Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/ 3rd Semester
Subject Name: Biodiversity and Conservation, Subject Code: ES-203
(w.e.f. July 2017)

L T P 3 1 0

Unit 1: Introduction to Biodiversity 10

Concept and levels of biodiversity**,** India as a mega diversity nation; Biogeographic zones of the country; Measurement of biodiversity, impact of hydropower development on biological diversity; status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.

Unit 2: Biodiversity patterns 06

Gradient of Biodiversity, Geological distribution of biodiversity. Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluctuations in biodiversity patterns, Barriers and means of disposal.

Unit 3: Importance of biodiversity 08

Economic values–medicinal plants, drugs, fisheries and livelihoods; ecological services – primary productivity, role in hydrological cycle, biogeochemical cycling; ecosystem services – purification of water and air, nutrient cycling, climate control, pest control, pollination, and formation and protection of soil; social, aesthetic, consumptive, and ethical values of biodiversity.

Unit 4: Threats to biodiversity 0 8

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 10

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.

Suggested Readings

- Gaston, K J. & Spicer, J.I. 1998. *Biodiversity: An Introduction.* Blackwell Science, London, UK.
- Krishnamurthy, K.V. 2004. *An Advanced Text Book of Biodiversity - Principles and Practices*. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
- Pandit, M.K. & Grumbine R.E. 2012. Ongoing and proposed hydropower development in the Himalaya and its impact on terrestrial biodiversity. *Conservation Biology* **26**:1061-1071.
- Primack, R.B. 2002. *Essentials of Conservation Biology* (3rd edition). Sinauer Associates, Sunderland, USA.
- Singh, J. S. & Singh, S. P. 1987. Forest vegetation of the Himalaya. *The Botanical Review* **53**: 80-192.
- Singh, J. S., Singh, S.P. & Gupta, S. 2006. *Ecology, Environment and Resource Conservation.* Anamaya Publications, New Delhi.
- Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. *Conservation Biology for All*. Oxford University Press.
- Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. *Conservation Biology: Voices from the Tropics.* Wiley-Blackwell, Oxford, UK.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/3rd Semester
Subject Name: Natural Resource Management and Sustainability, Subject Code: ES-204
(w.e.f. July 2017)

L T P 3 1 0

Unit 1: Introduction **08**

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

Unit 2: Natural resources and conservation **08**

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; food resources: world food problem, techniques to increase world food production, green revolution.

Unit 3: Non-renewable energy resources **08**

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.

Unit 4: Renewable energy resources **08**

Energy efficiency; solar energy: technology, advantages, solar thermal systems, solar cells, JNN solar mission; hydropower: technology, potential, operational costs, benefits of hydropower development; nuclear power: nuclear fission, fusion, reactors, pros and cons of nuclear power, storage of radioactive waste, tidal energy; wave energy; ocean thermal energy conversion (OTEC); geothermal energy; energy from biomass; bio-diesel.

Unit 5: Resource management **08**

Approaches in resource management: ecological approach; economic approach; ethnological approach; integrated resource management strategies; concept of sustainability science: sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.

Suggested Readings

- 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.
- Freeman, A.M. 2001. *Measures of value and Resources: Resources for the Future*. Washington DC.
- Freeman, A.M. 2003. *Millennium Ecosystem Assessment: Conceptual Framework*. Island Press.
- Ginley, D.S. & Cahen, D. 2011. *Fundamentals of Materials for Energy and Environmental Sustainability*. Cambridge University Press.
- Klee, G.A. 1991. *Conservation of Natural Resources*. Prentice Hall Publication.
- Miller, T.G. 2012. *Environmental Science*. Wadsworth Publishing Co.
  Owen, O.S, Chiras, D.D, & Reganold, J.P. 1998. *Natural Resource Conservation* –
- *Management for Sustainable Future* (7th edition). Prentice Hall.
- Ramade, F. 1984. *Ecology of Natural Resources*. John Wiley & Sons Ltd.
- Tiwari, G.N. & Ghosal. M. K. 2005. *Renewable Energy Resources: Basic Principles and Application*. Narosa Publishing House.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/ 3rd Semester
Subject Name: Human-Wildlife Conflict and Management, Subject Code: ES-205
(w.e.f. July 2017)

L T P 3 1 0

Unit 1: Introduction to wildlife management 08

Need of Wildlife management; Reasons of Man -Wild life, Importance of Wild life conservation, Role of government, biologists and social scientists in Wildlife management, concept of deep and shallow ecology.

