Estd.1917

पटना विश्वविद्यालय

PATNA UNIVERSITY

NAAC Accredited B+ Grade

Letter No. Acad/ 1670 Dated: 01-12-2020

To

1. The Programme Director-cum-Principal,
   Self-financing programmes,
   Patna Science College, Patna University
2. The Controller of Examinations,
   Patna University

Subject:-Regarding approval of the syllabus under CBCS of semester II to VI of B.Sc.(Hons.) in Environmental Science, a self-financing programme received vide the letter No.1378/139 dated 15/06/2020 of the Principal, Patna Science College-cum-Dean, Faculty of Science, Patna University.

Sir,

With reference to the above-noted subject, I am directed to inform that the Academic council vide its agenda noted below has taken the following resolution:-

Agenda AC 20.2.17

Resolution:- It was resolved to approve the syllabus.

Submitted for necessary action.

Enclosures:- As above, copies of the approved syllabus.

Yours faithfully,

Registrar
Patna University, Patna

Memo No. Acad/ 1671 Dated: 01-12-2020

Copy forwarded to the Incharge, Patna University Computer Centre for uploading this letter and the approved syllabus on the University website.

Registrar
Patna University, Patna

25/11/2020

375.

OFFICE OF THEPRINCIPAL

PATNA SCIENCE COLLEGE, PATNA
Phone No.0612-6453576,6453577,Fax.No.0612-2665151

L.No 1378/140
15.6.2020

Date :15.06.2020

To,
The Deputy Registrar
Patna University
Patna

Sub: Submission of the syllabus of B.Sc.(Hons.)in Environmental Science

Sir,

The complete syllabus of B.Sc. (Hons.) in Environmental Science is submitted herewith for necessary action.

Yours faithfully

15-6-20

(S.R. Padmadeo)
PRINCIPAL
PATNA SCIENCE COLLEGE
PATNA-800005

15/06/2020

DEPARTMENT OF BOTANY

(B.Sc. (Hons) in Environmental Science)

PATNA SCIENCE COLLEGE

Phone No: 0612-6453576, 6453577, Fax No.0612-2665151

To
The Deputy Registrar
Patna University
Patna

Date: 12.06.2020

Subject:Submission of Complete CBCS syllabus of B.Sc. Environmental Science for all semester (SEM- I, II, III, IV, V and VI).

Sir,

Please find enclosed a copy of complete syllabus of B.Sc. Environmental Science (2019-202 2) under C.B.C.S. system for all semester (SEM- I, II, III, IV, V and VI).

Yours Faithfully

Coordinator
Environmental Science

Head
Department of Botany

Principal
Patna Science College

PRINCIPAL
PATNA SCIENCE COLLEGE
PATNA-800 005

Dated- 03/06/20

Notification

A committee is being constituted to frame B.Sc (H) Environmental Science Syllabus, under CBCS pattern, from Semester I to Semester VI. The members are as below-

1. Professor Maheshwar Prasad Trivedi
   Head of the Department of Botany, Patna University. - Convenor

2. Professor Meenakshi Singh
   Head of the Department of Botany, Patna Science College. - Member

3. Professor Reena Mohanka
   Head of the Department of Biochemistry, Patna University. - Member

4. Professor Birendra Prasad
   Co-ordinator Biotechnology, Patna University. - Memeber

5. Dr. Punam Ranjan
   Assistant Professor, Co-ordinator Environmental Science
   Patna Science College. - Memeber

The Co-ordinator Environmental Science, is requested to frame the syllabus, co-ordinate with the members and present it for approval on 12/06/20 at 1 PM, in the office chamber of The Head, Department of Botany, Patna University.

3.6.2020

Punam Ranjan 12/06/20

12/6/2020

Reena 12/6/20

12.6.2020

12/6/2020

Table 1 . Description of courses for B. Sc (Hons) Environmental Science degree in the faculty of Science under CBCS

Semester	Course/ Paper Code	Nature of Course/ Paper	Marks	Marks of CIA	Marks of ESE		Passing criterion	Qualifying Criterion
					T	P		
SEMESTER I	BESC CC- 01	Ecology and Ecosystems	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 02	Environmental Pollution and Human Health	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC GE- 1	Chemistry-1	100	30	50	20	45% in CIA 45% in ESE	Qualifying
	BESC AECC- 1	English composition	100	30	70		45% in CIA 45% in ESE	Qualifying
SEM ESTER II	BESC CC- 03	Water and water resources	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 04	Land and soil Conservation and management	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC GE- 2	Chemistry-2	100	30	50	20	45% in CIA 45% in ESE	Qualifying
	BESC AECC- 2	Computer applications	100	30	70		45% in CIA 45% in ESE	Qualifying
SEMESTER III	BESC CC- 05	Physics and Chemistry of Environment	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 06	Environmental Biotechnology	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 07	Atmosphere and Global Climatic Change	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC GE- 3	Botany 1	100	30	50	20	45% in CIA 45% in ESE	Qualifying
	BESC SEC -1	Mushroom Culture	100	30	70		45% in CIA 45% in ESE	Qualifying
SEMESTER IV	BESC CC- 8	Systematics and Biogeography	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 9	Urban Ecosystem	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 10	Environmental Legislation and Policy	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC GE- 4	Botany 2	100	30	50	20	45% in CIA 45% in ESE	Qualifying
	BESC SEC -2	Solid Waste Management	100	30	70		45% in CIA 45% in ESE	Qualifying

Laxman Ranjan 12/06/20

12/6/2020

Leena 12/6/20

12/06/2020

17.6.2020

Semester	Course/ aper Code	Nature of Course/ Paper	arks	Marks of CIA	Marks of ESE		Passing criterion	Qualifying Criterion
					T	P		
SEMESTER V	BESC CC- 11	Biodiversity and conservation	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 12	Organismal and evolutionary biology	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC DSE- 1	Green Technology	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC DSE- 2	Environmental Economics	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
SEMESTER VI	BESC CC- 13	Earth and earth surface processes	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC CC- 14	Natural resources management & sustainability	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC DSE- 3	Environment Impact and Risk Assessment	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA
	BESC DSE- 4	Human Wildlife conflict and Management	100	30	50	20	45% in CIA 45% in ESE	Marks decide class/ CGPA

- T = Theory; P = Practical.

Kiran Ranjan 12/6/2020

12.6.2020 12/6/2020 Leena 12/06/20 12/06/2020

Bachelor in Environmental Science (Hons) Paper Code BESCC Courses/ Paper Sequence					
Year 1 Semester 1	Year 1 Semester 2	Year 2 Semester 1	Year2 Semester 2	Year 3 Semester 1	Year 3 Semester 2
CC- 01 Ecology and Ecosystems	CC- 03 Water and water resources	CC- 05 Physics and Chemistry of Environment	CC- 8 Systematics and Biogeography	CC- 11 Biodiversity and conservation	CC- 13 Earth and earth surface processes
CC- 02 Environmental Pollution and Human Health	CC- 04 Land and soil Conservation and management	CC- 06 Environmental Biotechnology	CC- 9 Urban Ecosystem	CC- 12 Organismal and Evolutionary biology	CC- 14 Natural resources management & sustainability
GE- 1 Chemistry-1	GE- 2 Chemistry-2	CC- 07 Atmosphere and Global Climatic Change	CC- 10 Environmental Legislation and Policy	DSE- 1 Green Technology	DSE- 3 Environment Impact and Risk Assessment
AECC- 1 English composition	AECC- 2 Computer applications	GE- 3 Botany 1	GE- 4 Botany 2	DSE- 2 Environmental Economics	DSE- 4 Human Wildlife conflict and Management
		SEC -1 Mushroom Culture	SEC -2 Solid Waste Management		

- CC- CORE COURSE, DSE- DISCIPLINE SPECIFIC ELECTIVE, and GE- GENERAL ELECTIVE, all are of 6 Credits each (Theory Credit- 5, Practical Credit- 1)
- AECC- ABILITY ENHANCEMENT COMPULSORY COURSE and SEC- SKILL ENHANCEMENT COURSE are of 4 Credit each.

