and scope of Environmental Economics; Concept of the commons, tragedy of commons, externalities (indirect costs), economic good/ service supply, demand, intangibles, public goods and bads; Limitations of Environmental Economics.

UNIT – II: Economic Tools: Valuing the environment and natural resources; Ecology and equity; Natural resource accounting, cost-benefit analysis; Life cycle assessment (LCA); Intellectual property rights (IPR) and environment.

UNIT – III: Fundamentals of Environmental Sociology: Definition, concept, issues and scope of Environmental Sociology; Concept of social groups, caste, tribe, clan, society, culture and social structure; Social and Cultural resources; Interaction of biosphere and Sociosphere/ Traditional Wisdom and Environment.

UNIT – IV: Social Issues and the Environment: Sustainable development; River rejuvenation, Resettlement and rehabilitation: Problems and concerns; National Policy for Rehabilitation and resettlement (NPRR, 2007); Major National and International environmental movements (Chipko, Appiko, Narmada Bachao Andolan, Tehri dam conflicts and Silent valley movement, Nadi Bachao Andolan, Beej Bachao Andolan, Green Peace and WWF).

UNIT – V: Environmental Ethics: Definition and concept; Resource consumption patterns and need for equitable utilization; Anthropocentrism, biocentrism, egocentrism, cosmocentrism; Conservation ethic: traditional value system in India.

RECOMMENDED BOOKS

1. Atchia, Michael and Shawna Troop, eds. (1995). Environmental Management; Issues and Solutions. New York: Willey.
2. Dunlap, Riley. Michelson, William (2008). Handbook of Environment Sociology. Rawat Publications, New Delhi.
3. Fien, John, *et al.*, eds. (1993). *Environmental Education: A pathway to sustainability*, New York: St. Martins.
4. Hanley N. & Colin J.R. (2002). Issues in Environmental Economics. Blackwell Pub. Ltd.
5. John A. Hannigan (1995). Environmental Sociology. London, Routledge, Jaipur, Rawat Publications.
6. Redclift, M. and Woodgate, G. (1997). International Handbook of Environmental Sociology. Cheltenham: Edward Elgar, GB.
7. SenGupta R.P. (2001). Ecology & Economics- An Approach to Sustainable Development. Oxford University Press, New Delhi.
8. Sociological Environment in Hitopdesh. Neha Publishers & Distributors. (2014)
9. Sociology Environment and Economic Development. Neha Publishers & Distributors. (2010).
10. Sundar, I. (2012). Principles of Environmental Sociology. Sarup Book Publishers, New Delhi.
11. Sunder, I. & Muthukumar, P.K. (2006). Environmental Sociology. Sarup & Song, New Delhi.
12. Welford, Richard (1995). Environment Strategy and Sustainable Development: The corporate challenges for the Twenty-first Century, New York: Routledge.

UNIT – I: Environmental Monitoring: Concept and objectives; Global environmental monitoring system (GEMS); National environmental monitoring programmes; Bioindicators and Biological monitoring

UNIT – II: Air Pollution: Sources and dispersal of air pollution; Methods of monitoring of SO_x, NO_x, CO, PM₁₀, PM_{2.5}; Methods of monitoring of Green Houses Gases; Effects of pollutants on human beings, plants, animals, and historical monuments; Indoor air pollution; Control of Air pollution.

UNIT – III: Water Pollution: Major sources of water pollution; Water pollution and human health; Heavy metals and their impact on aquatic life; Sewage and wastewater treatment and recycling; Industrial effluent treatment (Primary, Secondary & Advance).

UNIT – IV: Radioactive, Thermal and Noise Pollution: Radioactive pollution: causes and consequences; Radioactive fallout, Chernobyl Accident: Three Mile Island accident, Fukushima; Radioactive waste management; Thermal pollution: causes and consequences; Noise Pollution: Sources, measurement, impact and abatement.

UNIT – V: Solid Waste Management: Types and major sources of solid waste; Solid waste and environmental problems; Integrated solid waste management of municipal waste; Management of industrial waste; E-waste and its management; Biomedical waste and its management.