Unit 2: Evolution of the concept of wildlife management 10

Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetkawall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts, Bishnoi community; understanding wildlife management, conservation and policies regarding protected areas in 21st century .

Unit 3: Wildlife conservation laws in India 08

Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1980; introduction of Tiger task force.

Unit 4: Socio-economic and legal basis of conflicts 08

Concepts of development and encroachment, Impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: luxury hotels within protected areas vs. displacement of native tribes, forest produce as a need vs. forest exploitation, introduction to tribal rights in India, importance of forest produce to tribal populations, Scheduled tribes and other traditional Forest dwellers (Recognition of forest right) Act, 2006.

Unit 5: Wildlife conflicts 6

Insight into the important conflicts: Keoladeo National park conflict of Bharatpur, Human and Elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest, shifting cultivation in North east India.

Suggested Readings

- Conover, M. 2001. *Resolving Human Wildlife Conflicts*, CRC Press.
- Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation* **13:** 458-466.
- Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. *International Biodeterioration & Biodegradation* **45**: 97-102.
- Paty, C. 2007. *Forest Government and Tribe*. Concept Publishing Company.
- Treves, A. & Karanth, K. U. 2003. Human---carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology* **17**: 1491-1499.
- Woodroffe, R. 2005. *People and Wildlife: Conflict and Coexistence*. Cambridge.
- Woodroffe, R., Thirgood, S., & Rabinowitz, A. 2005. *People and Wildlife, Conflict or Coexistence?* (No. 9). Cambridge University Press

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/ 3rd Semester
Subject Name: Environmental Pollution and Human Health, Subject Code: ES-206
(w.e.f. July 2017)

L T P 3 1 0

Unit 1: Introduction to Environmental Pollution 04

Environmental pollution, types of environmental pollutant, basis and challenges of environmental pollution

Unit 2: Air pollution and Water Pollution 10

Natural and anthropogenic sources of air pollution, ambient air quality, air quality index, effects of different air pollutants on human health (NOx, SOx, PM, CO, CO2, hydrocarbons and VOCs) and control measures, Sources of surface and ground water pollution, water quality parameters and standards, effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides), water borne diseases.

Unit 3: Soil Pollution and Noise Pollution 08

Causes of soil pollution and degradation, effect of soil pollution on environment, vegetation and other life forms; control strategies, soil microorganisms and their functions, degradation of different insecticides, fungicides and weedicides in soil, Noise pollution: sources, frequency, intensity and permissible ambient noise levels, effect on communication, impacts on life forms working efficiency, physical and mental health and control measures.

Unit 4: Radioactive and thermal pollution 08

Radioactive material and sources of radioactive pollution, effect of radiation on human health (somatic and genetic effects) control of radiation pollution thermal pollution: causes, effects and control measures of thermal pollution.

Unit 5: Pollution control 10

Activated Sludge Process (ASP), Trickling Filters, oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, ETP sludge management, digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters, regulatory framework for pollution monitoring and control, case study: ganga action plan; yamuna action plan; implementation of CNG in NCT of Delhi.

Suggested Readings

- Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. *Air Pollution: Health and Environmental Impacts*. CRC Press, Taylor & Francis.
- Hester, R.E. & Harrison, R.M. 1998. *Air Pollution and Health*. The Royal Society of Chemistry, UK.
- Park, K. 2015. *Park's Textbook of Preventive and Social Medicine* (23rd edition). Banarsidas Bhanot Publishers.
- Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. *Environmental and Pollution Science*.

Elsevier Academic Press.
- Purohit, S.S. & Ranjan, R. 2007. *Ecology, Environment & Pollution*. Agrobios Publications.
- Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. *Environmental Pollution and Control*. Butterworth-Heinemann, USA.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/ 3rd Semester
Subject Name: Environmental Impact and Risk Assessment, Subject Code: ES-207
(w.e.f. July 2017)

L T P 3 1 0

Unit 1 Introduction to EIA **08**

Environmental impact assessment (EIA): 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).

Unit 2 Methods of EIA **08**

Rapid EIA; 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 ISO 14000; sustainable development.

