

**CBCS SYLLABUS**  
**FOR**  
**THREE YEARS UNDER-GRADUATE COURSE**  
**ENVIRONMENTAL SCIENCE (PROGRAMME)**  
*(w.e.f. 2017)*



**BANKURA UNIVERSITY**  
**BANKURA**  
**WEST BENGAL**  
**PIN 722155**

**STRUCTURE IN NUTRITION (PROGRAMME)****SEMESTER – I**

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SP/ENV/101/C-1A	Fundamentals of Environmental Science and Environmental Physics, Chemistry	6 (4+2)	10	40 (25+15)	50	4	-	4
SP/102/ C-2A	Discipline-2	6	10	40	50			
SP/103/ C-3A	Discipline-3	6	10	40	50			
ACSHP/ 104/ AECC-1	Environmental Studies	4	10	40	50	4	-	-
<b>Total in Semester – I</b>		<b>22</b>	<b>40</b>	<b>160</b>	<b>200</b>	<b>8</b>		<b>4</b>

**SEMESTER –II**

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SP/ENV/201/C-1B	Environmental Ecology	6 (4+2)	10	40 (25+15)	50	4	-	4
SP/202/ C-2B	Discipline – 2	6	10	40	50			
SP/ 203/C- 3B	Discipline – 3	6	10	40	50			
ACSHP/204/ AECC-2	English/MIL	2	10	40	50	2	-	-
<b>Total in Semester – II</b>		<b>20</b>	<b>40</b>	<b>160</b>	<b>200</b>	<b>6</b>		<b>4</b>

**SEMESTER – III**

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SP/ENV/ 301/C-1C	Environmental Pollution and human Health	6 (4+2)	10	40 (25+15)	50	4	-	4
SP/302/C-2C	Discipline - 2	6	10	40	50			
SP/ 303/ C-3C	Discipline - 3	6	10	40	50			
SP/ENV /304/ SEC-1	Remote Sensing, Geographic Information System & Modelling	2 (1+1)	10	40 (25+15)	50	1	-	2
<b>Total in Semester - III</b>		<b>20</b>	<b>40</b>	<b>160</b>	<b>200</b>	<b>5</b>		<b>6</b>

**SEMESTER – IV**

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SP/ENV/401/C- 1D	Biodiversity and Conservation of Biodiversity	6 (4+2)	10	40 (25+15)	50	4	-	4
SP/ 402/ C-2D	Discipline-2	6	10	40	50			
SP/ 403/ C-3D	Discipline-3	6	10	40	50			
SP/ENV/404/ SEC-2	Environment Impact & Risk Assessment	2 (1+1)	10	40 (25+15)	50	1	-	2
<b>Total in Semester - IV</b>		<b>20</b>	<b>40</b>	<b>160</b>	<b>200</b>	<b>5</b>		<b>6</b>

**SEMESTER – V**

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SP/ENV/501/DSE-1A	Energy & Environment / Solid Waste Management	6 (4+2)	10	40 (25+15)	50	4	-	4
SP/ 502/DSE-2A	Discipline - 2	6	10	40	50			
SP/ 503/DSE-3A	Discipline - 3	6	10	40	50			
S/PENV/504/SEC-3	Soil Conservation, Management and Ecotourism	2 (1+1)	10	40 (25+15)	50	1	-	2
<b>Total in Semester – V</b>		<b>20</b>	<b>40</b>	<b>160</b>	<b>200</b>	<b>4</b>		<b>8</b>

**SEMESTER – VI**

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SP/ENV/601/DSE-1B	Natural Hazards and Disaster Management/Environmental Economics	6 (4+2)	10	40 (25+15)	50	4	-	4
SP/ 602/DSE-2B	Discipline - 2	6	10	40	50			
SP/ 603/DSE-3B	Discipline - 3	6	10	40	50			
SP/ENV/604/SEC-4	Environmental Pollution Control and Natural Resource Management	2 (1+1)	10	40 (25+15)	50	1	-	2
<b>Total in Semester – VI</b>		<b>20</b>	<b>40</b>	<b>160</b>	<b>200</b>	<b>5</b>		<b>6</b>

SP= Science programme/Pass, Env=Environmental Science, ACSHP= Arts Commerce Science Honours Pass, C= Core Course, MIL= Modern Indian Language, AECC = Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, DSE= Discipline Specific Elective IA= Internal Assessment, ESE= End-Semester Examination, Lec.= Lecture, Tu.= Tutorial, and Pr.=Practical



