Appendix-6
Resolution No. 27 {27-1 (27-1-1)}

DEPARTMENT OF ENVIRONMENTAL STUDIES
SEMESTER-V

COURSES OFFERED BY DEPARTMENT OF ENVIRONMENTAL SCIENCE

Category-I

Environmental Science Courses for Undergraduate Programme of study with Environmental Science as a Single Core Discipline

BSC (H) ENVIRONMENTAL SCIENCE

DISCIPLINE SPECIFIC CORE COURSE – 13 (DSC-EVS-13): BIODIVERSITY AND CONSERVATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-EVS-13: BIODIVERSITY AND CONSERVATION	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Provide fundamental principles of origin and distribution of biodiversity and its conservation
- Examine major threats to biodiversity and their impacts on ecosystems and human well-being
- Investigate the methods and strategies for conserving biodiversity, including protected areas, and sustainable management practices.
- Develop critical thinking skills and to apply scientific principles to the analysis of biodiversity and conservation issues
- Appreciate the paradigm “think globally, act locally” for a sustainable common future of humankind

Learning outcomes

After this course, students will be able to:

- Assess biodiversity and determine its significance for ecological processes
- Explain the underlying factors of generating biodiversity on Earth
- Analyze major threats to biodiversity and its links with human well-being.
- Apply scientific principles to the analysis of biodiversity and conservation issues and evaluate the methods and strategies for conserving biodiversity

- Communicate effectively about biodiversity and conservation issues to both scientific and non-scientific audiences.

SYLLABUS OF DSC-EVS-13

Theory (02 Credits: 30 lectures)

UNIT – I Levels of biological organization and biodiversity patterns (2½ Week) (5 lectures)
From genes to ecosystems; tree of life; history of character transformation; organic evolution through geographic time scale; species concept – what's in a name?; how many species are there on earth?; concept and types of speciation.

Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluctuations in biodiversity patterns; importance of biodiversity patterns in conservation.

UNIT – II Biodiversity estimation (2½ Week) (5 lectures)
Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity; molecular techniques: RAPD, RFLP, AFLP; NCBI database, BLAST analyses.

UNIT – III Importance of biodiversity (2 Week) (4 lectures)
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 – IV Threats to biodiversity (2½ Week) (5 lectures)
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 – V Conservation of Biodiversity (3½ Week) (6 lectures)
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; ecological restoration; afforestation; social forestry; agro forestry; joint forest management; role of remote sensing in management of natural resources; Conservation planning.

UNIT – VI Biodiversity in India (2½Week) (5 lectures)
India as a mega diversity nation; phytogeographic and zoogeographic zones of the country; forest types and forest cover in India; fish and fisheries of India; impact of hydropower development on biological diversity; status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Practice and learn different field survey methods to assess and monitor biodiversity
2. Field trip to a local conservation area to assess the plant and animal diversity
3. Identify threatened and endangered species in a given
4. Assess variations in biodiversity with different types of ecosystems around
5. Estimate biodiversity indices and comparison of biodiversity levels in different locations
6. Determine magnitude of infestation of invasive species and their possible impacts on native species in a given ecosystem
7. Identify and investigate pollinators of selected plant species in a given ecosystem
8. Study the effects of habitat fragmentation or degradation on population of selected species
9. Analyze the conservation strategies and their effectiveness in protecting biodiversity in given natural and restored ecosystems
10. Identify and document economically important species in a given ecosystem
11. Undertake field trip to a local garden/ecosystem to observe different plant species and their adaptations to their environment
12. Analyse the effects of land use change on biodiversity of a given area
13. Investigate the coexistence or competition among species in a given area and based on literature suggest the possible underlying biotic interactions
14. Develop conservation planning for target species and make informed decisions for biodiversity conservation.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Essential/recommended readings

- Primack, R.B. (2017). Essentials of Conservation Biology (Sixth Edition). Sinauer Associates.
- Gaston, K.J. (2016). Biodiversity: An Introduction (Third Edition). Wiley-Blackwell.
- Wilson, E.O. (2016). Half-Earth: Our Planet's Fight for Life. Liveright Publishing Corporation.
- Kareiva, P., & Marvier, M. (2017). Conservation Science: Balancing the Needs of People and Nature (Second Edition). Roberts and Company Publishers.
- Koh, L.P., & Wilcove, D.S. (2016). Conservation for a New Era: Integrated Conservation Science for the 21st Century. Oxford University Press.

Suggestive readings

- Lovejoy, T.E. (2019). Biodiversity and Climate Change: Transforming the Biosphere. Yale University Press.
- Pimm, S.L. (2018). The Value of Everything: How to Save the World by Making it

Wealthier. PublicAffairs.
- Simberloff, D. (2013). The Ecology of Invasions by Animals and Plants. University of Chicago Press.
- Tallis, H. (2018). The Nature of Conservation: A Race Against Time. Island Press.
- Wilson, E.O. (2016). Half-Earth: Our Planet's Fight for Life. Liveright Publishing Corporation.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 14 (DSC-EVS-14): ORGANISMAL & EVOLUTIONARY BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-EVS-14: ORGANISMAL & EVOLUTIONARY BIOLOGY	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into principles of evolution and its significance in shaping biological diversity on Earth
- Familiar with classification of organisms from different domains of life and their unique structure and function
- Equip with scientific methods to investigate and understand nuances of organismal and evolutionary biology
- Appreciate the linkages among ecology, conservation biology, and evolutionary biology

Learning outcomes

After this course, students will be able to

- Explain the ecological and molecular processes contributing to evolution, including natural selection, genetic drift, gene flow, and mutation
- Identify and characterize organisms belonging to different domains of life based on their major characteristics and functions
- Design and conduct experiments for better understanding on organismal and evolutionary biology
- Evolve better strategies for biodiversity conservation and improving ecosystem health while taking into account their evolutionary biology

SYLLABUS OF DSC-EVS-14

Theory (02 Credits: 30 lectures)

UNIT – I History of life on Earth and theory of evolution (3½ Week) (7 lectures)
Paleontology and evolutionary History; evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multi cellular organisms; major groups of plants and animals; stages in primate evolution

including Homo.

