BACHELOR OF SCIENCE in

ENVIRONMENTAL SCIENCE

With Honours

CBCS Course Curriculum and Syllabi

(Applicable from the academic session 2021-2022)

Maulana Abul Kalam Azad University of Technology,
West Bengal

(Formerly West Bengal University of Technology)

Haringhata-741249, Nadia, West Bengal, INDIA

Overview of the course:

An exciting 3 Year 6 semester undergraduate degree in Environmental Science combines the range of subjects including Environmental Biology, Water Resource Management, Environmental Legislation & Policy, Environmental Engineering and pollution control measures, Biodiversity and Conservation, Environmental Analytics & Oceanography & Coastal Management etc. It focuses on applying science and technology to the biggest environmental challenges of today and future. The aim of this course is to explore the sustainable solution to environmental problem and to offer a rewarding career in many fields like energy management and conservation. There is ample scope of field work and experimental study where a student can collect and analyse the data using advanced GIS, Remote Sensing tools.

Program Outcome:

A student will be able to,

PO 1: Learn basic principles of and Concepts of Environmental Science and various aspects of Environmental concerns.

PO 2: Understand the fundamentals of Environmental Chemistry and Physics.

PO 3: Inculcate critical thinking and problem-solving skills to in handling Environmental Issues.

PO 4: Familiar with environmental hazards and suggest best remedial measures.

PO 5: Explore the inter-relationship between natural and man-made system.

PO 6: Conduct Data generation in the laboratory and data collection from field study.

PO 7: Analyse Data interpretation and report preparation skills.

PO 8: Practice Environmental Legislation, Economics and Audit.

PO 9: Undertake Environmental impact assessment and management.

PO 10: Frame up Environmental Conservation guidelines

PO 11: Acquire sound digital skills in the field of environmental science.

PO 12: Apply knowledge towards sustainable development of green environment.

ELIGIBILITY REQUIREMENTS

Candidates who have passed 10+2 from any recognised board in science stream shall be considered eligible for admission to B.Sc. Course with honours in Environmental Science.

General Guidelines

1. There shall be six semesters two in each year with total of 140 credits.
2. There shall be 14 core courses, 4 General Electives, 4 Discipline Specific Electives, 2 Ability Enhancement Compulsory Courses and 2 Skill Enhancement Courses in accordance with Choice Based Credit System.
3. Lab work based on theory papers will have total 28 credits.

COURSE STRUCTURE
SEMESTER-I

Sl. No.	Category	Code	Name of the Subject	Teaching Scheme in hour per week			Credits	Mode of Delivery
				L	T	P		
1	Core 1	BENVS 101	Environment and Sustainability- Concepts and Concerns	4	0	0	6	Online/Offline
		BENVS 191		0	0	2		
2	Core 2	BENVS 102	Earth-Environment System Science	4	0	0	6	
		BENVS 192		0	0	2		
3	General Elective 1	BENVS 103	Environmental Resources	4	0	0	6	
		BENVS 193		0	0	2		
4	Ability Enhancement Compulsory Course 1	BENVS 104	Communicative English	2	0	0	2	

SEMESTER-II

Sl. No.	Category	Code	Name of the Subject	Teaching Scheme in hour per week			Credits	Mode of Delivery
				L	T	P		
1	Core 3	BENVS 201	Physics and Chemistry of Environment	4	0	0	6	Online/Offline
		BENVS 291		0	0	2		
2	Core 4	BENVS 202	Environmental Biology	4	0	0	6	
		BENVS 292		0	0	2		
3	General Elective 2	BENVS 203	Environment and Society	5	1	0	6	
4	Ability Enhancement Compulsory Course 2	BENVS 204	Environmental Studies	2	0	0	2	

SEMESTER-III

Sl. No.	Category	Code	Name of the Subject	Teaching Scheme in hour per week			Credits	Mode of Delivery
				L	T	P		
1	Core 5	BENVS 301	Atmosphere and Climate Change	4	0	0	6	Online/Offline
		BENVS 391		0	0	2		
2	Core 6	BENVS 302	Biodiversity and Conservation	4	0	0	6	
		BENVS 392		0	0	2		
3	Core 7	BENVS 303	Water Resource Management	4	0	0	6	
		BENVS 393		0	0	2		
4	General Elective 3	BENVS 304	Environmental Pollution	5	1	0	6	
5	Skill Enhancement Course 1	BENVS 305	RS & GIS	2	0	0	2	