## SCHEME AND SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM

## B.Sc. WITH ENVIRONMENTAL SCIENCE

	CORE COURSE (12)	Ability Enhancement Compulsory Courses AEC (2)	Skill Enhancement Courses SEC (4)	Discipline Specific Elective DSE (2)
I	UGP/SC/101/C-1A – Fundamentals of Environmental Science and Environmental Physics, Chemistry  UGP/102/C-2A - Discipline-2 UGP /103/C-3A - Discipline-3	UG/ 104/ AECC-ENV - Environmental Studies		
II	UGP/SC/201/C-1B – Environmental Ecology JGP/202/C-2B - Discipline-2 P/203/C-3B - Discipline-3	UG/204/ AECC-E/MIL - English Communication		
III	UGP/SC/301/C-1C – Environmental Pollution and humanHealth  UGP/302/C-2C - Discipline-2 UGP/303/C-3C - Discipline-3		UGP/S.C/304/ SEC-1 Remote Sensing, Geographic Information System & Modelling	
IV	UGP/S.C./401/C-1D --Biodiversity and Conservation ofBiodiversity UGP/402/C-2D - Discipline-2 UGP/403/C-3D - Discipline-3		UGP/S.C/404/ SEC-2 Environment Impact & Risk Assessment	
V			UGP/S.C./504/SEC-3 Soil Conservation, Management and Ecotourism	UGP/S.C./501/DSE-1A-Energy & Environment / Solid Waste Management 2.UGP/ 502/DSE-2A-Discipline -2 3.UGP/502/DSE-2A
VI			UGP/S.C./604/SEC-4 Environmental Pollution Control and Natural Resource Management	UGP/S.C./ 601/DSE-1B- Natural Hazards and Disaster Management/Environmental Economics  2.UGP/ 602/DSE-2B-Discipline- 2 3.UGP/ 602/DSE-3B-Discipline- 3



**SCHEME AND SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM**

**B.Sc. WITH ENVIRONMENTAL SCIENCE**

**Discipline Core Courses: Environmental Science**

1. Fundamentals of Environmental Science and Social Issues
2. Environmental Ecology, Human-Wildlife Conflict and Management
3. Gender and Environment
4. Conservation of Biodiversityand Green Technologies

**Discipline Specific Electives: Environmental Science**

1. Energy and Environment/Solid Waste Management
2. Natural Hazardsand Disaster Management/Environmental Economics

**Skill Enhancement Courses: Environmental Science**

1. Remote Sensing, Geographic Information System &Modelling
2. Environment Impact &Risk Assessment
3. Soil Conservation, Management and Ecotourism
4. Environmental Pollution Control and Natural Resource Management



**SEMESTER-I**  
**CORE COURSE I**  
**FUNDAMENTALS OF ENVIRONMENTAL SCIENCE AND SOCIAL ISSUES**  
(SPENV/101/C-1A)  
**Credit:06**

**Theory: Marks: 25; Credit: 04**

**Unit 1: Introduction (4 lectures)**

Social and cultural construction of 'environment'; environmental thought from historical and contemporary perspective; Environmental education and Ethics; Deep and shallow ecology.

**Unit 2: Issues in environmentalism**

**(6 lectures)**

Significant global environmental issues such as climate change, and resource depletion; historical developments in cultural, social and economic issues related to land, forest, and water management in a global context.

**Unit 3: Development-environment conflict (6 lectures)**

Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: discussion on Project Affected People (PAPs).

**Unit 4: Urbanization and environment (4 lectures)**

Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; traffic congestion and social-economic problems.

**Unit 5: Environment and social inequalities**

**(10 lectures)**

Inequalities of race, class, gender, region, and nation-state in access to healthy and safe environments; history and politics surrounding environmental, ecological and social justice.

**Unit 6: Regulatory framework (4 lectures)**

Brief account of Forest Conservation Act 1980, 1988; Land Acquisition Act, 1894, 2007, 2011, 2012; Land Acquisition Rehabilitation and Resettlement Act, 2013.

**Unit 7: Community participation (6 lecture)**

State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement); role played by NGOs.

**Practical: Marks: 15; Credit:2**



Tutorials, analysis and exercise based on:

- A) Preparation of Environmental Impact Assessment of any developmental project.
- B) Urban Traffic Survey to assess the vehicular pollution.
- C) Environmental Perception survey in rural or urban area.
- D) To study a soil profile; Measurement of soil temperature and moisture, organic carbon and NPK.
- E) To determine pH, chloride, sulphate and nitrate composition of soil.