Unit 3 Status of EIA in India **08**

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

Unit 4 Impact Assessment **08**

Risk assessment: 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 EIA of major development projects & Environmental auditing

Transportation - River valley Projects – Irrigation and dams - Mining and quarrying - Oil refinery - Thermal Power Project - Cement Industries – *Environmental Auditing*: Scope, Objectives and Procedures for environmental auditing **08**

Suggested Readings

- Barrow, C.J. 2000. *Social Impact Assessment: An Introduction.* Oxford University Press.
- Glasson, J., Therivel, R., Chadwick, A. 1994. *Introduction to Environmental Impact Assessment*. London, Research Press, UK.
- Judith, P. 1999. *Handbook of Environmental Impact Assessment*. Blackwell Science.
- Marriott, B. 1997. *Environmental Impact Assessment: A Practical Guide*. McGraw-Hill, New York, USA

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/ 3rd Semester
Subject Name: Watershed Management, Subject Code: ES-208
(w.e.f. July 2017)

L T P 3 1 0

Unit 1 Introduction and Basic Concepts 08

Introduction to watershed management, Concept of watershed, Characteristics of Watershed: size, shape, physiography, slope, drainage, land use, vegetation, geology and soils, hydrology a hydro geology, socio-economic characteristics.

Unit 2 Watershed Modelling 08

Water quality and pollution, types and sources of pollution, environmental guidelines for water quality. Standard modelling approaches and classification, system concept for watershed modelling, overall description of different hydrologic processes, modeling of rainfall runoff process, subsurface flows and groundwater flow.

Unit 3 Soil Erosion & Its Modelling 08

Principles of Erosion: Types of erosion, factors affecting erosion, effects of erosion on land fertility and land capability, Measures to Control Erosion: Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control.

Unit 4 Watershed Management In India 08

History of watershed management programme in India, Need for watershed development in India, Case study of successful watershed management programmes in India**,** Watershed management policies and decision making, National Watershed Development Project for Rainfed Areas (NWDPRA).

Unit 5 Storm Water, Flood, Drought and Integrated Watershed Management 08

Storm Water Management, Case Studies of Flood Damage. Drought Assessment techniques, Drought Mitigation Planning. Introduction to Integrated Approach, Conjunctive Use Of Water Resources, Rainwater Harvesting.

REFERENCES:

- "Watershed management: Guidelines for Indian Conditions" By E.M. Tideman, Omega Scientific Publishers.
- "Hydrology and Soil Conservation Engineering" By Ghanshyam Das, Prentice Hall India.
- "Watershed Planning & Management" By - Dr. Rajvir Singh, Yash Pulishing House.
- "Watersheds - Processes, Assessment and Management" By - Pau A. Debarry, John Wiley & Sons.
- "Watershed Models" By V.P. Singh & Donald K. Frevert, Taylor & Francis. A joint venture by IISc and IITs, funded by MHRD, Govt of India

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/4th Semester
Subject Name: Biodiversity and Environment Lab, Subject Code: ES-209
(w.e.f. July 2017)

Experiment:

1. To study the vegetation of given area by physiognomic method.
2. To study the effects of gaseous air pollutants on the morphology organism in a polluted area.
3. To study the medicinal properties of the given flora.
4. Study the various types of soil erosions and their prevention techniques in your area.
5. Prepare a working model on watershed management technique.
6. Study of Phytoremediation of metal in a soil sample.
7. Study of Conversion of Agricultural waste into Compost
8. Study of Conversion of Agricultural waste into Vermicompost
9. Case Study of Man –WildLife Conflict
10. Case Study of Bishnoi Tribe Efforts for Conservation of Biodiversity
11. Collection of Forest Produce & explain its Significance.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/4th Semester
Subject Name: Environmental Legislation and Policy, Subject Code: ES-210
(w.e.f. July 2017)

L T P 3 1 0

Unit 1 History of environmental legislation and policy 08

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 2 Environmental legislation 10
(Study the basic introduction of these Acts and its application)

Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Forests (Conservation) Act 1980; Air (Prevention and Control of Pollution) Act 1981; Environment (Protection) Act 1986; Noise Pollution (Regulation and Control) Rules 2000; Biological Diversity Act 2002, National Green Tribunal Act; 2010.

