Annexure-68

UNIVERSITY OF DELHI

Environmental Science: Theory into Practice at Undergraduate Level

Ability Enhancement Course (AEC-I)

(SEMESTER-I)

based on

Undergraduate Curriculum Framework 2022 (UGCF)

(Effective from Academic Year 2022-23)

List of AEC-I Courses (Choose one from a pool)

S.No.	Course Title	Nature of Course	Total Credits	Components			Annexures (Contents of the Course and Reference is in)
				L	T	P	
1.	Environmental Science: Theory into Practice (I & II)	AEC-I	2	1	0	1	***Annexure-I***

Ability Enhancement Course on Environmental Science: Theory into Practice (I & II) at UG level (AEC I) Course Learning Outcomes

6.0 *The course will empower the undergraduate students by helping them to:*

i. Gain in-depth knowledge on natural processes and resources that sustain life and govern economy.
ii. Understand the consequences of human actions on the web of life, global economy, and quality of human life.
iii. Develop critical thinking for shaping strategies (scientific, social, economic, administrative, and legal) for environmental protection, conservation of biodiversity, environmental equity, and sustainable development.
iv. Acquire values and attitudes towards understanding complex environmental- economic-social challenges, and active participation in solving current environmental problems and preventing the future ones.
v. Adopt sustainability as a practice in life, society, and industry.

6.1 Year – 1

Ability Enhancement Course on Environmental Science: Theory into Practice (I) – at UG level (AEC-I)

Unit 1

Introduction to Environmental Studies (2 lectures and 3 practical/ outreach activities)

- Multidisciplinary nature of environmental studies; components of environment: atmosphere, hydrosphere, lithosphere, and biosphere
- Scope and importance; Concept of sustainability and sustainable development; Brief history of environmentalism

Suggested Readings

1. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). *Environment*, 8th Edition. Wiley Publishing, USA. **Chapter 1** (Pages: **1-17**); **Chapter 2** (Pages: **22-23**); **Chapter 3** (Pages: **40, 41**); **Chapter 4** (Pages: **64, 66**).
2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 1** (Page: **3-28**).

Practical/Exercises/Experiential activities/Outreach activities

(*College may choose as per requirement*)

1. Analysis of achievement of Sustainable Development Goals of any country.
2. Gain insights of sustainability framework for an industrial acitivty using activity worksheets
3. Use of environmental activity worksheets to understand interdependence and interactions between different environmental components.

Unit 2

Ecosystems (6 lectures and 6 practical/ outreach activities)

- Definition and concept of Ecosystem
- Structure of ecosystem (biotic and abiotic components); Functions of Ecosystem: Physical (energy flow), Biological (food chains, food web, ecological succession), and Biogeochemical (nutrient cycling) processes. Concepts of productivity, ecological pyramids and homeostasis

- Types of Ecosystems: Tundra, Forest, Grassland, Desert, Aquatic (ponds, streams, lakes, rivers, oceans, estuaries); importance and threats with relevant examples from India
- Ecosystem services (Provisioning, Regulating, Cultural, and Supporting); Ecosystem preservation and conservation strategies; Basics of Ecosystem restoration

Suggested Readings

1. Odum, E.P., Odum, H.T., and Andrews, J. (1971). *Fundamentals of Ecology*. Saunders, Philadelphia, USA. **Chapter 1** (Pages: **1-16**); **Chapter 2** (Pages: **18-76**); **Chapter 10** (Pages: **414-458**).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 3** (Pages: **38-52**); **Chapter 4** (Pages: **53-62**); **Chapter 5** (Pages: **100-103**); **Chapter 6** (Pages: **106-128**).
3. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 13** (Pages: **307-323**); **Chapter 18** (Pages: **420-442**); **Chapter 28** (Pages: **747-769**).

Practical/Exercises/Experiential activities/Outreach activities

(*College may choose as per requirement*)

1. Schematic collection of data for depicting ecological pyramids in the College campus
2. Differentiation of natural and managed ecosystems using Google Earth/Google Map
3. Field visit to terrestrial and aquatic ecosystems (forests, grasslands, wetlands, biodiversity parks, etc.)
4. Develop a working model of any ecosystem
5. Use of worksheets to identify structure and function of different ecosystems.