### Suggested Readings

1. Chokkan, K.B., Pandya, H. & Raghunathan, H. (eds). 2004. *Understanding Environment*. Sagar Publication India Pvt. Ltd., New Delhi.
2. Elliot, D. 2003. *Energy, Society and Environment, Technology for a Sustainable Future*. Routledge Press.
3. Guha, R. 1989. *Ecological change and peasant resistance in the Himalaya*. Unquiet Woods, Oxford University Press, Delhi.
4. Leopold, A. 1949. *The Land Ethic*. pp. 201-214. Chicago, USA.
5. National Research Council (NRC). 1996. *Linking Science and Technology to Society's Environmental Goals*. National Academy Press.
6. Pandit, M.K. 2013. Chipko: Failure of a Successful Conservation Movement. In: Sodhi, N.S., Gibson, L. & Raven, P.H. *Conservation Biology: Voices from the Tropics*. pp. 126-127. Wiley-Blackwell, Oxford, UK.
7. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publications.
8. Wilson, E. O. 1985. The Biological Diversity Crisis. *BioScience* **35**: 700-706.
9. Environmental Chemistry: A K De; New Age International Pvt. Ltd
10. ErachBharucha, 2016. Text Book of Environmental Studies for Undergraduate Courses (Second Edition) for UGC. University Press.





**SEMESTER-II**  
**CORE COURSE II**  
**ENVIRONMENTAL ECOLOGY, HUMAN-WILDLIFE CONFLICT**  
**AND MANAGEMENT**  
(SPENV /201/C-1B)      **Credit:06**

**THEORY: Marks: 25; Credit: 4**

**UNIT I: Basics of Ecology:**

**(Lectures-06)**

Concept and ideas on environment: Definition, Components; Environmental education: Primary objectives, Types and guiding principles; Environmental ethics, Earth: Constituents and compartments (Atmosphere, Lithosphere, Hydrosphere and Biosphere); Environmental awareness in India.

**Unit 2: Introduction to wildlife management**

**(06 lectures)**

Need and policy frame of wildlife conservation: philosophy of wildlife management; Role of government, wildlife biologists.

**Unit 3: Evolution of the concept of wildlife management**

**(04 lectures)**

Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetkawall paintings; excerpts from rock edicts; Bishnoi community.

**Unit 4: Wildlife conservation laws in India**

**(04 lectures)**

Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Brief introduction to Wildlife Protection Act, 1972; Forest Act, 1927; Environmental Protection Act, 1986; and Forest conservation Act, 1920.

**Unit 5: Socio-economic and legal basis of conflicts**

**(10 lectures)**

Concepts of development and encroachment, Impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation; introduction to tribal rights in India, demographic profile of tribes in India, importance of forest product, Scheduled tribes and other traditional Forest dwellers (Recognition of forest right) Act, 2006.

**Unit 6: Wildlife conflicts**

**(04 lectures)**

Insight into the important conflicts:, Human and elephant conflicts of JUNGLEMAHAL, Fisherman and tiger conflict of Sundarbans, Farmer and Bison conflict in North Bihar Plain.

**Unit 7: Human wild life coexistence**

**(06 lectures)**

Conservation of indigenous culture and traditions, role of international organizations: Man and biosphere programmes; concept of conservation reserves and community reserves, importance of wildlife corridors in minimizing the conflicts and conservation.

**Practical: Marks:15; Credit: 02**

1. Identification with reasons of the following
  - A) Study of microfauna of water viz., plankton, (e.g., *Brachionus*, *Keratella*, *Cyclops*, *Cypris*, *Diaptomus*, *Nauplius larva*, *Bosmina*, *Moina*, *Eubbranchipus*)
  - B) Study of aquatic flora, e.g., *Spirogyra*, *Zygnema*, *Pistia*, *Eichhornia*, *Hydrilla*, *Ceratophyllum*, *Ipomoea*, *Azolla*, *Lemna* (minor and major), *Limnophilia*, *Marselea*, *Nymphaeae*, *Nelumbo*.
2. Preparation of field report based on the visit to a Wild Life Sanctuary/National Park/Zoo/Biosphere Reserve.  
Or  
Project Report to be submitted on Human Elephant conflict in Junglemahal

**Suggested Readings**

1. Conover, M. 2001. *Resolving Human Wildlife Conflicts*, CRC Press.
2. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation* **13**: 458-466.
3. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. *International Biodeterioration & Biodegradation* **45**: 97-102.
4. Paty, C. 2007. *Forest Government and Tribe*. Concept Publishing Company.
5. Treves, A. & Karanth, K. U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology* **17**: 1491-1499.
6. Woodroffe, R. 2005. *People and Wildlife: Conflict and Coexistence*. Cambridge.
7. Woodroffe, R., Thirgood, S., & Rabinowitz, A. 2005. *People and Wildlife, Conflict or Coexistence?* (No. 9). Cambridge University Press.
8. Environmental Biology: Biswarup Mukherjee; Tata McGraw-Hill Publishing Com. Ltd.
9. Fundamentals of Ecology: M C Dash, McGraw Hill Publishers
10. Elements of Ecology: Smith and Smith, Pearson Publishers
11. Saha T.K. 2010. Ecology and Environmental Biology, Books and Allied (P) Ltd. Kolkata.
12. Santra S.C. 2005. Environmental Science, New Central Book Agency (P) Ltd. Kolkata.
13. Environmental Studies—Prof S.V.S Rana. --Rastogi Publication.
14. Text book of Ecology: The Experimental Analysis of distribution & abundance--(Charles J. Krebs). Pearson Education.