12.6.2020 12/6/2020 12/6/20 12/06/20 12/06/2020

- ESE question pattern for –
  - When Theory 70 Marks (mentioned in Table 1)

Theory- 70 Marks

(End Semester Exam: ESE)

PartA: All questions to be answered

1. **Multiple choice type. (1 x 05 = 05 Marks)**
2. **Fill in the blanks. (1 x 05 = 05 Marks)**

Part B: Short answer type, any three to be answered. (5x3 = 15 Marks)

Part C: Long answer type, any three to be answered. (15x3 = 45 Marks)

In each part, questions will be given preferably from all the Units.

- When Theory 50 Marks (mentioned in Table 1)

Theory 50 Marks

(End Semester Exam: ESE)

PartA: All questions to be answered

3. **Multiple choice type. (1 x 05 = 05 Marks)**
4. **Fill in the blanks. (1 x 05 = 05 Marks)**

Part B: Short answer type, any two to be answered. (5x2 = 10 Marks)

Part C: Long answer type, any three to be answered. (10x3 = 30 Marks)

In each part, questions will be given preferably from all the Units.

12.6.2020 12/6/2020 12/6/20 12/06/20 12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – I
CORE COURSE 01 - ECOLOGY AND ECOSYSTEMS

Theory (50 Lectures)

Preamble: This paper will introduce to the students the basic understanding of ecosystem andits structural and functional aspects. It will explore the interconnectedness among all the biotic andabiotic components of environment and the dynamic nature of the ecological processes inmaintaining equilibrium in nature.

Unit 1: Introduction (4 lectures)

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems,ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes.

Unit 2: Ecology of individuals (8 lectures)

Ecological amplitude;Liebig's Law of the Minimum; Shelford'sLawof Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types ofniche: niche breadth; nichepartitioning; niche differentiation; thermoregulation; strategies of adaptation in plants and animals.

Unit 3: Ecology of populations (10 lectures)

Concept of population and meta-population; r- and K-selection; characteristics of population:density, dispersion, natality, mortality, life tables, survivorship curves, age structure; populationgrowth: geometric, exponential, logistic, density-dependent; limits to population growth;deterministic and stochastic models of population dynamics; rudreal, competitive and stress-tolerancestrategies.

Unit 4: Ecology of communities (10 lectures)

Community structure and organization:species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect;species interactions: mutualism, symbiotic relationships, commensalism,amensalism, proto cooperation, predation, competition, parasitism, mimicry,ecologicalsuccession: Primary and Secondary succession, Model and types of Succession,climax community concepts, examples of succession.

Unit 5: Ecosystem ecology (9 lectures)

Types of ecosystem: forest, grassland, lantic,lotic, eustarine, marine, desert, wetlands; Ecosystem structure and functions; abiotic and biotic components of ecosystem; ecosystemfunction; primary production and models of energy flow; secondary production and trophicefficiency; ecosystem connections; food chain, food web; ecologicalefficiencies; ecological pyramids; Pyramid of number, biomass and energy.

Unit 6: Biogeochemical cycles and nutrient cycling (5 lectures)

Carbon cycle; nitrogen cycle;phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycle models; Ecosystem input of nutrients ; Role of mycorrhizae; Decomposition and nutrient release .

Unit 7: Biological invasions (4 lectures)

Concept of exotics and invasive; natural spread versus man-induced invasions; characteristics ofinvaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasionon ecosystem and communities; economic costs of biological invasions.

12/6/2020 12/6/2020 12/6/20 12/06/20 12/06/2020

Practicals: Based on Theory- **1 credit**

Suggested Readings

1. Odum, E. P. & Barrett, G. W. 2006. Fundamentals of Ecology (Cengage).
2. Molles, M. C. Ecology. 2009, McGraw Hill.
3. Beeby, A. Applied Ecology. Chapman and Hall.
4. Begon, M. Harper, J. L & Townsend, C. R. 2006. Ecology (Blackwell).
5. Smith R. L & Smith, T. M. Ecology and Field Biology. Benjamin Cummings/Addition Wesley.
6. Loreau, M. &Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives.Oxford University Press, Oxford, UK.
7. Dash, M. C. & S. P. Dash, Fundamental of Ecology. Tata Mcgraw Hill Publication.
8. Pimentel, D. (Ed.). 2011. Biological invasions: Economic and environmental costs of alien plant,animal, and microbe species. CRC Press.
9. Singh, J. S., Singh, S. P. & Gupta, S. R. 2006. Ecology, Environment and Resource Conservation.Anamaya Publications.
10. Santra, S. C. 2010. Fundamentals of Ecology and Environmental Biology, New Central Book Agency.

12.6.2020 12/6/2020 12/6/20 12/06/20 12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – I
CORE COURSE 02: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH

Theory (50 Lectures)

Preamble: This paper deals with different aspects of environmental contamination, which have adverse effects on human health. It will lay emphasis on understanding mechanisms of pollutants impacting human health by developing an understanding of different types of pollutants, their sources and mitigation measures. The students will also be introduced to the concept of permissible limits.

Unit 1: Air pollution(8 lectures)
Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NO_x, SO_x, PM, CO, CO_2, hydrocarbons and VOCs) and control measures; indoor air pollution: sources and effects on human health.

Unit 2: Water pollution(8 lectures)
Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).

Unit 3: Soil pollution(6 lectures)
Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies.

Unit 4: Noise pollution (5 lectures)
Noise pollution – sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans; control measures.

Unit 5: Radioactive and thermal pollution (6 lectures)
Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects); thermal pollution and its effects, concept of radioactive decay and half-life period.

Unit 6: Marine pollution (5 lectures)
Marine resources and their importance; sources of marine pollution; oil spill and its effects; coral reefs and their demise; coastal area management; existing challenges and management techniques (planning, construction, environmental monitoring of coastal zones).

Unit 7: Pollution control (12 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.

Practicals: Based on the theory **1 credit**

Suggested Readings

1. Gurjar, B.R., Molina, L.T. &Ojha C.S.P. 2010. *Air Pollution: Health and EnvironmentalImpacts*. 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* (23rd edition). BanarsidasBhanot Publishers.
4. Pepper, I.L., Gerba, C.P. &Brusseau, M.L. 2006. *Environmental and Pollution Science*. Elsevier Academic Press.
5. Purohit, S.S. &Ranjan, R. 2007. *Ecology, Environment & Pollution*. Agrobios Publications.
6. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. *Environmental Pollution and Control*. Butterworth-Heinemann, USA.

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – I
GENERIC ELECTIVES-1
GE 1- CHEMISTRY - 1

(Theory 50 Lectures)

Unit I
Chemical Energetics

Law of Thermodynamics, Important Principles and Definitions of thermochemistry, Concept of standard state and standard enthalpies of formation, Integral and Differential enthalpies of solution and dilution, Calculation of Bond Energy, bond dissociation energy and resonance energy from thermochemical data, Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third law of Thermodynamics and calculation of absolute entropies of substances

Unit II

Chemical Equilibrium
Free energy change in a chemical reaction.Thermodynamic derivation of the law of chemical equilibrium.Distictionbetween ΔG and ΔG_0, Le Chatelier's Principle. Relationship between Kp, Kc, Kx for reactions involving ideal gases.