Lamarck's concept of evolution; Darwin's Evolutionary Theory: variation, adaptation, struggle, fitness, and natural selection; Mendelism; spontaneity of mutations; The Evolutionary Synthesis.

UNIT – II Evolution of unicellular life (2½ Week) (5 lectures)
Origin of cells and unicellular evolution and basic biological molecules; abiotic synthesis of organic monomers and polymers; Oparin-Haldane hypothesis; study of Miller; the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT – III Evolution of multicellular organisms (2½ Week) (5 lectures)
Origin of multicellularity, Cellular differentiation and specialization, Developmental biology and body plans, Evolution of cell-to-cell communication, Emergence of tissues and organs, Evolution of organ systems, Evolution of life cycles and reproductive strategies, Evolution of multicellular organisms (protists, plants and animals) and their ecological interactions

UNIT – IV Geography of evolution (1½ Week) (3 lectures)
Biogeographic evidence of evolution; patterns of distribution; historical factors affecting geographic distribution; evolution of geographic patterns of diversity.

UNIT – V Molecular evolution (2 Week) (4 lectures)
Neutral evolution; molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.

UNIT – VI Fundamentals of population genetics (3 Week) (6 lectures)
Concepts of populations, gene pool, gene frequency; concepts and rate of change in gene frequency through natural selection, migration and genetic drift; adaptive radiation; isolating mechanisms; speciation (allopatric, sympatric, peripatric and parapatric); convergent evolution; sexual selection; co- evolution; Hardy-Weinberg Law.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Analyze effects of pH on the toxicity of heavy metals on model organism, such as Daphnia

2-3. Determine toxicity of varying concentration of industrial effluent on common alga and measure its growth and survival rates

4-5. Effects of heavy metal toxicity on plant growth, focussing on different plant parts and physiological characteristics

6. Analyze effects of climate change on diversity of pollinators
7. Determine the impacts of environmental chemicals on the abundance and diversity of nematodes (e.g., *Caenorhabditis elegans*)
8. Ascertain the possible impacts of herbicides on weed populations
9. Test the effects of a target organic contaminant on behaviour and mortality of earthworm

10-11. Measure developmental abnormalities in zebrafish embryos due to toxicity of target environmental chemicals

12-13. Prepare and characterize nanoparticles of selected heavy metal and assess effect of nanoparticles on plant growth

15. Effects of various concentrations of road salt on freshwater organisms (e.g., zooplankton) and measure changes in their behavior and survival

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Futuyma, D. J., & Kirkpatrick, M. (2017). Evolution (4th ed.). Sunderland, MA: Sinauer Associates.
- Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). Brock Biology of Microorganisms (15th ed.). London, UK: Pearson.
- Primack, R. B., & Rodricks, R. V. (2021). Essentials of Conservation Biology (7th ed.). Sunderland, MA: Sinauer Associates.
- Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2022). Biology of Plants (9th ed.). New York, NY: W. H. Freeman.
- Sodhi, N. S., Gibson, L., & Raven, P. H. (2021). Conservation Biology for All. Oxford, UK: Oxford University Press.
- Stearns, S. C., & Hoekstra, R. F. (2021). Evolution: An Introduction (3rd ed.). Oxford, UK: Oxford University Press.
- Zimmer, C., & Emlen, D. J. (2021). Evolution: Making Sense of Life. New York, NY: Macmillan Learning.

Suggestive readings

- Deacon, J. (2019). Fungal Biology (5th ed.). Hoboken, NJ: John Wiley & Sons.
- Haviland, W. A., Prins, H. E. L., Walrath, D., & McBride, B. (2021). Evolution and Prehistory: The Human Challenge (11th ed.). Boston, MA: Cengage Learning.
- Herron, J. C., & Freeman, S. (2020). Evolutionary Analysis (6th ed.). Hoboken, NJ: Pearson.

- Pough, F. H., Janis, C. M., & Heiser, J. B. (2018). Vertebrate Life (10th ed.). London, UK: Pearson.
- Raven, P. H., Johnson, G. B., Mason, K. A., Losos, J. B., & Singer, S. R. (2021). Biology (12th ed.). New York, NY: McGraw-Hill Education.
- Ruppert, E. E., Fox, R. S., & Barnes, R. D. (2021). Invertebrate Zoology: A Functional Evolutionary Approach. Boston, MA: Cengage Learning.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 15 (DSC-EVS-15): NATURAL RESOURCES MANAGEMENT & SUSTAINABILITY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-EVS-15: NATURAL RESOURCES MANAGEMENT & SUSTAINABILITY	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into the principles and practices of natural resources management and sustainability
- Understand critical linkages among social, economic, and environmental issues related to natural resources management and sustainability
- Impart analytical and critical thinking skills related to natural resources management and sustainability
- Equip students with the knowledge and skills necessary to develop and implement sustainable solutions to natural resource management challenges
- Prepare students for careers in natural resource management, environmental policy, sustainability, and related fields

Learning outcomes

After this course, students will be able to

- Analyze the socio-economic, and environmental issues related to natural resource management
- Explain the key principles and practices of natural resource management and sustainability.
- Evaluate the effectiveness of natural resource management and sustainability policies and practices and develop sustainable solutions
- Communicate effectively about natural resource management and sustainability issues to a variety of audiences.
- Assess the environmental impacts of natural resource management and sustainability practices and apply ecological, economic an ethical principle to natural resource management and sustainability issues

- Pursue careers in natural resource management, environmental policy, sustainability, and related fields.