Unit 3

Natural Resources (8 lectures and 6 practical/ outreach activities)

- Land resources: Minerals, soil, agricultural crops, natural forest products, medicinal plants, and forest-based industries and livelihoods; Land cover, land use change, land degradation, soil erosion, and desertification; Causes of deforestation; Impacts of mining and dam building on environment, forests, biodiversity, and tribal communities
- Water resources: Natural and man-made sources; Uses of water; Over exploitation of surface and ground water resources; Floods, droughts, and international &inter-state conflicts over water
- Energy resources: Renewable and non-renewable energy sources; Use of alternate energy sources; Growing energy needs; Energy contents of coal, petroleum, natural gas and bio gas; Agro-residues as a biomass energy source
- Case studies: Contemporary Indian issues related to mining, dams, forests, energy, etc (e.g., National Solar Mission, Cauvery river water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, etc)

Suggested Readings

1. Gadgil, M. and Guha, R. (1993). *This Fissured Land: An Ecological History of India*. University of California Press, Berkeley, USA. (pp. 1-245).
2. McCully, P. (1996). *Rivers no more: the environmental effects of dams*, In: *Silenced Rivers: The Ecology and Politics of Large Dams*, Zed Books, New York, USA. **Page. 29-64**.
3. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). Environment, 9th Edition. Wiley Publishing, USA. **Chapters 10, 11, 12, 13** (Pages: **180-263**); **Chapter 14** (Pages: **272-275**); **Chapter 15** (Pages: **286-289**).
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 25** (Pages: **623-663**).

Practical/Exercises/Experiential activities/Outreach activities (College may choose as per requirement)

1. Visit to a paper recycling unit/rainwater harvesting plant/solar plant/biogas plant in the College campus
2. Develop and understand working model of renewable/non-renewable sources of energy
3. Mapping of natural resources of a given study area using Google Earth
4. Time-series analysis of natural resource consumption of a given country using publicly available data
5. Comparison of energy demand and consumption of a particular state over the years using graphical tools
6. Assessing the consumption pattern of a natural resource in the dominant industry at local scale and status of natural resource in areas supplying it

Unit 4

Environmental Pollution (8 lectures and 6 practical/ outreach activities)

- Environmental pollution (Air, water, soil, thermal, and noise): causes, effects, and controls; Primary and secondary air pollutants; Air and water quality standards
- Nuclear hazards and human health risks
- Solid waste management: Control measures for various types of urban, industrial waste, Hazardous waste, E-waste, etc; Waste segregation and disposal
- Pollution case studies: Ganga Action plan (GAP), Delhi air pollution and public health issues, Plastic waste management rules, Bhopal gas tragedy, etc

Suggested Readings

1. Brusseau, M.L., Pepper, I.L. and Gerba, C.P. (2019). *Environmental and Pollution Science*, 3rd Edition. Academic Press, USA. **Chapter 16** (Pages: **243-255**); **Chapter 18** (Pages: **280-305**); **Chapter 21** (Pages: **352-358**); **Chapter 22** (Pages: **365-374**); **Chapter 23** (Pages: **378-388**); **Chapter 25** (Pages: **416-426**).
2. Carson, R. (2002). Silent Spring. Houghton Mifflin Harcourt, USA. Pp. 1-264.
3. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). Environment, 9th Edition. Wiley Publishing, USA. **Chapter 19** (Pages: **359-381**); **Chapter 21** (Pages: **401-421**); **Chapter 23** (Pages: **440-453**).
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi. **Chapters 19, 20, 12** (Pages: **445-535**).

Practical/Exercises/Experiential activities/Outreach activities

(*College may choose as per requirement*)

1. Determine water quality of a given location using rapid pollution monitoring kits
2. Assess air quality index (AQI) of any location using real-time air quality parameters
3. Determine magnitude of solid waste generated in a home/college on a monthly basis
4. Develop and maintain compost/vermicompost using biodegradable waste in the College
5. Identify suitability of given water samples for various purposes using given kits
6. Prepare water audit report of the college/house/locality/colony.
7. Map solid and liquid discharge of the college/colony and develop a management plan (show it using schematic diagram, and photographs.
8. Repurpose waste for economic and environmental benefits in your college/near by area/colony (submit a small video).
9. Analyze river-society-economy nexus based on primary or secondary data (use quantitative data, and show it using photographs on a poster).