**SEMESTER-III**  
**CORE COURSE III**  
**GENDER AND ENVIRONMENT**  
(SPENV / 301/C-1C) **Credit: 06**

**Theory: Marks: 25; Credit: 04**

**Unit 1: Introduction** (2  
**lectures)**

The socially constructed 'gender' concept.

**Unit 2: Gender and society** (04  
**lectures)**

Gender existence in society; gender: matriarchy and patriarchy (case studies in an Indian context); gender equity issues in rural and urban settings.

**Unit 3: Gender and the environment** (08  
**lectures)**

Relevance of the concept in an environmental context; evolution of gender hierarchies in historical and contemporary perspective; gendered division of roles in cultural, social and economic perspective; gender inequalities.

**Unit 4: Gender, resources and the environment** (08  
**lectures)**

Human –Environment relationship; differential dependencies on environmental resources; implications of gendered responses to environmental degradation.

**Unit 6: Gender and environmental management** (08  
**lectures)**

Women's participation in environmental movements and conservation; Role of women in environmental education, awareness and sustainable development.

**Unit 7: Strategies for change** (10  
**lectures)**

Need for gender equity; Instruments for change: education, media, action groups, policy and management; role of ICT in resource availability and consumption.

**Practical: Marks: 15; Credit: 02**

A Project/ Review work, Term-paper on environmental management or Any Global crisis.

**Suggested Readings**

1. Agarwal, B. 1992. *The Gender and Environment Debate: Lessons from India*. Feminist Studies (Minnesota).
2. Agarwal, B. 1997. Gender, Environment and Poverty Interlinks: Regional Variations and Temporal Shifts in Rural India: 1971-1991. *World Development* **25**: 1-42.
3. Agarwal, B. 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World Development* **29**: 1623-1648.
4. Jackson, C.1993.Doinwhatcomesnaturally? Women and environment in development *World Development* **21**: 1947-63.
5. Krishna, S. 2004. *Livelihood and Gender*. New Delhi, Sage.
6. Leach, M. 2007. Earth Mother myths and other ecofeminist fables: How a strategic notion rose and fell. *Development and Change* **38**: 67-85.
7. Miller, B. 1993. *Sex and Gender Hierarchies*. Cambridge University Press
8. Stein, R. (ed.). 2004. *New Perspectives on Environmental Justice: Gender, Sexuality, and Activism*. Rutgers University Press.
9. Steingraber, S. 1998. *Living Downstream: A Scientist's Personal Investigation of Cancer and the Environment*. New York: Vintage Books.
10. Zwarteveen, M.Z. 1995. *Linking women to the main canal: Gender and irrigation management*. Gatekeeper Series 54, IIED.

**SKILL ENHANCEMENT COURSE 1:****(SPENV /304/ SEC-1)****REMOTE SENSING, GEOGRAPHIC INFORMATION SYSTEM & MODELLING****Credit: 02****Theory: Marks 25(Lectures: 30)**

**Unit 1:** Remote Sensing: definitions and principles; electromagnetic spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation.

**(Lectures 07)**

**Unit 2:** Geographical Information Systems: definitions and components; spatial and non-spatial data; database generation; database management system; land use/ land cover mapping; data import, processing, and mapping. **(Lectures 07)**

**Unit 3:** Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies. **(Lectures 06)**

**Unit 4:** Basic elements of statistical analyses: Frequency Distribution; sampling; types, errors and fluctuation; measures of central tendency and dispersion; skewness; correlation and regression; curve fitting; Standard Error of Estimate; Absolute Regression Residual Mapping **(Lectures 10)**

**Practical: Marks: 15**

A Project File, comprising one exercise each is to be submitted

- B. Georeferencing of maps and images
- C. Image classification, post-classification analysis and class editing
- D. Overlay and preparation of thematic map
- E. Plotting of GPS data in Microsoft Excel
- F. GPS data downloading in software and mapping.

**Suggested Readings**

1. Das N.G. 2010, Statistical Methods Combined Edition (Vol-I & II), Tata McGraw Hill Education Private Ltd., New Delhi
2. Mahmood A. 2012, Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi
3. Sarkar A. 2013, Quantitative Geography: Techniques and Presentations, Orient Black Swan, Kolkata
4. Zar, J.H. 2010. *Biostatistical Analysis* (5<sup>th</sup> edition). Prentice Hall Publications.
5. Edmondson, A. & Druce, D. 1996. *Advanced Biology Statistics*. Oxford University Press.
6. Demers, M.N. 2005. *Fundamentals of Geographic Information System*. Wiley & Sons.
7. Fazal S. 2008, GIS Basics, New Age International Publishers, New Delhi
8. Richards, J. A. & Jia, X. 1999. *Remote Sensing and Digital Image Processing*. Springer.
9. Sabins, F. F. 1996. *Remote Sensing: Principles and Interpretation*. W. H. Freeman.