Unit III

Ionic Equilibrium
Strong, Moderate and Weak Electrolytes, Degree of Ionization, Factors affecting Degree of Ionization, Ionization constant, and Ionic Product of water, Ionization of weak acid and bases, pH scale, common ion effect, Salt hydrolysis- calculation of hydrolysis constant, Degree of Hydrolysis and pH for different salts, Buffer solutions, Solubility and solubility product of sparingly soluble salt-Applications of solubility product Principle.

Unit IV

Organic Chemistry Basic
Basic Principal in Organic Chemistry,Shape and Structure of Organic Compound, Tetra Valence of Carbon, Hybridisation Sp3, Sp2, Sp, Classification and Nomenclature of Organic compound.
Elementary idea of electron displacement effects, Electronic effect.
Functional group approach for the following reactions

Unit V

Aromatic Hydrocarbon
Preparation (case Benzene) from Phenol, by Decarboxylation, from Acetylation, from Benzene sulphonic acid.
Reactions (case Benzene) – Elementary idea of electrophilic substitution, Mechanism of nitration, Halogenation, Sulphonation. Direct influence of hydroxyl, amino, halogen and nitro groups, Friedel-Craft's reaction (alkylation and acylation) up to 4 carbon on benzene. Side chain oxidation of alkyl benzenes upto 4 carbon on benzene.

Unit VI

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

Alcohol and Phenols

Preparation of 1°, 2°, 3° alcohols, using organic reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters, Reactions with sodium, Hx (Lucas test), Esterification , Oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols (Upto 6 carbons, Pinacol-Pinacolone rearrangements.

Preparation- Cumenehydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution, Nitration, Halogenation and sulphonation. Reimer Tiemann Reaction, Gattermann Koch's Reaction, Houben-Hoesch Condensation, Schotten- Baumann Reaction, Aldehydes and Ketones- General Preparation Method, Properties, Reactions, Distiction between aldehyde and Ketones, Aldol Condensation, Baeyer's villegers oxidation

PRACTICAL- Based on Theory **1 Credit**

12.6.2020 12/6/2020 12/6/20 12/06/20 12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – II
CORE COURSE 3: WATER AND WATER RESOURCES

Theory (50 Lectures)

Preamble: The Paper introduces students to be the hydrological; cycle, properties of water, physicochemical and biological water quality assessment and indices, types of water resources, their use and management. It will also highlight the problems associated with water shortages in India and familiarizes students with case studies on international and national conflicts on water.

Unit 1: Introduction **(4 Lectures)**
Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo-transpiraiton; classification of water resources (oceans, river, lakes and wetlands).

Unit 2: Properties of water **(7 Lectures)**
Physical: temperature, colour, odor, total dissolved solid and total suspended solids; chemical: major inorganic and organic constituents, dissolved gases, DO,COD, BOD, acidity and alkalinity, electrical conductivity, Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes.

Unit 3: Surface and subsurface water **(9 Lectures)**
Introduction to surface and ground water; water table; vertical distribution of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; watershed and drainage basins; rain water harvesting in urban setting.

Unit 4: Wetland and their management **(8 Lectures)**
Definition of a wetland; types of wetlands (fresh water and marine): ecological significance of wetland; threats to wetland; wetland conservation and management; Ramsar Convention; 1971; major wetlands of India.

Unit 5: Marine resource management **(5 Lectures)**
Marine resources; commercial use of marine resources; threats to marine ecosystems and resource; marine ecosystem.

Unit 6: Water resources in India **(7 Lectures)**
Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; role of state in water resource management.

Unit 7: Water resources conflicts **(6 Lectures)**
Water resource and sharing problem, case studies on Kaveri and Krishna water disputes; effects of Dams and reservoirs.Case studies of dams- Narmada and Tehri dam- social and ecological losses verus economic benefits; international conflicts on water sharing between India and her neighbours; agreements to resolve these conflicts.

Unit 8: Major laws and treaties **(4 Lectures)**
National water policy; water pollution (control and prevention) Act 1972; National River Linking plan: ecological and economic impacts.

Practical: Based on the theory. **1 Credit**

Suggested readings

1. Bansil, P.C. 2004. *Water Management in India.* Concept Publishing Company, India.

2. Brebbia, C.A. 2013. *Water Resources Management VII.* WIT Press.
3. CEA. 2011. *Water Resources and Power Maps of India.* Central Board of Irrigation & Power.
4. Grumbine, R.E. &Pandit, M.K. 2013. Threats from India's Himalaya dams. Science **339:** 36-37.
5. Loucks, D.P., Stedinger, J.R. & Haith, D.A. 1981. *Water Resources Systems Planning and Analysis.* Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. *Water Resources Sustainability.* The McGraw-Hill Publicaitons.
7. Schward& Zhang, 2003. *Fundamentals of Groundwater.* John Willey and Sons.
8. Souvorov, A.V. 1999. Marine Ecologonomics: *The Ecology and Economics of Marine Resource Management.* Elsevier Publicaitons.
9. Vickers, A. 2001. *Handbook of Water Use and Conservation.* Water Plow Press.

12.6.2020 12/6/2020 12/6/20 12/06/20 12/06/2020

SEMESTER – II
CORE COURSE 4: LAND AND SOIL CONSERVATION AND MANAGEMENT

Theory (50 Lectures)

Preamble: The Paper introduces students to be the fundamental of land soil degradation.. Each unit covers a range of topics, which will help students develop basic understanding of properties of soil and how the quality and soil degrades due to anthropogenic activities.

Unit 1: Introduction **(5 Lectures)**

Land as a resource, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.

Unit 2: Fundamentals of soil science **(10 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 salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity;

Unit 3: 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, organic contaminants in soils; recycling of soil nutrients.

Unit 4: Landuse changes and land degradation **(10 Lectures)**

Land resources types and evaluation; biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation – deforestation, desertification; land salinization; soeio-economic and institutional factors.

Unit 5: Costs of land degradation **(15 Lectures)**

Economic valuation of land degradation; onsite and offsite costs of land degradation; loss fo ecosystem service; effects on farming communities; effects on food security; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries.

Unit 6: Controlling land degradation **(2 Lectures)**

Sustainable land use planning; land tenure and land policy; legal, institutional and sociological factors

Practical: Based on the theory/fieldwork. **1 Credit**

Suggested Readings

1. Brady, N.C. & Well, R.R. 2007. *The Nature and Properties of Soils* (13th 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* (2nd edition). Rowman & Littlefield 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 andsustainable land use, 9.*(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 (file:///Users/mkpandit/Downloads/Raven%20et%20al.%202013.%20CB%Voices%20from%20Tropic%20(2).pdf).
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.

12/6/2020 12/6/20 12.6.2020 12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER- II
GENERIC ELECTIVES-2
GE 2- CHEMISTRY - 2

(Theory 50 Lectures)

Unit I

1. **Chemical Kinetics**: rate of Reaction, Order and Molecularity of reaction, First and Second Order Reactions, Determination of the order of reaction, The effect of temperature on reaction rates, Energy of Activation.
2. **Electrochemistry:** Conductance of electrolytes, Weak and Strong electrolytes, Specific conductance, Equilvalent conductance and Molecular Conductance, their experimental determination, Variation of Conductance with Dilution, Ostwald's Dilution law, Solubility Principal, Application of Solubility product, Concept in Precipitation Reaction, Hydrolysis of Salts, Acids and bases (Bronsted Lowry and Lewis), pH and Buffer solutions, Common Ion Effect.