Unit 3 Government institutions 06

Role of Ministry of Environment, Forests & Climate Change in environmental law and policy making; role of central and state pollution control boards in environmental law and policy making.

Unit 4 Case studies 06

National Green Tribunal Act 2010: Case Study; 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 10

Stockholm Conference 1972, MARPOL (1973), CITES (1973), Montreal Protocol 1987, Convention on Biological Diversity (1992); United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21);; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention.

Suggested Readings

- Abraham, C.M. 1999. *Environmental Jurisprudence in India*. Kluwer Law International.
- Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. *Bulletin of the National Institute of Ecology* **15**: 227-238.
- Divan, S. & Rosencranz, A. 2001. *Environmental Law and Policy in India*. Oxford University Press.

- Divan, S. & Rosencranz, A. 2002. *Environmental Law and Policy in India: Cases, Materials and Statues* (2nd edition). Oxford University Press.
- Gupta, K.R. 2006. *Environmental Legislation in India*. Atlantic Publishers and Distributors.
- Leelakrishnan, P. 2008. *Environmental Law in India* (3rd edition). LexisNexis India.
- Naseem, M. 2011. *Environmental Law in India Mohammad*. Kluwer Law International.
- Venkat, A. 2011. *Environmental Law and Policy*. PHI Learning Private Ltd.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/4th Semester
Subject Name: Environmental Health, Accounting & Auditing, Subject Code: ES-211
(w.e.f. July 2017)

L T P 3 1 0

Unit-1 Environmental Health **08**

Concept of health and disease, principles of epidemiology and epidemiological methods - aims of epidemiology; measurement of mortality, measurement of morbidity.

Unit-2 Environmental Diseases **08**

Some communicable diseases - small pox, acute diarrheal disease, viral hepatitis, water-borne pathogens, diseases caused by contaminated food and water, soil-borne infections, insect-borne diseases ; immunology - elementary idea about antigens and antibody.

Unit-3 Health Programs **08**

Health Programs in India (NRHM), demography and family planning; nutrition and health, communication and awareness for health and education, health care of the country.

Unit 4 Environmental Accounting **08**

Environmental accounting, objectives of environmental accounting, methods of Environmental accounting, financial accounting, social accounting.

Unit-5 Environmental Auditing **08**

Overview of environmental audit, eco-management and audit scheme; typical audit programme, benefits of environmental auditing; environmental audit programme in India; ICC basic steps of an Environmental audit.

Suggested Books

- Agrawal, Sikdar and Deb (2002): A Text book of Environment; MacMillan
- Fischer (1984): Resources and Environment Economics, CUP
- Dasgupta (1982): The Control of Resources; Basil Blackwell
- Georgeacus-Roger (1971): The Entropy Law and Economic Process; HUP
- Concard and Clerk (1987): Natural Resources Economics; CUP
- Pearce and Turner (1991): The Economics of Natural Resource and Environment, Harvester & Wheatsheaf
- Dasgupta and Heal (1979): Economic Theory of Exhaustible Resources; CUP
- Kneese & Sweeny (1993): Handbook of natural Resource and Energy Economics/3 Volumes; North-Holland
- Crooper & Dates (1992): Environmental Economics: A survey/OEL
- Dorfman & Dorfman (1994): Economics of Environment/3
- Parikh (1993): Natural Resources Accounting: A Framework for India
- Botkin & Keller (1998): Environmental Science: Earth as a Living Planet; John Wiley & Sons.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/4th Semester
Subject Name: Environmental Methods and Analytical Techniques, Subject Code: ES-212
(w.e.f. July 2017)

L T P 3 1 0

Unit 1: Soil analysis **08**

Collection and preservation, analysis of particle size, water holding capacity, temperature, pH, conductivity, exchangeable calcium and Magnesium, sodium and potassium, available phosphorus, nitrogen, alkalinity, chlorides, sulphates, organic matter.

Unit 2: **Ecological Instrumentation** **08**

Humidity measurement, rainfall measurement, pH meter, calorimeter, UV-visible spectrophotometer, atomic absorption spectrophotometer and high performance liquid chromatography (HPLC).

Unit 3: **Principle and techniques of instrumentation used for environmental toxicology studies**: **08**

Thin layer chromatography & paper Electrophoresis, spectrophotometry, spectroscopy, Gas chromatography.