**SEMESTER-IV**  
**CORE COURSE IV**  
**CONSERVATION OF BIODIVERSITY AND GREEN TECHNOLOGIES**  
(SPENV /401/C-1D)

**Credit: 06**

**THEORY: Marks: 25; Credit: 04**

**Unit 1: Introduction**

**(5 lectures)**

Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; energy conservation; encouraged use of public transport instead of private transport.

**Unit 2: Green technologies**

**(5 lectures)**

Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3 R's of green technology: recycle, renew and reduce; paradigm shift from 'cradle to cradle' to 'cradle to grave'

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

**(05 lectures)**

Concept and frame of Green buildings; construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building.

Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development.

**Unit 4: Applications of green technologies**

**(05 lectures)**

Compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats. Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets. Basics of- Pollution reduction and removal, Flue Gas Desulfurization (FGD) methods, Low Volatile Organic Compound (VOC) paints and sealers.

**Unit 5: Green future**

**(10 lectures)**

Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); development of environmental friendly technologies.

**Unit 6: Conservation of biodiversity**

**(10 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),

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.



**Practical: Marks: 15; Credit: 02**

Tutorials and field based.

**Suggested Readings**

1. Anastas, P.T. & Warner, J.C. 1998. *Green Chemistry: Theory & Practice*. Oxford University Press.
2. Arceivala, S.L. 2014. *Green Technologies: For a Better Future*. Mc-Graw Hill Publications.
3. Baker, S. 2006. *Sustainable Development*. Routledge Press.
4. 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.
5. Thangavel, P. &Sridevi, G. 2015. *Environmental Sustainability: Role of Green Technologies*. Springer Publications.
6. Woolley, T. &Kimmins, S. 2002. *Green Building Handbook* (Volume 1 and 2). Spon Press.

**SKILL ENHANCEMENT COURSE 2:****( SPENV /404/ SEC-2)****ENVIRONMENTAL IMPACT AND RISK ASSESSMENT****Credit: 02****THEORY: Marks: 25****(Lectures: 30)**

**Unit 1:** Environmental impact assessment (EIA): definitions, introduction and concepts; rationale and historical development of EIA; scope and methodologies of EIA; Impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP): principles, problems and strategies **(Lectures 08)**

**Unit 2: Strategic** Environmental Assessment; Social Impact Assessment; Cost-Benefit analysis; Life cycle assessment; environmental appraisal; environmental planning; environmental audit; Principles/Characterization of Internal Standard Organisation **(Lectures 06)**

**Unit 3:** EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects/ thermal projects. **(Lectures 06)**

**Unit 4:** 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. **(Lectures 10)**

**PRACTICALS: Marks: 15**

A Project File, comprising one exercise each is to be submitted

- a) Impact Assessment Methods- Adhoc, Matrix- simple, weighted, Checklist methods
- b) Preparation of Environmental Impact Statement (EIS)
- c) Risk Zone Mapping

**Suggested Readings**

1. Barrow, C.J. 2000. *Social Impact Assessment: An Introduction*. Oxford University Press.
2. Glasson, J., Therivel, R., Chadwick, A. 1994. *Introduction to Environmental Impact Assessment*. London, Research Press, UK.
3. Judith, P. 1999. *Handbook of Environmental Impact Assessment*. Blackwell Science.
4. Marriott, B. 1997. *Environmental Impact Assessment: A Practical Guide*. McGraw-Hill, New York, USA.
5. Westman W.E. 1985, Ecology, Impact Assessment and Environmental Planning, John Wiley, New York





**SEMESTER-V**  
**DISCIPLINE SPECIFIC ELECTIVE 1:**  
**( SPENV /501/DSE-1A)**  
**ENERGY AND ENVIRONMENT**

**Credit: 06**

**Theory: Marks: 25; Credit:04**

**Unit 1: Introduction**

Defining energy; forms and importance; energy use from a historical perspective: sources and sinks of energy; energy over-consumption in urban setting

**Unit 2: Energy resources**

Global energy resources; renewable and non-renewable resources: distribution and availability; energy-use scenarios in rural and urban setups; energy conservation.

**Unit 3: Energy demand**

Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector; generation and utilization in rural and urban environments; changes in demand in major world economies; energy subsidies and environmental costs.

**Unit 4: Energy, environment and society**

Nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, greenhouse effect, global warming and, urban heat island effect; nuclear energy and related issues such as radioactive waste, spent fuel; social inequalities related to energy production, distribution, and use.