Unit II

3. **Electrochemical Cell**: Reversible and Irreversible electrode and cell potential,Origin of electrode potential, Concentration cells, E.M.F of Cocentration cell without transference, Application of E.M.F measurements for the determination of solubility product of sparingly soluble salts and valency of ions.
4. **Radioactivity:** Alpha, Beta and Gamma rays, Isotopes, isobars and Isotones, Group displacement law, Induced Radioactivity, Balancing of Nuclear Reaction, Half life, Average life, radioactive series, Radio Carbon Dating.

Unit III

5. **Isomerism**: Structural and Sterioisomerism.Geometrical and Optical Isomerism
6. **Hydroxyacids**: Lactic acid, tartaric acid, Citric Acid (Isolation, Synthesis, Properties, Constitution, Symmetry, Resolution of Racemic compounds).

Unit IV

7. **Carbohydrates**: Classification, Nomenclature, Structure of glucose and fructose, Concept of open chain structure and mention the ring structure (derivation of ring structure not required), elementary idea about configuration.
8. **Benzene and its monosubstituted products**: Toluene, Nitrobenzene, Aniline, Benzene diazonium chloride, Phenol, Benzaldehyde, Benzenesulphonic acid, benzoic acid (preparation properties and uses). The reaction involved in the study of Perkin, Cannizzaro, Kolbe, Reimer Tiemann, Sandmeyer reaction

Unit V

9. **Modern Periodic table and its Properties.**
10. **General Chemistry of the d-block element** (special reference to 3 d): Electronic Configuration, Oxidation State, Atomic and Ionic Radius, Magnetic Properties, Standard

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

electrode potential, Ionisation energies, Variable valency and Coloured compounds, Complex formation and Catalytic properties.

Unit VI

11. **Coordination compound:** Double salts and coordination compound, Nomenclature systematic approach to coordination compound with reference to cobalt amines, Werner's theoty, Elementary idea of Isomerism, Sidgwick theory of effective atomic number, Idea of valance bond theory.
12. **The Chemistry of individual elements** and their compounds: A part from the aspect mentioned below: the studies of the element must be mad with reference to (i) electronic configuration, (ii) Acid base character, (iii) General Chemical reactions of the element and their compounds, (iv) tests for ions and radicals formed by the elements and their compounds (v) shapes and structure of the covalent compound formed by the elements.

PRACTICAL – Based on theory 1 Credit

12/6/2020 12/6/20 12.6.2020 12/06/2020 12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)

SEMESTER – II

ABILITY ENHANCEMENT COMPULSORY COURSE- 2

AECC- 2 COMPUTER APPLICATIONS

4 Credits (40 Lectures)

Unit 1.Computer Fundamental (4 Lectures)

- **Introduction to Computer:** What is computer? , Role and importance of computer in environmental science, Comparison between computer and human brain, Characteristics of computer, Introduction to Computer Application
- **Computer Organization :** Basic units of computer, Block Diagram of Computer, input unit ,processing unit, Output unit, Storage unit, Types of Computer, Introduction to Microprocessor, Uni-processor and multiprocessor system

Unit 2. Concept of Data and Programming: (6 Lectures)

- **Data Representation:** Number System, Binary system, Binary to Decimal and Decimal to Binary conversion.
- **Computer Software and Programming Concept:** Introduction to Software and its types, Common application software in Biology.

Unit 3.Operating System: (10 Lectures)

- What is Operating System and its function, Introduction to various categories of software, Interaction of operating system with hardware and user program, Process states.
- Multi-user, Multi-tasking, Multi Processing and Real time operating system. Special requirement and facilities for multiprocessing environment.
- Introduction to Windows , operating system , Examples of Multiprocessing operating system

Unit 4. Database Management System: (10 Lectures)

- Introduction to database,What is DBMS?
- Introduction to Different types of file format like doc, docx, pdf, jpg, gif, ppt, exls etc. Introduction to MS_Excel, MS_Word, Powerpoint , editing of image /pictures.

Unit 5. Network and Internet Technology (10 Lectures)

- Introduction to data communication and its basic elements with its characteristics. Communication Modes
- Introduction to network and its types , Network devices, Network Topology ,
- Introduction to Web browsing software and search engine with special reference to online environmental resources

12/6/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – III
CORE COURSE 5: PHYSICS AND CHEMISTRY OF ENVIRONMENT

Theory (50 Lectures)

Preamble: This paper aims to build conceptual understanding of students by exposing them to thebasic principles behind various environmental processes. The paper has been divided into two sections, with the view to introduce students to the concepts of physics and chemistry associated with particle movement, chemical processes and pollutant chemistry.

Unit 1: Movement of pollutants in environment **(8 lectures)**
Diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, mixing heights, hydraulic potential, turbulence.Ions and radicals in atmosphere; acid-base reactions in atmosphere.

Unit 2: Fundamentals of environmental chemistry **(10 lectures)**
Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, synthesis of xenobiotic compounds like pesticides and dyes, synthetic polymers.

Unit 3: Atmospheric chemistry(10 lectures)
Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, case studies; reactions of NO_2 and SO_2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

Unit 4: Water chemistry **(10 lectures)**
Chemical and physical properties of water; alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; colloidal particles; heavy metals in water.

Unit 5: Soil chemistry **(12 lectures)**
Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil; phenolic compounds in soil.

Practicals: Based on the theory. **1 Credit**

Suggested Readings

1. Beard, J.M. 2013. *Environmental Chemistry in Society* (2nd edition). CRC Press.
2. Forinash, K. 2010. *Foundation of Environmental Physics*. Island Press.
3. Girard, J. 2013. *Principles of Environmental Chemistry* (3rd edition). Jones & Bartlett.
4. Harnung, S.E. & Johnson, M.S. 2012. *Chemistry and the Environment.* Cambridge University Press.
5. Hites, R.A. 2012. *Elements of Environmental Chemistry* (2nd edition). Wiley & Sons.
6. Manhan, S. E. 2000. *Fundamentals of Environmental Chemistry*. CRC Press.
7. Pani, B. 2007. *Textbook of Environmental Chemistry*. IK international Publishing House.

B.Sc (H) Environmental Science (CBCS pattern)

SEMESTER – III

CORE COURSE 6: ENVIRONMENTAL BIOTECHNOLOGY

Theory (50 Lectures)

Preamble: This paper presents an objective view of the application of biotechnological know-hows intackling environmental problems. It starts with basic knowledge about molecular biology and later links to application based processes and techniques.

Unit 1: The Structure and Function of Nucleic acid (10 lectures)

DNA: structure; DNA Replication, only elementary idea: basic

RNA: structure; RNA Transcription, only elementary idea: basic

Unit 2: Protein and Central Dogma (10 lectures)

Protein: structure; Protein Synthesis/Translation, only elementary idea: basic, Central dogma of biology.

Unit 3: Recombinant DNA Technology (12 lectures)

Recombinant DNA; enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reversetranscriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); Cloning and expression vectors: plasmids.

Unit 4: Ecological restoration and bioremediation (10 lectures)

Land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wetlands, use of bioreactors for bioremediation; phytoremediation.

Unit 5: Ecologically safe products and processes (8 lectures)

PGPR bacteria: introduction of biofertilizers, microbial insecticides and pesticides, microbial transformation, accumulation and concentration of metals, metal leaching, extraction.