SEMESTER-IV

Sl. No.	Category	Code	Name of the Subject	Teaching Scheme in hour per week			Credits	Mode of Delivery
				L	T	P		
1	Core 8	BENVS 401	Green Chemistry and Technological Applications	4	0	0	6	Online/Offline
		BENVS 491		0	0	2		
2	Core 9	BENVS 402	Ecotoxicology and Environmental Biotechnology	4	0	0	6	
		BENVS 492		0	0	2		
3	Core 10	BENVS 403	Environmental Engineering and Pollution Control Measures	4	0	0	6	
		BENVS 493		0	0	2		
4	General Elective 4	BENVS 404	Oceanography and Coastal Management	5	1	0	6	
5	Skill Enhancement Course 2	BENVS 405	Environmental Impact Assessment and Management	2	0	0	2	

SEMESTER-V

Sl. No.	Category	Code	Name of the Subject	Teaching Scheme in hour per week			Credits	Mode of Delivery
				L	T	P		
1	Core 11	BENVS 501	Environmental Legislation and Policy	5	1	0	6	Online/Offline
2	Core 12	BENVS 502	Natural Hazards and Disaster Management	4	0	0	6	
		BENVS 592		0	0	2		
3	Disciple Specific Electiv1	BENVS 503	Energy and Environment	5	1	0	6	
4	Discipline Specific Elective 2	BENVS 504	Instrumentation Techniques in Environment	5	1	0	6	

SEMESTER-VI

Sl. No.	Category	Code	Name of the Subject	Teaching Scheme in hour per week			Credits	Mode of Delivery
				L	T	P		
1	Core 13	BENVS 601	Environmental Statistics and Economics	4	0	0	6	Online/Offline
		BENVS 691		0	0	2		
2	Core 14	BENVS 602	Environmental Analytics	4	0	0	6	
		BENVS 692		0	0	2		
3	Disciple Specific Elective3	BENVS 603	Waste Management	5	1	0	6	
4	Discipline Specific Elective 4	BENVS 604	Environment and Public Health	5	1	0	6	

Total Credit of the program: 140

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N.B. Proposed MOOCS course of this program will be followed as per MAKAUT Notification.

SEMESTER- I

BENVS 101: ENVIRONMENT AND SUSTAINABILITY- CONCEPTS AND CONCERNS

CREDITS – 4+2 = 6
(Lecture – 4 :: Practical – 2)

Course Outcome:
Students will be able to,

- Understand components of environment and goals of environmental education.
- Visualize man-environment inter-relationship.
- Learn nature, structure and function of gene, fundamentals of genetics and theories of evolution.
- Familiar with concept and importance of triple bottom line.

4 Credits
Lectures - 60

Concept of Environment: Definition and concept of environment; Types and components of environment (Lithosphere, Atmosphere, Hydropshere, Biosphere); Scope and multidisciplinary nature of the subject; Man-environment relationships; Public awareness – Earth Summits, recent Conventions on climate change **(15)**

Environmental Education: Goals of environmental education; Environmental education at primary, secondary and tertiary level; Green politics; Concepts and importance of triple bottom line, Environmental movements – The Chipko movement, Silent Valley movement, Narmada Bachaao Andolan, Tehri Dam Conflict **(15)**

Cell and Genetics: Cell: Characteristics and types of Prokaryotic, and Eukaryotic cells; Concept of a gene, chemical nature of gene; Ultra structure and functions of plasma membrane, structure and function of Mitochondria, Ribosome, Golgi body, Chloroplast, Endoplasmic reticulum, Nucleus, Chromosome; Cellular reproduction: Stages of Mitosis and Meiosis **(22)**

Fundamentals of Genetics: Mendel's Law of inheritance and gene interaction; Darwinism and Modern Synthetic Theory of evolution; Gene pool, Genetic drift **(08)**

SEMESTER- I

BENVS 191: ENVIRONMENT AND SUSTAINABILITY- CONCEPTS AND CONCERNS

Credit: 2

PRACTICAL

Practical: 2 Credits :: 30 h (Class)

Major Experiments

a) Cytological preparation of Mitotic stages from onion root tips (*Allium cepa*)
b) Cytological preparation of Meiotic stages from grasshopper testis

Text/Reference Books:

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.

BENVS 102: EARTH-ENVIRONMENT SYSTEM SCIENCE
CREDITS – 4+2 = 6
(Lecture – 4 :: Practical – 2)

Course Outcome:
Students will be able to,

- Understand the elements and classification of climate and climatic parameters.
- Familiar with earth's mineral and water resources.
- Gather elementary knowledge on principle and platform of remote sensing and GIS.
- Enrich with energy interaction between atmosphere and earth surface materials.