**Unit 5: Energy, ecology and the environment**

Energy production, transformation and utilization associated environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution); energy over-consumption and its impact on the environment, economy, and global change.

**Unit 6: Politics of energy policy**

Political choices in energy policy globally and in the Indian context (historical and contemporary case studies); domestic and international energy policy; energy diplomacy and bilateral ties of India with her neighbors.

**Unit 7: Our energy future**

Current and future energy use patterns in the world and in India; evolution of energy use over time; alternative sources as green energy (biofuels, wind energy, solar energy, geothermal energy; ocean energy; nuclear energy); need for energy efficiency; energy conservation and sustainability; Strategies for sustainable energy mix and management.



**Practical: Marks: 15; Credit:02**

Tutorial-based.

**Suggested Readings**

1. McKibben, B. 2012. *Global Warming's Terrifying New Math*, Rolling Stone Magazine.
2. Craig. J.R., Vaughan, D.J., Skinner. B.J. 1996. *Resources of the Earth: Origin, use, and environmental impact* (2<sup>nd</sup> edition). Prentice Hall, New Jersey.
3. Elliott, D. 1997. *Sustainable Technology. Energy, Society and Environment* (Chapter 3). New York, Routledge Press.
4. Rowlands, I.H. 2009. *Renewable Electricity: The Prospects for Innovation and Integration in Provincial Policies* in Debora L. Van Nijnatten and Robert Boardman (eds), *Canadian Environmental Policy and Politics: Prospects for Leadership and Innovation*, Third Edition. Oxford University Press, pp. 167-82.
5. Oliver, J. 2013. *Dispelling the Myths about Canada's Energy Future*, Policy: Canadian Politics and Public Policy, June-July.
6. Mallon, K. 2006. *Myths, Pitfalls and Oversights, Renewable Energy Policy and Politics: A Handbook for Decision-Making*. EarthScan.

**ALTERNATIVE DISCIPLINE SPECIFIC ELECTIVE FOR SEMESTER-V****DISCIPLINE SPECIFIC ELECTIVE 1:****( SPENV /501/DSE-1A)****SOLID WASTE MANAGEMENT****Credit: 06****THEORY: Marks: 25; Credit: 04****Unit 1: Introduction**

Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.

**Unit 2: Effect of solid waste disposal on environment**

Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

**Unit 3: Solid waste Management**

Collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; disadvantages in waste management techniques.

**Unit 4: Industrial waste management**

Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant.

**Unit 5: Resource Recovery**

4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

**Unit 6: Waste- to- energy (WTE)**

Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.

**Unit 7: Integrated waste management**

Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management.

**Unit 8: Life cycle assessment (LCA)**

Cradle to grave approach; lifecycle inventory of solid waste; role of LCA in waste management; advantage and limitation of LCA; case study on LCA of a product.

**Unit 9: Policies for solid waste**

Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Ecofriendly or green products.

**Practical: Marks: 15; Credit: 02**

- A) A study of local resources and types of industrial waste.
- B) Demonstration of composting technique.

**Suggested Readings**

1. Asnani, P. U. 2006. Solid waste management. *India Infrastructure Report 570*.
2. Bagchi, A. 2004. *Design of Landfills and Integrated Solid Waste Management*. John Wiley & Sons.
3. Blackman, W.C. 2001. *Basic Hazardous Waste Management*. CRC Press.
4. McDougall, F. R., White, P. R., Franke, M., &Hindle, P. 2008. *Integrated Solid Waste Management: A Life Cycle Inventory*. John Wiley & Sons.
5. US EPA. 1999. *Guide for Industrial Waste Management*. WashingtonD.C.
6. White, P.R., Franke, M. &Hindle P. 1995. *Integrated Solid waste Management: A Lifecycle Inventory*. Blackie Academic & Professionals.
7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. *Improving Municipal Solid waste Management in India*. The World Bank, Washington D.C.

**SKILL ENHANCEMENT COURSE 3:****( SPENV /504/SEC-3); Credit: 02****SOIL CONSERVATION, MANAGEMENT AND ECOTOURISM****Theory: Marks: 25****(Lectures: 30)****Unit 1: Fundamentals of soil science****(8 lectures)**

Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil organic matter. Development of soil profile: Laterite and Pedzol, need for soil conservation and restoration of soil fertility.

**Unit 2: Soil degradation – causes****(8 lectures)**

Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, industrial and urban development.

**Unit 3: Controlling land degradation****(8 lectures)**

Sustainable landuse planning; role of databases and data analysis in landuse planning control and management; land tenure and land policy; legal, institutional and sociological factors; participatory land degradation assessment; integrating land degradation assessment into conservation.