Practicals: Based on the theory. 1 Credit

Suggested Readings

1. Evans, G.G. & Furlong, J. 2010. *Environmental Biotechnology: Theory and Application* (2nd edition). Wiley-Blackwell Publications.
2. Jordening, H.J. & Winter J. 2005. *Environmental Biotechnology: Concepts and Applications*. John Wiley& Sons.
3. Lodish, H.F., Baltimore, D., Berk, A. Zipursky, S.L. Matsudiara, P. & Darnell, J. 1995. *Molecular Cell Biology*. W.H. Freeman.
4. Nelson, D.L. & Cox, M.M. 2013. *Lehninger's Principles of Biochemistry*. W.H. Freeman.
5. Rittman, B.E. & McCarty, P.L. 2001. *Environmental Biotechnology. Principles andApplications*. McGraw-Hill, New York.
6. Scagg, A.H. 2005. *Environmental Biotechnology*. Oxford University Press.
7. Snustad, D.P. & Simmons, M.J. 2011. *Principles of Genetics* (6th edition). John Wiley& Sons.
8. Wainwright, M. 1999. *An Introduction to Environmental Biotechnology*. Springer.

12/6/2020 12/6/2020 12/6/2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – III
CORE COURSE 7: ATMOSPHERE AND GLOBAL CLIMATE CHANGE

Theory (50 Lectures)

Preamble: The paper deals with dynamics of atmospheric processes, which include its composition,meteorological phenomena and atmospheric chemistry. The paper also highlights the anthropogenic intervention in 'anthropocene', which has led to global climate change. The paper also explores effects of global changes on human communities and initiatives taken at global and regional levels to combat them.

Unit 1: Introduction **(10 lectures)**
Evolution and development of Earth's atmosphere; structure and composition of atmosphere.Earth's energy balance; energy transfers in atmosphere; global conveyor belt.

Unit 2: Atmospheric circulation **(10 lectures)**
Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; *El Nino* and *La Nina*; tropical cyclone; Indian monsoon and its development, changing monsoon in Holocene in the Indian subcontinent; effect of urbanization on micro climate.

Unit 3: Meteorology and atmospheric stability(10 lectures)
Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion.

Unit 4: Global warming and climate change **(10 lectures)**
Earth's climate through ages; trends of global warming and climate change; Global warming and the role of green housegases (GHGs) in climate change.Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes.

Unit 5: Climate change and policy(10 lectures)
Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Practicals: Based on the theory. **1 Credit**

Suggested Readings:

1. Barry, R. G. 2003. *Atmosphere, Weather and Climate*. Routledge Press, UK.
2. Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: Legal Commentarieswith Policy and Science Considerations*. MartinusNijhoff Publishers.
3. Hardy, J.T. 2003. *Climate Change: Causes, Effects and Solutions*. John Wiley & Sons.
4. Harvey, D. 2000. *Climate and Global Climate Change*. Prentice Hall.
5. Manahan, S.E. 2010. *Environmental Chemistry*. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. *Climate Change: A Very Short Introduction*. Oxford Publications.
7. Mathez, E.A. 2009. *Climate Change: The Science of Global Warming and our Energy Future*. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. *ClimateChange and India*. Universities Press, India.

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – III
GENERIC ELECTIVES- 3 (Sem III)
GE-3: BOTANTY-1

Theory(50 Lectures)

UNIT I
Microbiology: (10Lectures)
Five kingdom system of classification
Viruses – A general account.
Bacteria – Structure, Growth and Reproduction.
Economic importance of viruses and bacteria.

UNIT II
Algae: (10Lectures)
General character, classification and economic importance. Life histories of algae belonging to various classes:
Chlorophyceae – *Volvox,*
Xanthophyceae –*Vaucheria*
Phaeophyceae– *Ectocarpus*
Rhodophyceae- *Polysiphonia*

UNIT III
Fungi: (10Lectures)
General characters, classification & economic importance. Life histories of Fungi:
Mastigomycontina- *Phytophthora*
Zygomycotina-*Mucor*
Ascomycotina-*Saccharomyces*
Basidomycotina-*Agaricus*
Deutromycotina-*Colletotrichum*

UNIT IV
Lichens: (10Lectures)
Classification, general structure, reproduction and economic importance.
Plant diseases: Casual organism, symptoms and control of following plantdiseases.
Rust ofWheat
White rust ofCrucifers
Late blight of Potato

UNIT V
Bryophytes: (10Lectures)
General characters, classification & economic importance.Life histories of following:
Marchantia, Funaria.

Practicals: Based on Theory- 1 credit

PRACTICALS
1. Gram staining
2. Comparative study of thallus and reproductive organs of various algae mentioned in

12/6/20 6.2020

theory

3. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
4. Study of plant disease materials.
5. Study of external features & anatomy of vegetative and reproductive parts of *Bryophytes* studied in theory.

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – III
SKILL ENHANCEMENT COURSE – I
SEC- 1 MUSHROOM CULTURE (Sem III)

4 Credits **(40 Lectures)**

Unit 1: Introduction **(4 Lectures)**
History. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India - *Volvariellavolvacea, Pleurotuscitrinopileatus, Agaricusbisporus.*

Unit 2: Cultivation Technology I **(10 Lectures)**
Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag.

Unit 3: Cultivation Technology II **(10 Lectures)**
Pure culture method: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation. Factors affecting the mushroom bed preparation, composting technology in mushroom production.

Unit 4: Storage and nutrition **(10 Lectures)**
Short-term and Long term storage, drying, storage in saltsolutions.Nutritional components.Viatmins andmineral elements nutrition.

Unit 5: Food Preparation **(6 lectures)**
Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio in food processing - Marketing in India and abroad, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition. Vol. I & Vol. II.

12/06/2020 12/6/2020 12/6/20 12-6-2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – IV
CORE COURSE 8: SYSTEMATICS AND BIOGEOGRAPHY

Theory (50 Lectures)

Preamble: This course will discuss principles and applications of classical and modern daysystematics to classification of living organisms, develop understanding of historical and contemporary patterns of distributions of organisms, and design effective conservation strategies using biogeographic theories in an era of global change and large scale human induced degradation.

Unit 1: Concept and systematics approaches(10 lectures)
Definition of systematics; taxonomic identification; keys; field inventory; herbarium; museum; botanical gardens, numerical and molecular methods; taxonomy databases.

Unit 2: Taxonomic hierarchy **(6 lectures)**
Nomenclature; Concept of taxa, concept of species, categories and taxonomic hierarchy.

Unit 3: Nomenclature andSystematics(10 lectures)
Principles and rules (International Code of Botanical and Zoological Nomenclature.Characters; variations; phylogenetic tree (rooted,unrooted, ultrametric trees); clades: monophyly, paraphyly, polyphyly; homology and analogy; parallelism and convergence.

Unit 4: Introduction to Biogeography **(8 lectures)**
Genes as unit of evolutionary change; mutation; genetic drift; gene flow; natural selection; geographic and ecological variation; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species.

Unit 5: Speciation and extinction **(8 lectures)**
Types and processes of speciation – allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers to dispersal; extinction.

Unit 6: Ecological Biogeography **(8 lectures)**
Species' habitats; environment and niche concepts; biotic and abiotic determinants of communities; species-area relationships; concept of rarity and commonness; geography of diversification and invasion; phylogeography.