Year – 2
Ability Enhancement Course on
Environmental Science: Theory into Practice (I) – at UG level (AEC-I)

Unit 5

Global Environmental Issues and Policies (7 lectures 8 practical/ outreach activities)

- Causes of Climate change, Global warming, Ozone layer depletion, and Acid rain; Impacts on human communities, biodiversity, global economy, and agriculture
- International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity (CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc.
- Sustainable Development Goals: India's National Action Plan on Climate Change and its major missions
- Environment legislation in India: Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act 1980; Air (Prevention & Control of Pollution) Act, 1981; Environment Protection Act, 1986; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

Suggested Readings

1. Divan, S. and Rosencranz, A. (2002). *Environmental Law and Policy in India: Cases, Material & Statutes*, 2nd Edition. Oxford University Press, India. **Chapter 2** (Pages: **23-39**); **Chapter 3** (Pages: **41-86**).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 19** (Pages: **370-376**); **Chapter 20** (Pages: **385-399**).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 23** (Pages: **555-598**); **Chapter 30** (Pages: **801-807**).

Practical/Exercises/Experiential activities/Outreach activities

(*College may choose as per requirement*)

1. Depict temperature/precipitation trend of a given study area using online data
2. Formulate questionnaire/online surveys for assessment of the impact of climate change on people
3. Assess Nationally Determined Contributions (NDCs) of developed and developing countries
4. Development and simulation of Model UNFCCC for inoculating negotiation skills at climate change summits
5. Development and simulation of Moot Court for Mock Trials in Negotiation Green Tribunal
6. Identify carbon footprint of your college/home/locality (refer wwf@envis.nic.in).
7. Analyze the status of at least 3 sustainable development goals in your neighbourhood and write a proposal to help achieve them at global standard (identify environmental problems and its social and economic impact, define objectives, explain methodology, budgetary requirements, and suggest the expected outcomes). A PowerPoint presentation to be made based on the project proposal.

Unit 6

Biodiversity and Conservation (8 lectures and 8 practical/ outreach activities)

- Definition of Biodiversity; Levels of biological diversity: genetic, species and ecosystem diversity
- India as a mega-biodiversity nation; Biogeographic zones of India; Biodiversity hotspots; Endemic and endangered species of India; IUCN Red list criteria and categories

- Value of biodiversity: Ecological, economic, social, ethical, aesthetic, and informational values of biodiversity with examples; sacred groves and their importance with examples
- Threats to biodiversity: Habitat loss, degradation, and fragmentation; Poaching of wildlife; Man-wildlife conflicts; Biological invasion with emphasis on Indian biodiversity; Current mass extinction crisis
- Biodiversity conservation strategies: in-situ and ex-situ methods of conservation; National Parks, Wildlife Sanctuaries, and Biosphere reserves; Keystone, Flagship, Umbrella, and Indicator species; Species reintroduction and translocation
- *Case studies*: Contemporary Indian wildlife and biodiversity issues, movements, and projects (e.g., Project Tiger, Project Elephant, Vulture breeding program, Project Great Indian Bustard, Crocodile conservation project, Silent Valley movement, Save Western Ghats movement, etc)

Suggested Readings

1. Primack, R.B. (2014). *Essentials of Conservation Biology*, Oxford University Press, USA. Page. 1-536.
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 5** (Pages: 97-99); **Chapter 16** (Pages: **299-318**).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapters 24** (Pages: **599-690**); **Chapter 26** (Pages: **664-714**).

Practical/Exercises/Experiential activities/Outreach activities

(*College may choose as per requirement*)

1. Acquaintance with open-source databases of biodiversity
2. Determine species location in a given study area
3. Depict distribution of biodiversity across latitude and altitude
4. Show species distribution across space and time
5. Quantify species loss across different time periods
6. Sampling of plant and animal biodiversity of the College campus
7. Identification of the floral diversity of Delhi and other states.

   Documentation of the plants by clicking pictures, finding out the scientific names/ local names through literature or mobile applications, identification of their conservation status (IUCN red book list), medicinal properties, water consumption status, and socio-economic-environmental importance. A short report to be submitted)
8. Exercise to understand the socio-economic-environmental impact of wildlife conservation.