Unit 4: **Water analysis** **08**

Appearance, color, turbidity, odor, taste, Acidity Alkalinity, Hardness, pH, conductivity, salinity and temperature, Heavy Metals: calcium, magnesium, chloride, sulphate, sodium and potassium.

Unit 5: **Air Analysis** **08**

Classification & properties, emission sources- particulates, hydrocarbons, oxides of carbon sulphur and nitrogen, photochemical smog. Sampling methods and analytical gadgets and control measures.

Suggested Readings:

- Chapin, F.S., Matson, P.A. and Mooney, H.A. 2002. *Principles of Terrestrial Ecosystem Ecology*. Springer-Verlag, New York
- Clark, R.N. 1999. *Spectroscopy of Rocks and Minerals, and Principles of Spectroscopy*. U.S. Geological Survey, Denver
- John Wainwright and Mark Mulligan (Eds).2004.Environmental Modelling: Finding Simplicity in Complexity. John Wiley & Sons Inc., New York.
- Manahan, S.E. 2000. *Environmental Chemistry*. Seventh Edition. Lewis Publishers, NY
- Odum, E.P. (1971), Fundamentals of Ecology: Saunders, Philadelphia.
- Pierzynski, G.M., Sims, J.T. and Vance, G.F. 2000. *Soils and Environmental Quality*. Second Edition. CRC press, New York.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/4th Semester
Subject Name: Introduction to Environmental Biotechnology, Subject Code: ES-213
(w.e.f. July 2017)

L T P 3 1 0

Unit-1 Introduction to Biotechnology **08**

Concept of environmental biotechnology, Biodegradation of Xenobiotics, Vermicomposting. Bioremediation of metal contaminated soils, spilled oil and grease deposits and synthetic pesticides, Biosensors to detect environmental pollutants, Extremophiles.

Unit-2 Principles of Genetic Engineering **08**

Basic concepts of genetic engineering of plants and its applications-herbicide and stress tolerant plant. Biotechnological strategies in forestry and wasteland management. Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA banks.

Unit-3 Techniques of Genetic Engineering **08**

Basic techniques in genetic engineering: Genetic manipulation, Restriction endonucleases, Introduction of cloned genes into new hosts using plasmid and phage vector systems. RFLP, Polymerase chain reaction. Environmental genomics/metagenomics-a general account. Microbes and environmental management.

Unit-4 Application of Biotechnology **08**

Bioenergy, ethanol fermentation. Liquid waste treatment, Biofilters, activated sludge systems; membrane bioreactors, Biotechnological approaches for solid waste management, Phytotechnology- terrestrial phytosystems, metal phytoremediation. Phytotechnology-aquatic phytosystems, nutrient film techniques, algal treatment systems.

Unit-5 Future aspects of Biotechnology **08**

The future and Scope of Biotechnology, Biophysics in Biological Sciences, Current advancement in Toxicology, Clinical industry, Bio nanotechnology, Clinical Data Management and clinical Trials, Genetically modified organisms and Biosafety- a general account.

Suggested Readings

- *Evans, G.M. and Furlong J.C. 2003.* Environmental Biotechnology: Theory and
- Application. *John Wiley and Sons.*
- *Glick, B.R. and Pasternak J.J. 2007.* Molecular Biotechnology: Principles and
- Applications of Recombinant DNA. *Washington, D.C. ASN Press.*
- *Horton, H.R., Moran L.A., Perry M.D. and Rawn J.D. 2006.* Principles of
- Biochemistry, *Pearson Education International.*
- *Manahan, S.E. 1997.* Environmental Science and Technology. *Lewis, New York.*
- *Metcalf and Eddy (Eds).2003.* Wastewater Engineering: Treatment and Reuse.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/4th Semester
Subject Name: Green Technologies, Subject Code: ES-214
(w.e.f. July 2017)

L T P 3 1 0

Unit 1: Introduction **06**

Introduction to green science and green technology, branches of Green Technology, 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 **06**

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

Unit 3: **Green infrastructure, planning and economy** **10**

Green buildings, concept of green building, history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings, outlined examples of green buildings; LEED certified building, Eco-mark certification, establishment of Eco-mark in India, its importance and implementation, Green planning: role of governmental bodies, land use planning, concept of green cities, famous Green Buildings.