SYLLABUS OF DSC-EVS-15

Theory (02 Credits: 30 lectures)

UNIT – I Natural resources and reserves and their management (3½ Weeks) (7 lectures)

Classification of natural resources, Renewable and non-renewable resources, Land resources; Soil resources, Forest resources, food resources, Water resources; Fisheries and other marine resources; energy resources; mineral resources; resource availability and factors influencing its availability; human impact on natural resources; Resource degradation; Resource conservation; Concept of natural resource management, Relationship between natural resource management and sustainability, Stakeholders and natural resource management, Social and economic dimension of resource management, Role of science and technology in natural resource management, Sustainable Development Goals (SDGs) and natural resources.

UNIT –II Land Use and Management (2 Weeks) (4 lectures)

Land use and land cover change, Land use planning and management, Land degradation and desertification, Soil conservation and management, Agroforestry and sustainable agriculture, Urbanization and land use, Land tights, Land use conflict and resolution

UNIT – III Mineral resources (3 Weeks) (6 lectures)

Mineral resources: definition, types, rock cycle, significance in society and importance economic development, Mineral extraction and processing: types of mining, techniques, methods, waste management, and social and environmental impacts, Global consumption patterns of mineral resources, techniques to increase mineral resource supplies; ocean mining for mineral resources, Mineral markets and economics, Mineral governance and policy, Sustainable mineral resource management, Future of mineral resources

UNIT – IV Non-renewable and renewable energy resources (3½ Weeks) (7 lectures)

Oil, coal natural gas liquified natural gas: formation, reserve, exploration, extraction and processing, and consumption; Environmental and economic impacts of non-renewable energy consumption;

Solar energy, hydropower, geothermal energy, tidal energy, wave energy, ocean thermal energy, nuclear power, biomass and biofuel: technology, potential, operational costs, advantages, challenges, innovation and future; Radioactive contamination; Application of green technology; India’s efforts and its global impacts on solar mission, Indian renewable energy programme, Future energy options and challenges.

UNIT – V Resource management for sustainability (3 Weeks) (6 lectures)

Approaches in Resource Management: ecological, economic, and ethnological, Implications of integrated resource management; Climate Change and Energy Management: energy sources, efficiency and conservation, carbon capture and storage;

Urban Ecosystems: energy efficiency, transportation, industry, and reduction in greenhouse gas emissions; Energy policy and governance.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Identify, classify and assess the status of different tree species in a given ecosystems and recommend appropriate management strategies
2. Investigate the effects of different land management practices on soil erosion to understand how to prevent soil degradation and protect natural resources
3. Test the water quality of given water samples collected from two water bodies and suggest appropriate management practices
4. Survey and document the socio-economic and ecological importance of plant species sampled from a local ecosystem
5. Assess the current status of plant species prioritized in practical 4 and recommend the appropriate conservation and management practices
6. Calculate and interpret the ecological footprint of a community or organization using the Ecological Footprint Standards.
7. Conduct energy audits of buildings or facilities using standard methods such as the ASHRAE Level I, II, or III Energy Audits.
8. Analyze stakeholders to identify and engage with key stakeholders in natural resources management and sustainability.
9. Conduct life cycle assessment of products or processes using standard methods such as the ISO 14040/14044 standards
10. Document agricultural research priorities of India and comment on its importance as sustainable agricultural practices for natural resource management and food security
11. Develop and implement a sustainable plan for water resource management of your institute
12. Assess the environmental impacts of mining activities in India during past 10 years and identify the shift in trend, if any
13. Analyze mineral/energy resource policies in a national or global context to understand the importance of sustainable mineral resource management.
14. Extract bioenergy from organic waste or crops to understand the importance of renewable energy sources and their management.

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Cleveland, C. J. (2018). Biophysical economics: From physiocracy to ecological economics and industrial ecology. Routledge.
- Folke, C., Österblom, H., Jouffray, J. B., Lambin, E. F., & Adger, W. N. (Eds.). (2020). For ocean sustainability: Challenges, opportunities, and the role of science-policy interaction. Cambridge University Press.
- Mitchell, B. (2019). Resource efficiency and sustainable production: A handbook for achieving sustainability in manufacturing. Springer.
- Reed, M. G. (2021). Environmental and natural resource economics: A contemporary approach. Routledge.
- Varghese, J. (2019). Resource management for sustainable development. Springer.

Suggestive readings

- Agyeman, J. (Ed.). (2020). Sustainability: A handbook for management and leadership. Routledge.
- Daly, H. E. (Ed.). (2017). Valuing the Earth: Economics, ecology, ethics. MIT Press.
- Norton, B. G. (2018). Sustainability: A philosophy of adaptive ecosystem management. University of Chicago Press.
- Westman, W. E. (Ed.). (2018). How much is enough? Shaping the defense program, 1961-1969. Routledge.
- Wright, T. (2020). Sustainable communities and urban housing: A comparative analysis of self-help housing practices in the United States and Mexico. Routledge.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-05): WATERSHED MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-05: WATERSHED MANAGEMENT	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Familiarize with the concepts of watershed management and its relevance in ecological balance
- Gain insights into various physico-chemical, and biological processes related to watersheds and its impact on water quality and quantity
- Empower with tools and methods widely used in watershed management, such as remote sensing and GIS
- Understand the legal and regulatory frameworks governing watershed management at different levels (local, state, and national)