RECOMMENDED BOOKS

1. APHA. (1981). Standard methods for the examination of water and waste water. 15th ed.
2. Burrell, D.C. (1974). Atomic spectrometric analysis of heavy metal pollutants in water. Ann Arbor Science Publishers, Ann Arbor.
3. Environmental Pollutants: Selected Analytical methods SCOPE. 6 (1975). Butterworths, London.
4. Gilbert R.O. (1987). Statistical Methods for Environmental Pollution Monitoring John Wiley & Sons.
5. Grasshoff, G. (1975). Methods of sea water analysis. Verlag- Chemie, Weinheim (1975).
6. Marr, I.L. and Cresser, M.S. (1983). Environmental chemical analysis. International Textbook Co.,
7. Rana, S.V.S. (2007). Bio-techniques theory and practices, Rastogi Publications, Meerut.
8. Samant, H.S. (1973). Methods for chemical analysis of water and waste water. Surveillance report EPSS. AR. 73-12. Canada.
9. Trivedi, P.R. (2004). Environmental Pollution and Control. APH Publishing.
10. Vesilind, P.A. et al. (2013). Environmental Pollution and Control. Elsevier.

UNIT – I : Introduction to Environmental Toxicology: Definition, concept and scope of Environmental Toxicology; Common environmental toxicants; Heavy metals: Sources and their effects on life and environment; Pesticides: Types, uses and harmful effect of pesticides; brief note on Biopesticides; Mutagenic and Carcinogenic Chemicals, Polyaromatic hydrocarbons, nitrosamines, organic solvents, alcohol, carbon tetrachloride, anaesthetic (chloroform, ether, xylocaine); Tobacco chewing and smoking.

UNIT – II: Toxicity Assessment: *In-vivo* and *in-vitro* toxicity assessment; Accute, subacute, sub chronic and chronic toxicity test; Skin and eye test, behavioural, neurotoxic, reproductive, mutagenic and carcinogenic test; LD₅₀, LC₅₀, EC₅₀ and IC₅₀; Factors affecting toxicity.

UNIT – III: Systemic Toxicity: Absorption, Translocation and Excretion Xenobiotics: Membrane permeability and mechanism of chemical transfer, Absorption of xenobiotics, translocation of xenobiotics, membrane barriers, Binding of Xenobiotics, excretion of xenobiotics; Neurotoxicity, hepatotoxicity, immunotoxicity, cardio-vascular toxicity, respiratory disfunction and hypersensitivity.

UNIT – IV: Environmental Occupational health- Concept, indicator & determinants of health (Physical, Chemical & Biological), Dust Diseases (Pneumoconiosis with reference to silicosis, absestosis, anthracosis, bagassosis & byssinosis), Occupational hazards, pneumoconiosis, lead poisoning (plumbism), Occupational cancer, occupational dermatitis, radiation hazards.

UNIT – V: Epidemiology, definition, history, Scope of epidemiology, Epidemiology of selected communicable, Water borne (diarrhea, cholera, dysentery, typhoid), Vector borne diseases (Malaria & filariae), Air Borne (tuberculosis, influenza, diphtheria), AIDS.

RECOMMENDED BOOKS

1. Alleman, J. E. and Karanagh, J. T. (1982). Industrial Waste. Ann Arbor Science.
2. Cataldo, R.B. Environmental Hazards and Human Health.
3. Dhaliwal G.S. & Singh, B. (2000). Pesticides & Environment. Commonwealth Publishers for Indian Ecological Society, Ludhiana.
4. Herman Koren and Michel Bisesi. Handbook of Environment Health and Safety. Jaico Publishing House, Delhi.
5. Monroe T. Morgan, Darryl Bradley Barnett (2003). Environmental Health. Thomson/Wadsworth.
6. Niesink, John de Vries & Holligner. Toxicology – Principles and Applications.
7. Park J.E. and Park, K. Textbook of Preventive and social Medicine.
8. Sharma. P.D. Toxicology. Rastogi Publications.
9. Timbrell, J. (2001). Introduction to Toxicology, 3rd Edition. CRC Press.

UNIT – I : International And Constitutional Efforts

Environmental issues and problems.

International Efforts : Stockholm Conference, Rio Conference, Montreal and Kyoto Protocol, Ramsar Convention, CITIES, World Summit on Sustainable Development, 2002.

Protection under Indian Constitution :

- i. **Constitutional Provisions:** Protection under Article 21, Article 48A, Article 51A(g) and related Articles.
- ii. **Judicial Approach** : Meaning and relevance of “Precautionary Principle”, “Polluter Pays Principle”.

UNIT – II: Environmental Protection and Indian Legislations – I: The Water (Prevention and Control of Pollution) Act 1974 and Judicial approach; Air (Prevention and Control of Pollution) Act 1981 and Judicial approach; The Environment (Protection) Act 1986; Judicial approach on these legislations.