Practicals: Based on the theory. **1 Credit**

Suggested Readings

1. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. 2010. *Biogeography* (4th edition). Sinauer Associates, Sunderland.
2. Mani, M.S. 1974. *Ecology and Biogeography in India*. Dr. W Junk Publishers., The Hague.
3. Singh, G. 2012. *Plant Systematics: Theory and Practice* (3rd edition). Oxford & IBH Pvt. Ltd., New Delhi.
4. Williams, D. M., Ebach, M.C. 2008. *Foundations of Systematics and Biogeography*. Springer.
5. Wilkins, J. S. 2009. *Species: A History of the Idea* (Vol. 1). University of California Press.

12/06/2020 12/6/2020 12/6/20 12/6/2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – IV
CORE COURSE 9: URBAN ECOSYSTEMS

Theory (50 Lectures)

Preamble: The paper is designed to enable the students to examine the existing environmental issues, conflicts and their potential role in urban development. It beholds importance as interaction between urban society and its environment transpires in governance and policy decisions. It also aims to address key challenges posed by increasing development to far-reaching goal of sustainability in urban areas.

Unit 1: Introduction **(2 lectures)**
Introduction to urbanization; urban sprawl and associated environmental issues.

Unit 2: Environment in an urban setting **(10 lectures)**
Man as the driver of urban ecosystem; commodification of nature; metros, cities and towns as sources and sinks of resources; resource consumption and its social, cultural, economic and ecological perspectives; urban transformation; Urban transformation and challenges.

Unit 3: Urban dwelling **(10 lectures)**
Housing scenario across a range of large-medium-small cities; poverty and slums in an urban context; Town planning Acts and their environmental aspects; energy consumption and waste disposal as well as accumulation.

Unit 4: Urban interface with the environment **(10 lectures)**
Management of urban environment; alternative resources; policy and management decisions; urban settings as loci of sustainability; challenges associated with sustainability and urban future.

Unit 5: Natural spaces in a city **(8 lectures)**
Concept of 'controlled nature'; scope, importance and threats to nature in the city; organization and planning of green spaces such as parks, gardens and public spaces; concept of green belts.

Unit 6: Planning and environmental management **(10 lectures)**
Urban planning and its environmental aspects from historical and contemporary perspectives; benefits of environmental management; introduction to green buildings; urban governance; smart cities.

Practicals:Based on the theory. **1 Credit**

Suggested Readings

1. D'Monte, Darryl. 1985. Industry versus Environment Temples or Tombs. Three Controversies. Delhi, CSE.
2. Ernstson, H. 2011. Re-translating nature in post-apartheid Cape Town: The material semiotics of people and plants at Bottom Road. In: Heeks, R., (Ed.) Conference on "Understanding Development through Actor-Network Theory", London School of Economics, 30 June, London.
3. Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.
4. Grimm, N. B., Faeth, S. H., et al. 2008. Global Change and the Ecology of Cities. Science 319: 756-760.

11/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

5. Hinchliffe, S. &Whatmore, S. 2006. Living cities: Towards a politics of conviviality. Science as Culture 15: 123–138.
6. McIntyre, N.E. 2000. Urban ecology as an interdisciplinary field: differences in the use of 'urban' between the social and natural sciences. Urban Ecosystems 4: 5-24.
7. Montgomery, M.R. 2009. Urban Transformation of the developing world. Science 319: 761-764.
8. Richter, M. & Weiland, U. (ed.). 2012. Applied Urban Ecology. Wiley-Blackwell, UK.

12/6/20 12.6.2020 12/06/20

12/8/2020

12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)

SEMESTER – IV

CORE COURSE 10: ENVIRONMENTAL LEGISLATION AND POLICY

Theory (50 lectures)

Preamble: This paper introduces students to the legal structure of India and fundamentals ofenvironmental legislation and policy making. Each unit will help the students to develop basic concepts of environmental legislation and policy making in India and around the world.

Unit 1: Introduction **(6 lectures)**

Introduction to Envirommental law in India; Constitutional provisions; General principle in Environmental law, a brief introduction of SDGs.

Unit 2: Environmental legislation **(8 lectures)**

Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

Unit 3: Legislative Instruments I **(10 lectures)**

The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988.

Unit 4: Legislative Instruments I **(12 lectures)**

The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; Scheme and labeling of environment friendly products, Ecomarks.

Unit 5: Government institutions **(6 lectures)**

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

Unit 6: International laws and policy **(8 lectures)**

United Nations Conference on Environment and Development 1992; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention.

Practicals: Tutorial and case study based. **1 Credit**

Suggested Readings

1. Abraham, C.M. 1999. *Environmental Jurisprudence in India*. Kluwer Law International.
2. Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. *Bulletin of the National Institute of Ecology* **15**: 227-238.
3. Divan, S. &Rosencranz, A. 2001. *Environmental Law and Policy in India*. Oxford University Press.
4. Divan, S. &Rosencranz, A. 2002. *Environmental Law and Policy in India: Cases, Materialsand Statues* (2nd edition). Oxford University Press.
5. Gupta, K.R. 2006. *Environmental Legislation in India*. Atlantic Publishers and Distributors.
6. Leelakrishnan, P. 2008. *Environmental Law in India* (3rd edition). LexisNexis India.

12/6/20 12/6/20 12/6/2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – IV
GENERIC ELECTIVE-4(Sem IV)
GE-4: Botany- 2

Theory (50 Lectures)

UNIT I: Pteridophytes (10Lectures)
General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia.*

UNIT II: Pteridophytes: Type studies (10Lectures)
Life histories of *Selaginella*- (Heterospory and seed habit) and *Lycopodium.*

UNIT III: Gymnosperms (10Lectures)
General characters, classification, types of fossils, fossil gymnosperms- *Williamsonia*
Telome and stele concept.

UNIT IV: Gymnosperms: Type studies (10Lectures)
Life histories of *Cycas&Pinus*, economic importance of gymnosperms.

UNIT V: Angiosperms: (10Lectures)
Introduction to Classification of Angiosperms
Important rules of plant nomenclature.
A study of diagnostic features of the following families of Angiosperms:
Malvaceae, Apocynaceae, Poaceae

Practicals: Based on Theory- **1 credit**

PRACTICALS

1. Examination of morphology and anatomy of vegetative and reproductive parts of *Selaginella, Equisetum &Pteris*
2. Examination of morphology and anatomy of vegetative & reproductive parts of - *Cycas&Pinus*
3. Plant collection (Pteridophytes&Gymnosperms)
4. Angiosperm plant description of mentioned families.

11/06/2020 12/6/2020 Meena 12/6/20 12.6.2020 Puram Ranjan 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – IV
SKILL ENHANCEMENT COURSE – 2
SEC- 2 SOLID WASTE MANAGEMENT (Sem IV)

4 Credits **(40 Lectures)**

Unit 1: Introduction **(6 lectures)**
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 **(8 lectures)**
Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life.

Unit 3: Solid waste Management **(10 lectures)**
Different techniques used in 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.

Unit 4: Industrial waste management (8 lectures)
Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; effluent treatment plant and sewage treatment plant.

Unit 5: Resource Recovery **(8 lectures)**
4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment.Concept of energy recovery from waste; refuse derived fuel (RDF).

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.* Washington D.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.

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – V
CORE COURSE 11: BIODIVERSITY AND CONSERVATION

Theory (50 Lectures)

Preamble: This course is aimed at helping students to understand and appreciate various concepts andissues concerning biodiversity and conservation at local, regional and global levels. The course will attempt at encouraging students to appreciate the paradigm "think globally, act locally" for a sustainable common future of humankind.