Learning outcomes

After the course, the students will be able to

- Explain the concept of a watershed and its importance in maintaining ecological balance
- Describe the various physical, chemical, and biological processes occurring in watersheds and their impact on water quality and quantity
- Use remote sensing, GIS, and modeling tools to analyze and manage watersheds.
- Identify and explain the legal and regulatory frameworks governing watershed management at the local, state, and national levels
- Evaluate the effectiveness of a watershed management plan through critical analysis of case studies and practical exercises
- Critically evaluate case studies in watershed management to understand challenges and opportunities in the field

SYLLABUS OF DSE-EVS-05

Theory (02 Credits: 30 lectures)

UNIT – I Watershed Management Basics (2½ Weeks) (05 lectures)
Watershed: definition, and characteristics: Watershed Management: approaches, principles, planning, importance, institutional and legal framework, role in sustainable development, and challenges and opportunities

UNIT – II Watershed Hydrology (2 Weeks) (04 lectures)
Precipitation and its measurement, Evaporation and transpiration, Infiltration and percolation, Runoff generation and calculation, Streamflow and stream gauging, Watershed models and simulations, Hydrologic design of watershed management practices, Impacts of climate change on watershed hydrology

UNIT – III Water Quality in Watershed (1½ Weeks) (03 lectures)
Water quality parameters and standards, Sources of water pollution, Point and non-point source pollution, Water quality monitoring and sampling, Water quality modeling

Eutrophication and harmful algal blooms, Water quality management practices, Watershed management for drinking water supply

UNIT – IV Land Use in Watersheds (2½ Weeks) (05 lectures)
land use and land cover change, Land use planning and zoning, Soil erosion and sedimentation, Agricultural management practices for soil and water conservation, Forest management for watershed protection, Urbanization and watershed management, Wetland conservation and management, Mining and watershed management

UNIT – V Management Practices for Sustainable Watershed Management (2 Weeks) (04 lectures)
Best management practices (BMPs), Conservation tillage and crop rotation, Agroforestry and silvopasture, Riparian buffer management, Grassland management, Land treatment and land application, Green infrastructure and low-impact development (lid), Restoration of degraded watersheds

UNIT – VI Watershed Economics (2½ Weeks) (05 lectures)
Economic valuation of watershed services, Benefit-cost analysis of watershed management projects, Water pricing and market-based mechanisms for watershed management, Environmental economics and watershed management, Cost-effective watershed management, Watershed financing and investment, Economic instruments for watershed conservation, Watershed management and rural livelihoods

UNIT –VII Stakeholder Participation and Governance in Watershed Management

(2 Weeks) (04 lectures)
Community-based watershed management, Public participation and stakeholder engagement, Social equity and environmental justice, Governance structures and watershed management, Water user associations (WUAs), Secentralization and devolution of watershed management, Indigenous knowledge and watershed management, Gender and watershed management

UNIT – VIII Case Studies in Watershed Management (1½ Weeks) (03 lectures)
Case studies on: success and failures of watershed management, from developing countries, influence by and adaptation to climate change conflicts and resolution, and ecological restoration; Watershed management and sustainable development goals

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Delineate and categorize watershed boundary using digital elevation data and GIS software
2. Calibrate and validate the model by collecting data on climate, land use, soil properties, and topography of the watershed
3. Set up the model in the chosen software by defining the watershed boundary, hydrological processes, and inputs and outputs of the model
4. Conduct a sensitivity analysis to identify the most important model parameters that affect the model's output
5. Document prevalence of invasive species in two most significant watershed regions of India
6. Design and suggest best management practices (BMPs) of world’s most notable watershed region and compare it with any watershed region of India
7. Analyze different types of satellite imagery and their use in watershed management
8. Determine the impact of changes in land use and land cover on water quality and watershed management
9. Create a hydrological model of a watershed using remote sensing and GIS, simulating runoff, soil erosion, and other hydrological processes
10. Map wetlands in a watershed using remote sensing and GIS and analyze their functions, such as water storage, nutrient cycling, and biodiversity conservation
11. Determine soil erosion rates in a watershed using remote sensing and GIS and analyze their impact on water quality, sedimentation, and flooding

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Anderson, C. W., & Miller, W. W. (2021). Watershed management: Planning for the 21st century. John Wiley & Sons.
- Bruijnzeel, L.A., Hamilton, L.S., and Asdak, C. (2011). Rainforest Hydrology, Ecology and Management. Springer.
- Dupigny-Giroux, L. A., McCabe, G. J., & Hirsch, R. M. (2017). State of the art in watershed modeling. John Wiley & Sons.
- King, K.W., Balogh, J.C., and Harmel, R.D. (2010). Watershed Management for Potable Water Supply: Assessing the New York City Strategy. American Society of Agricultural and Biological Engineers.
- National Research Council. (2008). Urban Stormwater Management in the United States. National Academies Press.
- Tindall, J.A., Keren, R.A., and Stone, J.J. (2016). Watershed Management: Planning for the 21st Century. American Society of Civil Engineers.