UNIT – III: Environmental Protection and Indian Legislations – II: Indian Forest Act 1927, and Forest (Conservation) Act 1980; Wildlife Protection Act 1972 as amended in 1991; National Environmental Tribunal Act 1995; National Green Tribunal Act, 2010; Judicial approach on these legislations.

UNIT – IV: Indian Rules and Regulations on Environmental Protection: Biomedical Waste (Management and Handling) Rules, 1998; Hazardous Waste (Management and Handling) Rules, 1989; New Plastic Waste (Management and Handling) Rules, 2011; Environmental Protection (Fifth Amendment Rules), 2014.

UNIT – V: National Policies on Environmental Protection: Current National Environmental Policies relating to protection of air, water, and forest.

RECOMMENDED BOOKS

1. Bell, C.L., Brownell, F.W. et al. (2013). Environmental Law Handbook. 22nd Ed. Bernan Press.
2. Jaswal P.S., *Environmental Law*.
3. Kumar Naresh (1999). Air Pollution and Environment Protection. Mittal Publ.
4. Pal Chandra (1999). Environmental Pollution & Development. Mittal Publications.
5. Paras, D. & Diwan, P. (1992). *Environment Administration, Law and Judicial Attitude: Studies on environment protection, leading cases*. Deep & Deep Publications.
6. Sahasranaman, P.B. (2009). Handbook on Environmental Law. Oxford University Press.
7. Senger, D.S. (2007). Environmental Law. PHI Learning Pvt. Ltd.
8. Singh Gurdip (2005). Environmental Law. Macmillan India.
9. Tiwari, A.K. (2006). Environmental Laws in India: Contribution of the Supreme Court. Deep and Deep Publications.
10. Trivedi, P.R. & Singh U.K. (1994). Environmental Protection & Law. Commonwealth Publisher.

UNIT - I : Introduction to EIA: Definition , scope and development of EIA, purpose, objectives and basic principles of EIA, Types of EIA, Strategic environmental assessment (SEA); History of EIA in India - EIA Gazette Notification, 1994 & 2006 - Category A & Category B Projects, Prior Environment clearance (EC) requirements and stages.

UNIT - II: Screening- criteria, prohibited zones; Scoping: Identification of Valued Environmental Components (VEC), Impact Identification- Checklists, matrices, qualitative methods, networks and overlay maps.

UNIT - III: Prediction and assessment of impacts on water, air, land, biological and socio-cultural environment.

UNIT - IV: Case studies: EIA of thermal power plant, pulp and paper mills, river valley projects, mining projects, urbanization and linear development, Ports and harbour.

UNIT - V: Impact mitigation, monitoring & audit : Mitigation Methods and Approaches, Appraisal, review, Decision making, Public Consultation and Participation, Monitoring and auditing in EIA process, various forms of audit, Environment management plan (EMP) - ISO 14000, Environmental Impact Statement (EIS), Post-clearance Monitoring Protocol; Comparison of EIA in different countries

RECOMMENDED BOOKS

1. Anjanvelu Y. (2002). Environmental Impact Assessment Methodologies, B.S. Publications.
2. Canter, Larry W. (1996). Environment Impact Assessment. McGraw-Hill.
3. Eccleston, C.H. (2011). Environmental Impact Assessment, Taylor & Francis.
4. John Glasson, Riki Therivel and Andrew Chadwick (2005). Introduction to Environmental Impact Assessment, 2nd Ed., UCL Press, Philadelphia, USA
5. Jon C. Lovett, David G. Ockwell (2012). A Handbook of Environmental Management. Edward Elgar, ISBN 1849808252, 9781849808255
6. Lawrence, D. P. (2003). Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons.
7. Peter Wathem (2013). Environmental Impact Assessment: Theory and Practice , Taylor & Francis
8. Petts Judith (2009). Handbook of Environmental Impact Assessment: Volume 2: Impact and Limitations. John Wiley & Sons.
9. Rau, G.J. and C.D. Weeten (1980). Environmental Impact Analysis Handbook McGraw Hill.
10. Shrivastava, A.K. (2003). Environment Impact Assessment. APH Publishing.

UNIT – I : Remote Sensing – Introduction: Introduction to remote sensing, definition, physical basis of remote sensing, electromagnetic spectrum, radiation laws, atmospheric effects, basics of optical, thermal and microwave remote sensing, history of remote sensing, geometric and radiometric aspects of RS data. EMR interaction with earth surface materials, Spectral signatures of vegetation, water, soil, snow etc. in different regions of EMR, ground truth data collection; concepts in photogrammetry.