   (Students can choose any global animal species and identify the relevance of the species for the ecosystem/ society/ culture/ local economy, historic or present range of the species, emerging threats due to human activities, identification of documented events of natural disasters/ conflicts/ poaching of the species in the present range, conservation status (IUCN red book list), identification of protected areas/ programs of the government/ international organisation, and their opinion to further improve the conservations of the species. A short report to be submitted.

Unit 7

Human Communities and the Environment (6 lectures and 7 practical/ outreach activities)

- Human population growth: Impacts on environment, human health, and welfare; Carbon foot-print
- Resettlement and rehabilitation of developmental project affected persons and communities; relevant case studies
- Environmental movements: Chipko movement, Appiko movement, Silent valley

movement, Bishnois of Rajasthan, Narmada Bachao Andolan, etc
- Environmental justice: National Green Tribunal and its importance
- Environmental philosophy: Environmental ethics; Role of various religions and cultural practices in environmental conservation
- Environmental communication and public awareness: case studies (e.g., CNG vehicles in Delhi, Swachh Bharat Abhiyan, National Environment Awareness Campaign (NEAC), National Green Corps (NGC) "Eco-club" programme, etc)

Suggested Readings

1. Divan, S. and Rosencranz, A. (2002). Environmental Law and Policy in India: Cases, Material & Statutes, 2nd Edition. Oxford University Press, India. **Chapter 10** (Pages: **416-473**).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). Environment, 9th Edition. Wiley Publishing, USA. **Chapter 2** (Pages: **33-36**); **Chapter 8** (Pages: **148-162**).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi. **Chapter 1** (Pages: **23-26**); **Chapter 31** (Pages: **826-842**).

Practical/Exercises/Experiential activities/Outreach activities

(*College may choose as per requirement*)

1. Assessment of carbon foot-print of different countries using online databases and mathematical tools
2. Visit to marginalized localities and students for environmental education and environmental awareness
3. Formulation of questionnaire/online surveys for assessment of the impact of environmental education
4. Visit to any developmental project affected locality for assessing the impacts of economic development on human lives
5. Correlation analysis of human population growth and impacts on the environment and human health

6.2 Essential Readings

1. Brusseau, M.L., Pepper, I.L., and Gerba, C.P. (2019). *Environmental and Pollution Science*, 3rd Edition. Academic Press, USA. (pp. 1-520).
2. Divan, S. and Rosencranz, A. (2002). Environmental Law and Policy in India: Cases, Material & Statutes, 2nd Edition. Oxford University Press, India. (pp. 1-837).
3. Gadgil, M., and Guha, R. (1993). *This Fissured Land: An Ecological History of India*. University of California Press, Berkeley, USA. (pp. 1-245).
4. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). *Environment*, 8th Edition. Wiley Publishing, USA. (pp. 1-472).
5. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation.* S. Chand Publishing, New Delhi. (pp.1-842).

6.3 Weekly Lesson Plan (Year 1)

Weeks 1 -2

Multidisciplinary nature of environmental studies; components of environment: atmosphere, hydrosphere, lithosphere, and biosphere

Scope and importance; Concept of sustainability and sustainable development; Brief history of environmentalism

Weeks 3–7

Definition and concept of Ecosystem: Structure of ecosystem (biotic and abiotic components);

Functions of Ecosystem: Physical (energy flow), Biological (food chains, food web, ecological succession), and Biogeochemical (nutrient cycling) processes. Concepts of productivity, ecological pyramids and homeostasis

Types of Ecosystems: Tundra, Forest, Grassland, Desert, Aquatic (ponds, streams, lakes, rivers, oceans, estuaries); importance and threats with relevant examples from India
Ecosystem services (Provisioning, Regulating, Cultural, and Supporting); Ecosystem preservation and conservation strategies; Basics of Ecosystem restoration

Weeks 8–11
Land cover, land use change, land degradation, soil erosion, and desertification; Causes of deforestation; Impacts of mining and dam building on environment, forests, biodiversity, and tribal communities Natural and man-made sources of water; Uses of water; Over exploitation of surface and ground water resources; Floods, droughts, and international & inter-state conflicts over water

Renewable and non-renewable energy sources; Use of alternate energy sources; Growing energy needs; Energy contents of coal, petroleum, natural gas and bio gas; Agro-residues as a biomass energy source
Case studies: Contemporary Indian issues related to mining, dams, forests, energy, etc (e.g., National Solar Mission, Cauvery river water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, etc).