Suggestive readings

- Ma, J., Su, C., and Liu, W. (Eds.). (2018). River basin management in the twenty-first century: Understanding people and place. CRC Press.
- Miao, S. L., Zhang, C., Cai, Y., & Zhou, J. (Eds.). (2022). Sustainable watershed management in China. Springer.
- Water Environment Federation. (2012). Urban Watersheds: Geology, Contamination, and Sustainable Development. Wiley.
- Wilcock, R.J., and Iverson, R.M. (2013). Surface Water-Quality Modeling. Waveland Press.
- Yang, H. (2010). Integrated Watershed Management in the Global Ecosystem. Nova Science Publishers.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-EVS-6): WETLAND CONSTRUCTION AND MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-6: WETLAND CONSTRUCTION AND MANAGEMENT	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Understand physical and chemical processes for classifying, segregating, and managing solid wastes
- Characterize the different solid waste types and apply interdisciplinary knowledge for effective solid waste collection and processing of solid waste
- Compare methods of collection, transfer, storage, treatment, disposal, and use of solid waste in developed and developing nations
- Management, construction, and operations of landfill and other solid waste management facilities

Learning outcomes

After successful completion of this course, students will be able to:

- Conduct the life cycle assessment of solid waste and its impact on the urban metabolisms
- Identify and select landfill sites using GIS and other analytical techniques
- Examine and apply technical and legal solutions for sustainable management of solid waste
- Plan and design waste recycling programmes, compost and incineration facilities, and landfills
- Mine and analyze the relevant data and apply multiple criteria decision-making systems for a sustainable integrated solid waste management plan

SYLLABUS OF DSE-EVS-06

Theory (02 Credits: 30 lectures)

UNIT – I Wetlands Basics (1½ Weeks) (3 lectures)

Wetlands: definition, classification, functions and values, ecology and hydrology, ecosystem services; Importance in global environment, Wetland plant and animal communities, Wetland biogeochemistry, Threats to wetlands and wetland conservation

UNIT – II Design and Construction of Wetlands (2 Weeks) (4 lectures)

Design and planning principles, Construction techniques and materials, Wetland hydrology and water management, Vegetation selection and planting methods, Soil preparation and amendment, Erosion and sediment control, Monitoring and maintenance of constructed wetlands, Case studies in wetland design and construction

UNIT – III Restoration, Creation, and Wetland Management in Practice (3 Weeks) (6 lectures)

Restoration and creation goals and objectives, Site assessment and planning, Hydrological restoration techniques, Vegetation establishment and management, Wildlife habitat restoration and management, Monitoring and adaptive management of wetland restoration projects, Wetland restoration and creation in urban areas, Case studies in wetland restoration and creation,

Wetland management for: biodiversity conservation, water quality improvement, climate change adaptation and mitigation, and flood control and stormwater management; Challenges and opportunities for wetland management and restoration

UNIT – IV Monitoring and Assessment of Wetlands (2½ Weeks) (5 lectures)

Monitoring and assessment goals and objectives, Indicators of wetland health and function, Methods for measuring wetland hydrology, Vegetation sampling and analysis, Wildlife monitoring and assessment, Water quality monitoring, Data management and analysis, Case studies in wetland monitoring and assessment

UNIT – V Socio-Economic Benefits of and Emerging Issues in Wetland Management (3½ Weeks) (7 lectures)

Economic valuation of wetland services, Wetland-based: livelihoods, tourism, recreation and sustainable development, Wetlands and cultural heritage, Stakeholder engagement in wetland management, Social equity considerations in wetland management

Climate change impacts on wetlands, Innovative wetland management and restoration techniques, Role of wetlands in green infrastructure, and social justice, Wetland management and restoration in the developing world andthe Anthropocene, and Policy and research needs for wetland management and restoration

UNIT – VI Wetland Regulations and Policy (2½ Weeks) (5 lectures)
Wetland regulatory frameworks in India and other developed countries, Wetlands (Conservation and Management Rules) 2017, Wetland impact assessment, Ramsar Convention and international wetland protection, Wetland mitigation banking, Adaptive management for wetland restoration, Legal and ethical considerations in wetland management

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Conduct a wetland site assessment and identify wetland vegetation, soils, and hydrological features
2. Analyze a wetland construction project and learn about the methods and materials used in wetland construction
3. Monitor wetland using specific indicators including vegetation characteristics and water quality
4. Identify a suitable site and develop a wetland restoration project based on theoretical concepts
5. Analyze wetland conservation policy and its relations with other environmental and biodiversity conservation policies and regulations
6. Develop and implement a wetland education and outreach program for a local community
7. Calculate water budget of a selected wetland in your area or from any other parts of the country
8. Survey a local wetland and identify characteristics plants using field guides and manuals
9. Document wetland specific wildlife, including birds, amphibians, and reptiles,
10. Analyze wetland soil samples for key soil physico-chemical properties
11. Map wetlands in your city using GIS mapping and assess the ecosystem diversity
12. Conduct a wetland education program and evaluate its effectiveness in promoting importance of wetlands

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Brinson, M. M., & Rheinhardt, R. D. (2017). The practice of wetland restoration. American Society of Civil Engineers.
- Craft, C. B., Seneca, E. D., & Broome, S. W. (2018). Methods in biogeochemistry of wetlands. Soil Science Society of America.
- Lewis, J. (Ed.). (2018). Wetlands law and policy: understanding regulatory and environmental challenges. American Bar Association.
- Richardson, C. J. (Ed.). (2019). The wetland book: I: structure and function, management and methods (2nd ed.). Springer.
- Vymazal, J. (2018). Constructed wetlands for wastewater treatment: municipal, industrial and agricultural. Elsevier.