UNIT – II: Platforms and Sensors: Aerial and space borne platforms, orbits, sensors types – optical (multispectral, hyper-spectral), thermal and microwave, resolutions, Landsat, SPOT, IRS, ERS, Radarsat, RISAT, and other operational remote sensing satellites.

UNIT – III: Data Analysis: Visual interpretation – Scale, maps and map projections, interpretation keys; image characteristics, media and formats of digital images, image enhancement, image transformations, classification – unsupervised and supervised classification, classifiers, statistical reparability, accuracy estimation, change detection, 3-D visualization.

UNIT – IV: Geographical Information System and Satellite based Navigation systems: Introduction, GIS definition and terminology, data types, raster and vector data, GIS database design, spatial database creation – digitization, scanning; processing of data, GIS implementation and project management. Commercially available remote sensing and GIS software.

Satellite based navigation systems (GPS, Gallelio, Glonass, IRNSS): concepts and applications; Map projections and datums, coordinate systems; Survey of India topographical maps types and numbering system.

UNIT – V: Geospatial techniques in Environmental Management: Ecosystem inventory and monitoring – case studies on agriculture, forestry, wetlands, urban planning, snow and glaciers, coastal zone management, protected area management, climate change, air and water pollution; disaster management; remote sensing and GIS in international conventions and protocols (Ramsar, CBD, Kyoto etc).

RECOMMENDED BOOKS

1. Burrough, P.A. (2007). Principles of Geographic Information System. Oxford University Press.
2. Jensen, John R. (2003). Remote Sensing of the Environment. Pearson Education. Singapore.
3. Jensen, John R. (2004). Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall.
4. Jensen, John R. (2009). Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.
5. Joseph L. Awange and Kyalo Kiema (2013). Environmental Geo-informatics – Monitoring, Springer, 541p.
6. Joseph, George (2005). Fundamentals of Remote Sensing, 2nd Edition. University Press India.
7. Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman (2007). Remote Sensing and Image Interpretation. Wiley India.
8. Lo, C.P., and Albert K.W. Yeung (2009). Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.
9. Longley, Paul A., Michael F. Goodchild, David J. Maguire and David W. Rhind (2005). Geographic Information System and Science, 2nd Edition. John Wiley and Sons.
10. Mario A. Gomasasca (2009). Basics of Geomatics, Springer, 656p.
11. Sabins, Floyd F. (2007). Remote Sensing: Principle and Interpretation. Waveland Press.

COURSE XII: Environmental Statistics & Computer Applications [MM : 100]

UNIT – I: An overview of environmental systems, Basic definitions and applications, Generation of environmental data; Types and objectives of environmental studies; Random processes, Stochastic processes in the environment; Significance / relevance of data analysis in environmental management.

UNIT – II: Measures of Central Tendency & Dispersion: Various measures of Central tendency (Mean, Median & Mode) and their Merits & Demerits. Properties of good measures of dispersions, types of measures of dispersions and its merits and demerits.

UNIT – III: Co-relation analysis: Correlation and regression (positive and negative correlation) and calculation of karlpearsons co-efficient of correlation; Linear regression and regression equation, ANOVA (one and two way).

UNIT – IV: Tests of Hypotheses: Null and Alternative Hypothesis; Type I and Type II Errors; Level of significance; Tests of significance (Z-test, T-test F-test for comparison of variance; Goodness-of-fit test; Chi-Square test; Non-parametric tests – Sign test, Wilcoxon Signed Rank test , Kruskal-Wallis test.

UNIT – V: Basics of Computer: Organization and working of a computer; Computer architecture fundamentals; Hardware, types of memory (primary and secondary); Software (windows an operating system); Information types, quality, needs, data processing and computer as a tool; Important features of MS word, MS excel and MS power point.

RECOMMENDED BOOKS

1. Berthouex, P.M. and Brown, L.C. (1994). *Statistical for Environmental Engineers*. Lewis Publishers, CRC Press.
2. Gilbert, R.O. (1987). *Statistical Methods for Environmental Pollution Monitoring*, New York, Van Nostrand Reinhold.
3. Johnson, R.A. (1999). *Miller & Freund's Probability and Statistical for Engineers (5th edn)*.
4. Joseph, A.J. (1997). *Health, Safety and Environmental Data Analysis*, Lewis Pub.: New York.
5. Keith, L.H. (Ed.) (1988). *Principles of Environmental Sampling* ACS Professional References, American Chemical Society.
6. Manly (2001). *Statistics for environmental science and management*. Chapman and Hall/CRC.
7. McBeen, E.A. (1999). *Statistical Procedures for Analysis of Environmental Monitoring Data*.
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