Weeks 12–15
Environmental pollution (Air, water, soil, thermal, and noise): causes, effects, and controls; Primary and secondary air pollutants; Air and water quality standards
Related case studies

Nuclear hazards and human health risks; Control measures for various types of urban, industrial waste, Hazardous waste, E-waste, etc; Waste segregation and disposal
Related case studies

6.4 Weekly Lesson Plan (Year 2)

Weeks 1–4
Definition of Biodiversity; Levels of biological diversity; India as a mega-biodiversity nation; Biogeographic zones of India; Biodiversity hotspots; Endemic and endangered species of India; IUCN Red list criteria and categories
Value of biodiversity: Ecological, economic, social, ethical, aesthetic, and informational values of biodiversity with examples; sacred groves and their importance with examples

Threats to biodiversity: Habitat loss, degradation, and fragmentation; Poaching of wildlife; Man-wildlife conflicts; Biological invasion with emphasis on Indian biodiversity; Current mass extinction crisis; Biodiversity conservation strategies: in-situ and ex-situ methods of conservation; National Parks, Wildlife Sanctuaries, and Biosphere reserves; Keystone, Flagship, Umbrella, and Indicator species; Species reintroduction and translocation

Case studies: Contemporary Indian wildlife and biodiversity issues, movements, and projects (e.g., Project Tiger, Project Elephant, Vulture breeding program, Project Great Indian Bustard, Crocodile conservation project, Silent Valley movement, Save Western Ghats movement, etc)

Weeks 5–9
Causes of Climate change, Global warming, Ozone layer depletion, and Acid rain; Impacts on human communities, biodiversity, global economy, and agriculture
International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols,

Convention on Biological Diversity(CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc

Sustainable Development Goals: India's National Action Plan on Climate Change and its major missions Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act 1980; Air (Prevention & Control of Pollution) Act, 1981; Environment Protection Act, 1986; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

Weeks 10–15

Human population growth: Impacts on environment, human health, and welfare; Carbon foot-print; Resettlement and rehabilitation of developmental project affected persons and communities; relevant case studies; Environmental movements: Chipko movement, Appiko movement, Silent valley movement, Bishnois of Rajasthan, Narmada Bachao Andolan, etc; Environmental justice: National Green Tribunal and its importance

Environmental philosophy: Environmental ethics; Role of various religions and cultural practices in environmental conservation

Environmental communication and public awareness: case studies (e.g., CNG vehicles in Delhi, Swachh Bharat Abhiyan, National Environment Awareness Campaign (NEAC), National Green Corps (NGC) "Eco-club" programme, etc)

7.0 Teaching Learning process

The teaching–learning methodologies are designed to provide the undergraduate students a comprehensive understanding of the subject in a simplistic manner as well as evoke critical reasoning and analytical thinking among them. The various approaches to teaching–learning process include classroom lectures, video presentations, and ICT enabled teaching tools. For enhancing practical understanding, field visits are encouraged to relevant places in Delhi like Biodiversity parks, Protected areas, Wetlands, Sewage treatment plants, etc.

7.1 Assessment methods

1. Written examinations (Semester exams) [(**Year 1:** 01 credit (1 hour); **Year 2:** 01 credit (1 hour)]
2. Project work and reports related to field visits, outreach activities, case study, project formulation, assignments, presentations and practical learning (Internal practical assessment) [(**Year 1:** 01 credit (2 hour); **Year 2:** 01 credit (2 hour)]

   Year 1 (Sem-I/Sem-II): 01 Credit Theory+ 01 Credit practical exercises, etc.
   = Total 02 Credits (03 hours)

   Year 2 (Sem-I/Sem-II): 01 Credit Theory+ 01 Credit practical exercises, etc.
   = Total 02 Credits (03 hours)

8.0 Keywords

Environment, Ecosystem, Biodiversity, Conservation, Pollution, Natural Resources, Environmental Degradation, Protection, Sustainable Development, Climate Change, Environmental Justice, Environmental Ethics, Environmental Communication