Suggestive readings

- Middleton, B. A. (2018). Wetland restoration: flood pulsing and disturbance dynamics (2nd ed.). Island Press.
- Millennium Ecosystem Assessment. (2005). Ecosystems and human well-being: wetlands and water synthesis. World Resources Institute.
- Mitsch, W. J., & Gosselink, J. G. (2015). Wetlands (5th ed.). John Wiley & Sons.
- Richardson, C. J., & King, R. S. (2019). Understanding and managing freshwater wetlands (2nd ed.). CRC Press.
- Zedler, J. B., & Kercher, S. (Eds.). (2015). Wetland restoration and construction: a technical guide (2nd ed.). CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-7): WATER TREATMENT TECHNOLOGIES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-7: WATER TREATMENT TECHNOLOGIES	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into physico-chemical, and biological processes involved in water treatment
- Familiarize with different types of water treatment technologies and their applications
- Understand the importance of water quality standards and learn criteria to evaluate the effectiveness of water treatment processes
- Identify and appreciate the critical linkages among environmental, socio-economic impacts of water treatment and importance regulations

Learning outcomes

After the course, students will be able to:

- Explain the performance of water treatment plant based on the physico-chemical, and biological processes
- Apply theoretical concepts for operation, management, and improvement of water treatment systems
- Evaluate the effectiveness of water treatment plants and its link with socio-economic and environmental impacts
- Collaborate for learning the structure and function of local water treatment plants to solve related problems

SYLLABUS OF DSE-EVS-7

Theory (02 Credits: 30 lectures)

UNIT – I Fundamentals of Water Treatment Technologies (1½ Weeks) (3 lectures)
Water sources: types, quality parameters, different uses; Water treatment processes: overview, types, importance in public health; Water treatment plants: design, operations, maintenance, future trends; Regulations and standards

UNIT – II Pre-Treatment and primary treatment processes (3½ Weeks) (7 lectures)
Screening and sedimentation, Adsorption and absorption, Coagulation and flocculation, Chemical dosing, pH control methods, Aeration and degasification, Membrane filtration and reverse osmosis

Sedimentation and clarification, Dissolved air flotation and gravity separation, Hydrocyclone and centrifugation methods, Physical and chemical disinfection, UV irradiation and ozonation, Chlorination and chloramination, Taste and odor control methods, Color removal and demineralization techniques

UNIT – III Secondary Treatment Processes (2½ Weeks) (5 lectures)
Biological treatment methods, Activated sludge: aerobic and anaerobic digestion; Bioreactors, Nutrient: removal, denitrification, and recovery techniques; Sludge dewatering and drying methods, Biofilm and trickling filters, Constructed wetlands and bioswales

UNIT – IV Tertiary Treatment Processes (2½ Weeks) (5 lectures)
Advanced oxidation processes, Granular activated carbon and adsorption beds, Ion exchange and membrane technologies, Electrocoagulation and electrochemical treatment, Chemical precipitation and coagulation-flocculation, Disinfection byproduct removal and control, Emerging contaminants and micropollutants, Industrial wastewater treatment methods

UNIT – V Water Distribution Systems (2½ Weeks) (5 lectures)
Water distribution systems: overview, and components; Pipeline materials and design considerations, Pumping stations and pressure regulation, Storage tanks and reservoirs, Water quality monitoring and testing, Water loss and leak detection, Cross-connection control and backflow prevention

UNIT – VI Water Treatment Plant Management (2½ Weeks) (5 lectures)
Water treatment plant performance metrics, Safety and emergency response planning, Human resources and staffing, Asset management and maintenance, Energy management and optimization, Capital and budgeting planning, Public outreach and Regulatory compliance

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Visit local water treatment plant and understand its structure and function and link it with the efficacy of water treatment
2. Analyze the water samples collected from local water treatment plant at different stages of treatment and analyze the role of ongoing physico-chemical and biological processes
3. Based on analyses of practicals 1 and 2, prepare a plan for improvement of water treatment plant with appropriate justification
4. Assess efficacy of filtration by different media, including sand, activated carbon, and gravel in removing contaminants from water
5. Prepare and test the potential of biofilters to remove nutrients and organic matter from water.
6. Ascertain the requirement and assess the effectiveness of chlorination for disinfection of microbial contaminated water samples
7. Test the effectiveness of coagulation-flocculation in removing suspended particles from water and determine effectiveness of different coagulants and flocculants
8. Determine the sedimentation rate of suspended particles in water using graduated cylinders packed with different soil particle size fractions
9. Determine effectiveness of UV radiation and ozone treatment in reducing the microbial load in water samples.
10. Assess the effectiveness of reverse osmosis in treating the water loaded with salts and other contaminants and improving the water quality
11. Determine the effectiveness of activated carbon and other self-prepared biological sorbent in reducing the chemical oxygen demand (COD)

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Crittenden, J. C., Trussell, R. R., Hand, D. W., Howe, K. J., & Tchobanoglous, G. (2012). MWH's Water Treatment: Principles and Design (3rd ed.). John Wiley & Sons.
- Farooq, R., & Fan, J. (2020). Water Treatment Technologies for the Removal of High-Toxicity Pollutants. Elsevier. https://doi.org/10.1016/C2019-0-03681-3
- Johnson, L. (2021). Emerging Water Treatment Technologies. Boca Raton, FL: CRC Press.

- Kim, S. (2021). Sustainable Water Treatment Technologies. Amsterdam, Netherlands: Elsevier.
- Zhang, Q. (2020). Innovative Water Treatment Technologies. Singapore: Springer.

Suggestive readings

- Brown, R. (2020). Membrane-Based Water Treatment Technologies. Hoboken, NJ: Wiley.
- Chen, X., Li, Y., & Li, P. (2021). Environmental Water Treatment Technologies: Advanced Treatment Processes, Modeling and Optimization. Elsevier. https://doi.org/10.1016/C2021-0-03457-3
- Chen, W. (2019). Advanced Oxidation Technologies for Water and Wastewater Treatment. Springer.
- Davis, M. L., & Masten, S. J. (2018). Principles of Environmental Engineering and Science (3rd ed.). McGraw-Hill Education.
- Smith, J. (2022). Advanced Water Treatment Technologies. New York, NY: Springer.
- Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2013). Wastewater Engineering: Treatment and Resource Recovery (5th ed.). McGraw-Hill Education.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-8): ENVIRONMENTAL ENGINEERING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-8: ENVIRONMENTAL ENGINEERING	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into the principles and practices of environmental engineering and develop skills in the environmental systems and technologies
- Cultivate skills for effective awareness for the environmental impacts of human activities and foster critical thinking in the context of sustainable development
- Evaluate tools and techniques, such as mathematical-, experimental-, and computer-based, used in environmental engineering
- Equip with laboratory techniques for estimating quality of water, air and waste