Unit 4: **Green chemistry** **08**

Introduction to green chemistry, principles and recognition of green criteria in chemistry, biodegradable and bio-accumulative products in environment, green nanotechnology, reagents, reactions and technologies that should be and realistically could be replaced by green alternatives, photodegradable plastic bags.

Unit 5: Green future **10**

Agenda of green development, reduction of ecological footprint, role of green technologies towards a sustainable future, major challenges and their resolution for implementation of green technologies, green practices to conserve natural resources (organic agriculture, agro forestry, reducing paper usage and consumption, etc.), emphasis on waste reduction instead of recycling, emphasis on innovation for green future, green laws compliance.

Suggested Readings

- Anastas, P.T. & Warner, J.C. 1998. *Green Chemistry:Theory & Practice*. Oxford Univ Press.
- Arceivala, S.L. 2014. *Green Technologies: For a Better Future*. Mc-Graw Hill Publications.
- Baker, S. 2006. *Sustainable Development*. Routledge Press.
- Hrubovcak, J., Vasavada, U. & Aldy, J. E. 1999. *Green technologies for a more sustainable agriculture* (No. 33721). United States Department of Agriculture, Economic Research Service.
- Thangavel, P. & Sridevi, G. 2015. *Environmental Sustainability: Role of Green Technologies*. Springer Publications.
- Woolley, T. & Kimmins, S. 2002. *Green Building Handbook* (Volume 1 and 2). Spon Press.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/4th Semester
Subject Name: Natural Hazards and Disaster Management, Subject Code: ES-215
(w.e.f. July 2017)

L T P 3 1 0

Unit 1: Introduction **08**

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 and Anthropogenic hazards **08**

Natural hazards: hydrological, atmospheric & geological hazards; earthquake: volcanoes, floods, landslides, drought, cyclone & hurricanes, tsunamis **,** Impacts of anthropogenic activities such as rapid urbanization, deforestation, mangroves destruction, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.

Unit 3: Risk and vulnerability assessment **08**

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 **08**

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 **08**

Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster and Bhopal tragedy; 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.

Suggested Readings

- Coppola D. P. 2007. *Introduction to International Disaster Management*. Butterworth Heinemann.
- Cutter, S.L. 2012. *Hazards Vulnerability and Environmental Justice*. EarthScan, Routledge Press.
- Keller, E. A. 1996. *Introduction to Environmental Geology*. Prentice Hall, Upper Saddle

River, New Jersey.
- Pine, J.C. 2009. *Natural Hazards Analysis: Reducing the Impact of Disasters*. CRC Press, Taylor and Francis Group.
- Schneid, T.D. & Collins, L. 2001. *Disaster Management and Preparedness*. Lewis Publishers, New York, NY.
- Smith, K. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge Press.
- Wallace, J.M. & Hobbs, P.V. 1977. *Atmospheric Science: An Introductory Survey*. Academic Press, New York.
- Wasson, R.J., Sundriyal, Y.P., Chaudhary, S., Jaiswal, M.K., Morthekai, P., Sati, S.P.& Juyal, N. 2013. A 1000-year history of large floods in the upper Ganga catchment, central Himalaya, India. *Quaternary Science Reviews* **77**: 156–166.

Integral University, Lucknow
Department of Environmental Science
B.Sc. (Hons.) Environmental Science, 2nd Year/ 4th Semester Subject
Name: Green Technology Lab, Subject Code: ES-216

L	T	P
0	0	8

List of Experiments:

1. Demonstration of composting techniques.
2. Demonstration of working of an atomic absorption spectrophotometer for detecting heavy Metals
3. Preparation of Hazard zone map of India for landslides, earthquakes, floods etc.
4. Visit to waste water treatment plants.
5. Visit to industry for a survey of air pollution control equipments.
6. Measurement of noise level using sound level meter.
7. To study the NPK of Soil Samples by using soil testing kit.

Suggested Books:

- Rao M.N. and H.V.N. Rao, 1989 : Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi
- Misra, R. 1968. Ecology workbook Oxford and IBH Publishing Co., New Delhi.
- Anderson, J.M. and J.S.I, Ingram 1993, Tropical soil biogas and fertility: A handbook of method, CAB International, Wailing ford, U.K.
- Khopkar S.M., 1993: Environment Pollution Analysis, Eastern Limited, New York.