**Unit 4: Ecotourism (6 lectures)**

Elementary idea of Mass tourism and its Impact on environment and culture; Concept of Ecotourism, Guideline and policy (National and International) of ecotourism; Planning of ecotourism; Ecotourism circuit development; Types of Alternative Tourism, Elementary idea of Rural tourism, Adventure tourism; Development, economical benefits and impacts of Ecotourism; Management of ecotourism; Ecotourism potentiality in India - Case study (ecotourism in Kenya, India and Australia)

**Practical: Marks: 15**

A Characterization of soil Laterite, Pedzol— Texture, Bulk density, Porosity

B) Determination of Soil parameters—pH, Colour, and conductivity.

**Suggested Readings**

1. Brady, N.C. & Well, R.R. 2007. *The Nature and Properties of Soils* (13<sup>th</sup> edition), Pearson Education Inc.
2. Gadgil, M. 1993. Biodiversity and India's degraded lands. *Ambio* **22**: 167-172.



3. Johnson, D.L. 2006. *Land Degradation* (2<sup>nd</sup> edition). Rowman&Little field Publishers.
4. Marsh, W. M. &Dozier,J. 1983. *Landscape Planning: Environmental Applications*. John Wiley and Sons.
5. Oldeman, L. R. 1994. The global extent of soil degradation. *Soil resilience and sustainable land use*, 9. ([http://library.wur.nl/isric/fulltext/isricu\\_i26803\\_001.pdf](http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf)).
6. Pandit, M .K. *et al.*, 2007. Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. *Biodiversity Conservation* **16**: 153-163.
7. Pandit, M.K. & Kumar, V. 2013. Land use and conservation challenges in Himalaya: Past, present and future. In: Sodhi, N.S., Gibson, L. & Raven, P.H. *Conservation Biology: Voices from the Tropics*. pp. 123-133. Wiley-Blackwell, Oxford, UK
8. Peterson, G. D., Cumming, G. S. & Carpenter, S. R. 2003. Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* **17**: 358-366.
9. Scherr, S. J. 1999. *Soil degradation: A threat to developing-country food security by 2020* (Vol. 27). International Food Policy Research Institute.

**SEMESTER-VI****DISCIPLINE SPECIFIC ELECTIVE 2:****( SPENV / 601/DSE-1B)****NATURAL HAZARDS AND DISASTER MANAGEMENT****Credit: 06****THEORY, Marks: 25, Credit: 04****Unit 1: Introduction**

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 hazards**

Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought - meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF); tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

**Unit 3: Anthropogenic hazards**

Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, mangroves destruction; role of construction along river banks in elevating flood hazard; disturbing flood plains. Deforestation and landslide; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.

**Unit 4: Risk and vulnerability assessment**

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 5: Mitigation and preparedness**

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 6: Disaster management in India**



Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster, and Bhopal tragedy; National Disaster Management Framework, national response mechanism, 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 during cyclone 'Phailin' in 2013.

**Practical; Marks: 15; Credit: 02**

A Project File, comprising one exercise each is to be submitted

Construction of Hydrograph, Unit Hydrograph, Rating Curve

C.Risk and Vulnerability Analysis of any hazard

D.Vulnerability Mapping

**Suggested Readings**

1. Coppola D. P. 2007. *Introduction to International Disaster Management*. Butterworth Heinemann.
2. Cutter, S.L. 2012. *Hazards Vulnerability and Environmental Justice*. EarthScan, Routledge Press.
3. Keller, E. A. 1996. *Introduction to Environmental Geology*. Prentice Hall, Upper Saddle River, New Jersey.
4. Pine, J.C. 2009. *Natural Hazards Analysis: Reducing the Impact of Disasters*. CRC Press, Taylor and Francis Group.
5. Schneid, T.D. & Collins, L. 2001. *Disaster Management and Preparedness*. Lewis Publishers, New York, NY.
6. Smith, K. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge Press.
7. Wallace, J.M. & Hobbs, P.V. 1977. *Atmospheric Science: An Introductory Survey*. Academic Press, New York.
8. 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.



**ALTERNATIVE DISCIPLINE SPECIFIC ELECTIVE FOR SEMESTER-VI****DISCIPLINE SPECIFIC ELECTIVE 2:****(UGP/S.C/ 601/DSE-1B)****ENVIRONMENTAL ECONOMICS****Credit: 06****THEORY- Marks: 25; Credit: 04****Unit1: Introduction to microeconomics**

Definition and scope of environmental economics; environmental economics versus traditional economics; brief introduction to major components of economy: consumer, firm and their interaction in the market, producer and consumer surplus, market failure, law of demand and supply, tangible and non-tangible goods; utilitarianism; Pareto optimality; compensation principle.