Unit 1: Levels of organization and Biodiversity patterns(6 lectures)
Tree of life: genes to ecosystems; Spatial patterns and temporal patterns: Importance of biodiversity patterns in conservation.

Unit 2: Biodiversity estimation **(10 lectures)**
Sampling strategies, qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity.

Unit 3: Importance of biodiversity **(8 lectures)**
Economic values – medicinal plants, drugs, fisheries and livelihoods; ecological services – primary productivity, role in hydrological cycle, biogeochemical cycling.

Unit 4: Threats to biodiversity **(8 lectures)**
Natural and anthropogenic disturbances; habitat loss, habitat degradation, and habitat fragmentation; climate change; pollution; hunting; over-exploitation; deforestation; hydropower development; invasive species; Intermediate Disturbance Hypothesis.

Unit 5: Conservation of biodiversity **(10 lectures)**
In-situ conservation and *Ex-situ* conservation, Biodiversity hotspots; IUCN Red List categorization – guidelines, practice and application; Red Data book; ecological restoration; afforestation; social forestry; agro forestry.

Unit 6: Biodiversity in India **(8 lectures)**
Phytogeographic and Zoogeographic zones of the country; status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.

Practicals: Based on the theory. **1 Credit**

Suggested Readings

1. Gaston, K J. & Spicer, J.I. 1998. *Biodiversity: An Introduction.* Blackwell Science, London, UK.
2. Krishnamurthy, K.V. 2004. *An Advanced Text Book of Biodiversity - Principles andPractices.* Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
3. Pandit, M.K. &Grumbine R.E. 2012. Ongoing and proposed hydropower development in the Himalaya and its impact on terrestrial biodiversity. *Conservation Biology*26:1061-1071.
4. Primack, R.B. 2002. *Essentials of Conservation Biology* (3rd edition). Sinauer Associates, Sunderland, USA.

12/06/2020 12/6/2020 12/6/120 12.6.2020 12/06/20

5. Singh, J. S. & Singh, S. P. 1987. Forest vegetation of the Himalaya. *The Botanical Review* **53**: 80-192.

6. Singh, J. S., Singh, S.P. & Gupta, S. 2006. *Ecology, Environment and Resource Conservation.* Anamaya Publications, New Delhi.

7. Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. *Conservation Biology for All*. Oxford University Press.

8. Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. *Conservation Biology: Voices from the Tropics.* Wiley-Blackwell, Oxford, UK.

12/06/2020 12/6/2020 12/6/20 12-6-2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – V
CORE COURSE 12: ORGANISMAL AND EVOLUTIONARY BIOLOGY

Theory (50 Lectures)

Preamble: This paper introduces students to the fundamentals of ecology and evolutionary biology.Each unit covers vast range of topics, which will help the students to develop basic concepts of ecology and evolutionary biology.

Unit 1: History of life on Earth **(8 lectures)**
Paleontology and evolutionary History; origins of unicellular and multi cellular organisms; Introduction to major groups of plants and animals.

Unit 2: Introduction **(10 lectures)**
Lamarck's concept of evolution; Darwin's Evolutionary Theory: variation, adaptation, struggle, fitness and natural selection; Mendelism; Neodarwinism.

Unit 3: Evolution of unicellular life **(10 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.

Unit 4: Molecular evolution **(8 lectures)**
Neutral evolution; molecular divergence and molecular clocks; molecular tools in phylogeny, gene duplication and divergence.

Unit 5: Fundamentals of population genetics **(14 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; convergent evolution; sexual selection; co-evolution; Hardy-Weinberg Law.

Practicals: Based on the theory. **1 Credit**

Suggested Readings

1. Futuyma, D.J. 2009. *Evolution* (2nd edition). Sinauer Associates.
2. Gillespie, J. H. 1991. *The Causes of Molecular Evolution*. Oxford University Press.
3. Graur, D. & Li, W.H. 1999. *Fundamentals of Molecular Evolution* (2nd edition). Sinauer Associates.
4. Kimura, M. 1984. *The Neutral Theory of Molecular Evolution*. Cambridge University Press.
5. Minkoff, E.C. 1983. *Evolutionary Biology*. Addison Wesley. Publishing Company.
6. Nei, M. & Kumar, S. 2000. *Molecular Evolution and Phylogenetics*. Oxford University Press.
7. Nei, M. 1975. *Molecular Population Genetics and Evolution*. North-Holland Publishing Company.
8. Nei, M. 1987. *Molecular Evolutionary Genetics*. Columbia university press.
9. Thorne, J. L., Kishino, H., & Painter, I. S. 1998. Estimating the rate of evolution of the rate of molecular evolution. *Molecular Biology and Evolution*15: 1647-1657.

12/06/2020 12/6/2020 12/6/2020 12/06/2020 12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – V
DISCIPLINE SPECIFIC ELECTIVE COURSE- 1
DSE- 1 GREEN TECHNOLOGY

Theory (50 Lectures)

Preamble: This paper introduces students to the concept of green technology, its goals and advantages. It also highlights potential role of green technologies in realizing the goal of sustainable development and focuses on community participation to tap the economic benefits associated with switching to green technologies.

Unit 1: Introduction **(8 lectures)**
Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources.

Unit 2: Green technologies **(8 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 **(12 lectures)**
Green buildings; need and relevance of green buildings over conventional buildings, construction of green buildings; Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning, concept of green cities.

Unit 4: Applications of green technologies I **(10 lectures)**
Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermalmelting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats.

Unit 5: Applications of green technologies II **(12 lectures)**
Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods, catalytic or thermal destruction of NOX, Fluidized Bed Combustion.
Green alternatives; photodegradable plastic bags.

Unit 6: Green future (10 lectures)
Agenda of green development; reduction of ecological footprint; Role of green technologies towards a sustainable futuregreen practices to conserve natural resources; Role of advancement in science in developing environmental friendly technologies.

Practicals: Based on Tutorial/ Assignment/Case study **1 Credit**

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.

11/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – V
DISCIPLINE SPECIFIC ELECTIVE COURSE- 2
DSE- 2 ENVIRONMENTAL ECONOMICS

Theory (50 Lectures)

Unit1: Introduction to microeconomics **(10 lectures)**
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.

Unit 2: Environmental economics **(14 lectures)**
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.

Unit 3: Economic solutions to environmental problems **(14 lectures)**
Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginal social cost of abatement; environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.

Unit 4: Natural resource economics **(6 lectures)**
Economics of non-renewable resources; economics of fuels and minerals; Hotelling's rule and extensions; taxation; economics of renewable resources.

Unit 5: Tools for environmental economic policy **(6 lectures)**
Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis.Principles of Cost-Benefit Analysis.

Practical: Based on Tutorial/Assignment/Case study **1 Credit**

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.

12/6/2020 12/6/2020 12/6/20 12.6.2020 12/06/2020

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – VI
CORE COURSE 13: EARTH AND EARTH SURFACE PROCESSES

Theory (50 Lectures)

Preamble: The paper will introduce students to the basic structure and composition of the Earth andwill explore various surface processes and their impact on and role in living systems. It will also deal with the interactive processes in the inner as well as outer Earth's surface.

Unit 1: History of Earth **(6 lectures)**
Solar system – Age and origin: formation and composition of core, mantle, crust, atmosphere and hydrosphere; geological time scale and major changes on the Earth's surface.

Unit 2: Earth system processes **(10 lectures)**
Lithospheric plates; mantle convection and plate tectonics, major plates and hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; continental drift, paleontological evidences of plate tectonics; continental collision and mountain formation with specific example of the Himalaya.