Learning outcomes:

After the course, students will be able to

- Apply principles of environmental engineering into environmental systems and technologies
- Analyze and design environmental systems for treating water, controlling air pollution and manage waste
- Evaluate the environmental impacts of human activities, and appreciate ethical and professional responsibilities of environmental engineers for sustainability
- Demonstrate proficiency in the use of environmental engineering tools and technologies for sustainable development

SYLLABUS OF DSE-EVS-8

Theory (02 Credits: 30 lectures)

UNIT – I Basics of Environmental Engineering (2 Weeks) (4 lectures)

Environmental Engineering: concept, history and evolution, potential in sustainable development; Green chemistry and life cycle assessment, Ethics and environmental policies and regulations, Chemistry of water, air and soil, Redox reactions and chemical equilibrium, Biological processes and environmental functioning (photosynthesis, respiration, decomposition, nutrient cycling)

UNIT – II Water and Wastewater Treatment (2½ Weeks) (5 lectures)
Water and wastewater treatment methods: physical, chemical, biological, integrated and advanced methods; Water quality: parameters, standards, and related regulations; Sludge: treatment, use, and disposal; Water reuse and recycling

UNIT – III Air Pollution Control (2½ Weeks) (5 lectures)
Air quality: parameters, standards, and regulations; Air Pollutants: types, sources, dispersion, and their control; Indoor air quality, Emerging air pollutants

UNIT – IV Solid Waste Management (2½ Weeks) (5 lectures)
Solid waste: types, characteristics, collection, transportation, storage, processing, treatment, and disposal or resource recovery and recycling; Integrated solid waste management; Hazardous waste management

UNIT – V Microbial and plant biology and ecology (2½ Weeks) (5 lectures)
Microbial and plant physio-ecological processes and waste treatment, Ecophysiology of microbes and plants, Growth of microbes and plants during waste management, Pathogen control in soil, water, and air by biological methods

UNIT – VI Environmental Impact Assessment (EIA) (1½ Weeks) (3 lectures)
EIA: Process, Statement, and case studies; Social and Economic Impact Assessment, Environmental Management Plan

UNIT – VII Sustainable Energy and Climate Change (1½ Weeks) (3 lectures)
Sustainable Energy and Climate Change: renewable energy sources, energy efficiency, climate change science, case studies, Climate change: mitigation and adaptation strategies, Carbon footprinting

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1-3. Conduct physico-chemical characterization of given water samples (pH, temperature, dissolved oxygen, turbidity, total suspended solids, and NO3-N or PO4-P)
4. Characterize the given wastewater sampled from an industry and agricultural field
5. Measure the concentration of particulate matter, NO2, SO2, CO, using different methods
6. Characterize solid waste and determine its moisture content, density, and calorific value

7. Visit a landfill site and draw its design and explain the underlying geotechnical principles
8. Based on practical 5, improve and propose a design and justify the improvement in the design
9. Test the ability of given bacteria to tolerate different levels of the selected pollutants
10. Select and evaluate a proposed project or activity using life cycle assessment
11. Perform a life cycle assessment of a selected product or process and determine its possible environmental impacts from cradle to grave
12. Using principles of green chemistry, perform the selected experiment using environmentally friendly methods and reagents

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Chiang, C. Y., & Lin, Y. P. (2021). Sustainable Environmental Engineering: Trends and Innovations. Elsevier.
- Gribb, M., & Banerjee, S. (2021). Environmental Engineering: Principles and Practice. Cambridge University Press.
- Kharaghani, A., & Fazeli, A. (2021). Environmental Engineering and Management: Sustainable Development and Hazard Mitigation. CRC Press.
- Vesilind, P. A., & Morgan, S. M. (2020). Introduction to Environmental Engineering. Cengage Learning.
- Wang, Y. (2020). Environmental Engineering: An Introduction to the Fundamentals. Wiley.

Suggested readings

- Falletti, L., & Paolini, R. (2019). Environmental Remediation Technologies for Metal-Contaminated Soils. Springer.
- Lichtfouse, E. (2020). Environmental Chemistry for a Sustainable World. Springer.
- Shuyler, H. (2021). Sustainability and Engineering: Concepts, Metrics, and Opportunities. Springer.
- Tchobanoglous, G., & Burton, F. L. (2019). Wastewater Engineering: Treatment and Resource Recovery. McGraw-Hill Education.
- Wang, L. K., Hung, Y. T., & Shammas, N. K. (2016). Advanced Treatment Technologies for Urban Wastewater Reuse. Springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-EVS-9): NATURAL HAZARDS & DISASTER MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-9: NATURAL HAZARDS & DISASTER MANAGEMENT	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into the types and causes of natural hazards and their potential impacts on individuals and communities.
- Examine the socio-economic, and environmental factors contributing to disaster risk and vulnerability
- Identify principles of disaster risk reduction and management, including mitigation, preparedness, response, and recovery.
- Understand different perspectives of disaster management, including ethical social and cultural
- Analyze the critical linkages between climate change and natural hazards and prepare plans for disaster preparedness, emergency response and recovery

Learning outcomes

After successful completion of this course, students will be able to:

- Identify a specific risk of natural hazards to the given locality or community conduct a hazard assessment and identify potential weaknesses in disaster preparedness of a local community or infrastructure
- Develop an emergency preparedness plan for their residential colony highlighting evacuation routes, emergency contacts, and supplies
- Design a communication plan for disaster response and recovery operation and develop a disaster risk reduction plan for mitigation, preparedness, response, and recovery
- Evaluate the relevance of GIS mapping, remote sensing, and social media in disaster response and recovery plans and examine the associated issues, such as equity, justice, and human rights

SYLLABUS OF DSE-EVS-09

Theory (02 Credits: 30 lectures)

UNIT – I Natural Hazards and Disasters Basics (2½ Weeks) (5 lectures)
Natural hazards and disasters: definition, classification (geological, meteorological, hydrological, biological), causes (plate tectonics, climate change, etc.), social and economic effects; Historical and recent natural disasters and their impacts, Disaster risk reduction and management frameworks, International disaster response mechanisms, Disaster preparedness and mitigation strategies

UNIT – II Geological Hazards (2 Weeks) (4 lectures)
Earthquakes: causes, prediction and warning systems, Seismic hazards and risk assessment, Tsunamis: causes and early warning systems; Volcanic hazards and eruptions: risk assessment and mitigation strategies; Landslides: causes and impacts

UNIT – III Meteorological Hazards (2 Weeks) (4 lectures)
Causes and impacts of: hurricanes, typhoons, cyclones, tornadoes, thunderstorms and lightning, floods and flash floods, drought, heat waves, wildfires; Climate change and its impact on meteorological hazards

UNIT – IV Hydrological Hazards (2 Weeks) (4 lectures)
Causes and impacts of: river flooding, coastal flooding and storm surges, dam and levee failures, urban flooding, groundwater depletion and contamination; Water scarcity and its effects on society, Water management and conservation strategies, Climate change and hydrological hazards

UNIT – V Biological Hazards (2 Weeks) (4 lectures)
Pandemics and epidemics, Zoonotic diseases and their transmission, Vector-borne diseases and their prevention, Foodborne diseases and their causes, Bioterrorism and its impacts, Environmental health and its relationship to natural hazards, Health systems and emergency response to biological hazards, One Health approach to disaster management

UNIT – VI Technological Hazards (2 Weeks) (4 lectures)
Causes and consequences of hazards, such as: industrial accidents, nuclear accidents, chemical spills, transportation accidents, and cybersecurity threats; Communication technologies and their role in disaster response, Technological risk assessment and mitigation strategies, Relationship between technological hazards and natural hazards

UNIT – VII Disaster Response and Recovery: Policy and ethics (2½ Weeks) (5 lectures)
Emergency response, Disaster recovery and reconstruction, Psychological impacts of disasters, Gender and disaster response, Social vulnerability and disaster risk reduction, Community resilience and disaster preparedness, Role of government and international community

Disaster risk reduction policies and frameworks, Environmental ethics and human rights in disaster response and recovery, and disaster management, Stakeholder engagement public-private partnerships, Legal frameworks and liability, Innovation and technology in future

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Conduct a hazard assessment of your college or a given locality or local community to identify the vulnerability to most likely natural hazards and its potential impacts
2. Develop an emergency preparedness plan for the area investigated in practical 1, highlighting evacuation routes, emergency contacts, and supplies
3. Conduct a disaster simulation exercise in the area selected in practicals 1 and 2 to practice emergency response skills
4. Analyze disaster preparedness plan of a local community or infrastructure, assess vulnerability, and identify potential weaknesses for improvement
5. Analyze a recent case study of natural disaster from India or the country of your choice and critically evaluate its socio-economic impacts, including effects on housing, healthcare, and employment
6. Design a communication plan for an effective disaster response and recovery operation,
7. Develop a plan to reduce the risk of disasters for a community giving details of mitigation, preparedness, response, and recovery
8. Analyze the risk of a critical infrastructure system of your city including transportation network or power grid and identify vulnerabilities and potential consequences of failure
9. Examine the climate change scenarios and assess the potential for increased frequency and intensity of natural hazards in a given area
10. Analyze a recent case study on natural disaster and evaluate the emerging importance of technology use in disaster response and recovery, including GIS mapping, remote sensing, and social media
11. Identify the populations vulnerable to possible natural disasters in an area and develop a specific plan for the preparedness of low-income communities, elderly populations, and people with disabilities
12. Analyze different components of Community Emergency Response Team (CERT) training or community-based disaster preparedness programme

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Birkmann, J., Cardona, O. D., & Carreño, M. L. (2018). Risk Analysis of Natural Hazards: Interdisciplinary Challenges and Integrated Solutions. Springer.
- Cutter, S. L. (2019). Hazards, Vulnerability and Environmental Justice. Routledge.
- Dash, N. (2018). Climate Change and Disaster Risk Management. CRC Press.
- Keller, E., DeVecchio, D., & Galloway, D. (2021). Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes. Pearson.
- Musaazi, M., Cunha, R., & Kibreab, M. (2019). Disaster Risk Reduction and Management Approaches. Springer.
- Smith, K. (2019). Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge.

Suggestive readings

- Berke, P. R., & Beatley, T. (2017). Planning for Resilience: Handbook for Practitioners. Island Press.
- Comfort, L. K. (2019). Crisis Management and Emergency Planning: Preparing for Today's Challenges. Routledge.
- Li, J., & Chen, Y. (2021). Risk Management of Natural Disasters: A Comparative Study of the Role of Governments. Springer.
- Okuyama, S., & Chang, R. (2018). Managing Natural Disasters through Public-Private Partnerships. Springer.
- Wisner, B., Gaillard, J. C., & Kelman, I. (2019). The Routledge Handbook of Disaster Risk Reduction Including Climate Change Adaptation. Routledge.

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