**Unit 2: Environmental economics**

Main characteristics of environmental goods; marginal analysis; markets and market failure; social benefit, costs and welfare functions; meaning and types of environmental values; measures of economic values; tangible and intangible benefits; Pareto principle or criterion; Hardin's Thesis of 'The Tragedy of Commons'; prisoner's dilemma game; methods of abatement of externalities; social cost benefit analysis; cost-effectiveness analysis.

**Unit 3: Economic solutions to environmental problems**

Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginal social cost of abatement; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards vs. emissions charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.

**Unit 4: Natural resource economics (5 lectures)**

Economics of non-renewable resources; economics of fuels and minerals; Hotelling's rule and Extensions; taxation; economics of renewable resources; economics of water use, management of fisheries and forests; introduction to natural resource accounting.

**Unit 5: Tools for environmental economic policy**

Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis, assessing benefits and cost for environmental decision making; cost benefit analysis and valuation: discounting, principles of Cost-Benefit Analysis, estimation of costs and benefits, techniques of valuation, adjusting and comparing environmental benefits and costs.

**Practical: Marks: 15, Credit: 02**

Tutorials, analysis and exercise based.



**Suggested Readings:**

1. Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C.S., Jansson, B.O., Levin, S., Maler, K.G., Perrings, C., Pimentel, D. 1995. Economic growth, carrying capacity, and the environment. *Ecological Economics* 15: 91-95.
2. Hanley, N., Shogren, J. F., & White, B. 2007. *Environmental Economics: In Theory and Practice*. Palgrave Macmillan.
3. Kolstad, C.D. 2010. *Environmental Economics*. Oxford University Press.
4. Perman, R. 2003. *Natural Resource and Environmental Economics*. Pearson Education.
5. Singh, K. & Shishodia, A. 2007. *Environmental Economics: Theory and Applications*. Sage Publications.
6. Thomas, J.M. & Callan, S.J. 2007. *Environmental Economics*. Thomson Learning Inc.
7. Tietenberg, T. 2004. *Environmental and Natural Resource Economics (6th Edition)*. Pearson Education Pvt. Ltd.
8. Tietenberg, T. H. & Lewis, L. 2010. *Environmental Economics and Policy*. Addison-Wesley.
9. Turner, R. K., Pearce, D., & Bateman, I. 1994. *Environmental Economics: An Elementary Introduction*. Harvester Wheatsheaf



**SKILL ENHANCEMENT COURSE 4:**  
**( SPENV / 604/SEC-4)**  
**ENVIRONMENTAL POLLUTION CONTROL AND NATURAL RESOURCE**  
**MANAGEMENT**  
**Credit: 02**

**Theory: Marks: 25 (30 Lectures)**

**Unit 1: Air, Water, Soil and Radioactive pollution (10 lectures)**

Sources and types of pollutants (primary and secondary); effects of different pollutants on human health (NO<sub>x</sub>, SO<sub>x</sub>, PM, CO, CO<sub>2</sub>, hydrocarbons and VOCs) and control measures; Sources of surface and ground water pollution; organic waste and water pollution; eutrophication; COD, BOD; Causes of soil pollution and degradation; effect of soil pollution on environment, control strategies. Radioactive material and sources of radioactive pollution; effect of radiation on human health

**Unit 2: Pollution control (8 lectures)**

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, bio scrubbers, bio trickling filters; regulatory framework for pollution monitoring and control.

**Unit 3: Natural resources and conservation (5 lectures)**

Forest resources: economic and ecological importance of forests, forest management strategies, strategies of water conservation; soil resources: importance of soil, soil conservation strategies; food resources: world food problem,

**Unit 4: Resource management (7 lectures)**

Approaches in resource management: ecological approach; economic approach; implications of the approaches; integrated resource management strategies; concept of sustainability: different approach towards sustainable development and its different constituents; sustainability of society, resources and framework; sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.

**Practical: Marks: 15**

- A) Identification and listing of different types of water and soil pollutants in the locality.
- B) LC<sub>50</sub> calculation by probit analysis with data provided (theoretical).
- C) To determine energy efficiencies from the given data



### Suggested Readings

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. *Air Pollution: Health and Environmental Impacts*. CRC Press, Taylor & Francis.
2. Hester, R.E. & Harrison, R.M. 1998. *Air Pollution and Health*. The Royal Society of Chemistry, UK.
3. Park, K. 2015. *Park's Textbook of Preventive and Social Medicine* (23<sup>rd</sup> edition). Banarsidas Bhanot Publishers.
4. Freeman, A.M. 2001. *Measures of value and Resources: Resources for the Future*. Washington DC.
5. Owen, O.S, Chiras, D.D, & Reganold, J.P. 1998. *Natural Resource Conservation – Management for Sustainable Future* (7<sup>th</sup> edition). PrenticeHall.
6. Ramade, F. 1984. *Ecology of Natural Resources*. John Wiley & Sons Ltd.