Unit 3: Minerals and rocks **(12 lectures)**
Minerals: Basic Concept and important; rock cycle: lithification and metamorphism; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, wind and glaciers.

Unit 4: Earth surface processes **(14 lectures)**
Interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface; land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes.

Unit 5: Physiographic division of India **(8 lectures)**
Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc.Formation of the Himalaya; development of glaciers;Progression of agriculture in the Indian subcontinent in Holocene; withdrawing monsoon and lessons to draw.

Practicals: Based on the theory/ fieldwork. **1 Credit**

Suggested Readings

1. Bridge, J., &Demicco, R. 2008. *Earth Surface Processes, Landforms and Sediment deposits.* Cambridge University Press.
2. Duff, P. M. D., & Duff, D. (Eds.). 1993. *Holmes' Principles of Physical Geology.* Taylor & Francis.
3. Gupta, A. K., Anderson, D. M., &Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. *Nature*421: 354-357.

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

4. Gupta, A. K., Anderson, D. M., Pandey, D. N., &Singhvi, A. K. 2006. Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. *Current Science* **90:** 1082-1090.
5. Keller, E.A. 2011. *Introduction to Environmental Geology* (5th edition). Pearson Prentice Hall.
6. Krishnan, M. S. 1982. *Geology of India and Burma*. CBS Publishers & Distributors.
7. Leeder, M., Arlucea, M.P. 2005. *Physical Processes in Earth and Environmental Sciences.* Blackwell Publishing.
8. Pelletier, J. D. 2008. *Quantitative Modeling of Earth Surface Processes* (Vol. 304). Cambridge: Cambridge University Press. Chicago.

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)

SEMESTER – VI

CORE COURSE 14: NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY

Theory (50 Lectures)

Preamble: This paper takes an objective view of the nature of Earth's resources, their generation,extraction and impact of human activities on earth's environment. The students are expected to understand effective management strategies. It aims to provide an idea of effective management strategies and a critical insight of the major sustainability issues.

Unit 1: Introduction **(8 lectures)**

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

Unit 2: Mineral resources **(10 lectures)**

Mineral resources and the rock cycle; identified resources; undiscovered resources; environmental effects of extracting and using mineral resources.

Unit 3: Non-renewable energy resources **(10 lectures)**

Oil; Natural gas; liquefied petroleum gas, liquefied natural gas; Coal reserves: classification, coal gasification; environmental impacts of non-renewable energy consumption.

Unit 4: Renewable energy resources **(12 lectures)**

Energy efficiency; life cycle cost; cogeneration; solar energy technology, solar cells; Hydropower technology; Nuclear power: reactors, Tidal energy; wave energy; ocean thermal energy conversion (OTEC); geothermal energy; energy from biomass; bio-diesel.

Unit 5: Resource management **(10 lectures)**

Approaches in resource management: ecological approach; economic approach; ethnological approach; integrated resource management; Different approach towards sustainable development and its different constituents; sustainable energy strategy; Principles of energy conservation; Indian renewable energy programme.

Practicals: Based on the theory. **1 Credit**

Suggested Readings

1. Craig, J.R., Vaughan. D.J. & Skinner. B.J. 1996. *Resources of the Earth: Origin, Use, andEnvironmental Impacts* (2nd edition). Prentice Hall. New Jersey.
2. Freeman, A.M. 2001. *Measures of value and Resources: Resources for the Future*. Washington DC.
3. Freeman, A.M. 2003. *Millennium Ecosystem Assessment: Conceptual Framework*. Island Press.
4. Ginley, D.S. &Cahen, D. 2011. *Fundamentals of Materials for Energy and EnvironmentalSustainability*. Cambridge University Press.
5. Klee, G.A. 1991. Conservation of Natural Resources. Prentice Hall Publication.
6. Miller, T.G. 2012. Environmental Science. Wadsworth Publishing Co.

12/06/2020 12/6/2020 12/6/20 12-6-2020 12/06/20

7. Owen, O.S, Chiras, D.D, &Reganold, J.P. 1998. Natural Resource Conservation – Management for Sustainable Future (7th edition). Prentice Hall.
8. Ramade, F. 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
9. Tiwari, G.N. &Ghosal. M. K. 2005. Renewable Energy Resources: Basic Principles and Application. Narosa Publishing House.

12/06/2020 12/6/2020 12/6/20 12-6-2020 12/06/20

B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – VI
DISCIPLINE SPECIFIC ELECTIVE COURSE- 3
DSE- 3 ENVIRONMENTAL IMPACTS AND RISK ASSESEMENT

Theory (50 Lectures)

Unit 1: Environmental impact assessment (EIA) (10 Lectures)
Definitions, introduction and concepts; rationale and historical development of EIA; scope and methodologies of EIA; role of project proponents, project developers and consultants; Terms of Reference; impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP)

Unit 2: Rapid EIA; Strategy (10 Lectures)
Environmental Assessment; Social Impact Assessment; Cost-Benefit analysis; Life cycle assessment; environmental appraisal; environmental management - principles, problems and strategies; environmental planning; environmental audit; introduction to ISO and ISO 14000; sustainable development.

Unit 3: EIA regulations (8 Lectures)
EIA regulations in India; status of EIA in India; Current issues in EIA; case study of hydropower projects/ thermal projects.

Unit 4: Risk and vulnerability (10 lectures)
Concept of risk and vulnerability; 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: Risk assessment (12 Lectures)
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.

Practicals: Based on Tutorial/Assignment/Case study 1 Credit

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. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press.

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B.Sc (H) Environmental Science (CBCS pattern)
SEMESTER – VI
DISCIPLINE SPECIFIC ELECTIVE COURSE- 4
DSE- 4 HUMAN WILDLIFE CONFLICT AND MANAGEMENT

Theory (50 Lectures)

Unit 1: Introduction to wildlife management (4 lectures)
Need of environmental management; wildlife conservation: moral obligation? Philosophy of wildlife management; deep and shallow ecology.

Unit 2: Evolution of the concept of wildlife management (10 lectures)
Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetkawall paintings; conservation of wildlife in the reign of king Ashoka. Conservation and policies regarding protected areas in 21st century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

Unit 3: Wildlife conservation laws in India (10 lectures)
Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920; introduction of Tiger task force, Status of current protected areas in India.

Unit 4: Socio-economic and legal basis of conflicts (10 lectures)
Concepts of development and encroachment, who is the intruders: human or animal? Impact of conflict on humans and wildlife, impact of habitat fragmentation, forest produce as a need vs. forest exploitation, introduction to tribal rights in India, demographic profile of tribes in India, importance of forest produce to tribal populations, Scheduled tribes and other traditional Forest dwellers (Recognition of forest right) Act, 2006.

Unit 5: Wildlife conflicts (6 lectures)
Insight into the important conflicts: Keoladeo National park conflict of Bharatpur, Human and elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest, shifting cultivation in North east India.

Unit 6: Human wildlife coexistence (10 lectures)
Symbiotic relationship between tribals and forest, forest and development, focus on the inclusive growth of tribes: community participation in forest management, case study of Chipko movement, India's Bishnoi community and their conservation practices; ecological economic welfare and development: conservation of indigenous culture and traditions, role of international organizations: Man and biosphere programmes.

Practicals: Based on Tutorial/Assignment/Case study 1 Credit

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.

12/06/2020 12/6/2020 12/6/20 12.6.20 12/06/20

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.

12/06/2020 12/6/2020 12/6/20 12.6.2020 12/06/20