4 Credits
Lecture- 60

Earth Processes: Origin and evolution of earth; Big Bang theory, Geological time scale; Major rock types; Continental drift theory, Plate tectonic theory **(10)**

Climatology: Elements of climates; Spatial and temporal patterns of climate; Climate parameters in India and climatic classification (Koppen's classification) **(10)**

Earth Resources: Mineral resources--classification, Indian occurrences; Water resources (surface and groundwater), hydrological cycles, geological formation as aquifers, type and characteristics of aquifers; Groundwater plume; Darcy's law; Depletion of groundwater; Artificial recharging of ground water; Influence of land use on water resources **(15)**

Elementary Idea of Remote Sensing: Definition, source of energy, energy interactions with the atmosphere and Earth's surface materials; Principle of Remote sensing; Remote sensing platforms; Principle and function of sensors; Types of satellites; Latest Indian operating satellites and their utilities; Advantages and limitations of remote sensing; GIS **(25)**

BENVS 192: EARTH-ENVIRONMENT SYSTEM SCIENCE
PRACTICAL
Credit:2

Practical: 2 Credits :: 30
h (Class) Major
Experiments

1. **Identification of Rocks and Minerals:** Granite, Basalt, Shale, Sand Stone, Lime Stone, Marble, Quartzite, Bauxite, Mica, Haematite, Fire Clay.
2. **Topographical seed interpretation of geo-morphology:**
3. **Soil pH, Soil organic Matter, Water Holding Capacity, Available NPK in Soil.**
4. **Soil Electrical Conductivity.**

Text/Reference Books:

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.
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 Modelling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.

BENVS 103: ENVIRONMENTAL RESOURCES

CREDITS– 4+2 = 6

(Lecture – 4 :: Practical – 2)

Course Outcome:

Students will be able to,

- Familiar with natural resources of earth like water, land, forest, minerals.
- Build knowledge on energy resources like fossil, alternate and renewables.
- Gain elementary idea on biological wealth and aspects of biodiversity.

4 Credits

Lectures - 60

Natural Resources: Current status of Water, Land, Forest, Food and Minerals resource **(05)**

Soil: Weathering processes and soil formation; Soil profile development; Basic concept of physical, chemical and mineralogical composition of soil; Soil types, porosity, permeability **(07)**

Energy Resources: Classification - conventional, non-conventional, renewable, non-renewable **(03)**

Fossil Fuels: Coal (composition, origin and classification); Petroleum (origin, mining, chemical composition, classification); Natural gas (concept on LNG, CNG, LPG); Oil (origin, utilization) **(10)**

Renewable Resources: Solar energy, Geothermal energy (origin, utilization); Ocean energy; Biomass energy; Hydroelectricity **(08)**

Alternate Sources of Energy: Process of energy extraction from waste; Basic concept of petro-plants, biofuel **(07)**

Biological Wealth: Biodiversity – Concept, value; Mega-diversity Hotspots, hotspots of biodiversity, Red Data Book; Aspects of biodiversity (International & National); Threats of biodiversity **(20)**

BENVS 193: ENVIRONMENTAL RESOURCES PRACTICAL

Credit: 2

Practical: 2 Credits :: 30 h (Class)

1. Major Experiments:

Estimation of soil plasticity, Soil porosity, Bulk density, Swelling Volume, Proximate Analysis of coal, Calorific value from modified Majumder formula, Orsat analysis of gas mixtures.

Text/Reference Books:

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. Chokkan, K.B., Pandya, H. & Raghunathan, H. (eds). 2004. Understanding Environment. Sagar Publication India Pvt. Ltd., New Delhi.

4. Elliot, D. 2003. Energy, Society and Environment, Technology for a Sustainable Future.Routledge Press.

5. Guha, R. 1989. Ecological change and peasant resistance in the Himalaya. Unquiet Woods, Oxford University Press, Delhi.

BENVS 104: COMMUNICATIVE ENGLISH

CREDITS – 2

(Lecture – 2)

Course outcome:

Students will be able to,

- Endow with aptitude for spoken, written, documentation, dialogue, group discussion skills.
- Gain competency and confidence towards interpretation, letter writing, inter language translation and preparation of report.

Theory (30 Lectures)

COMMUNICATION: THEORY AND TYPES Theory of Communication, Types and modes of Communication Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication

(8)

SPEAKING SKILLS: Monologue Dialogue Group Discussion Effective Communication/ Mis- Communication Interview Public Speech

(8)

READING AND UNDERSTANDING Close Reading Comprehension Summary Paraphrasing Analysis and Interpretation Translation (from Indian language to English and vice-versa) Literary/Knowledge Texts

(8)

WRITING SKILLS: Documenting Report Writing Making notes Letter writing

(6)

Text/Reference Books:

1. Techniques and Principles in Language Teaching- Larsen-Freeman & Anderson- OUP
2. A Course in Language Teaching- Penny Ur- CUP
3. Approaches and Methods in Language Teaching- Jack C. Richards & T.S. Rodgers- Cambridge University Press
4. English Language Teaching – Geetha Nagaraj – Orient Blackswan

SEMESTER: II

BENVS 201: PHYSICS AND CHEMISTRY OF ENVIRONMENT

CREDITS –4+2 = 6

(Lecture – 4, Practical-2)

Course outcome:

Students will be able to,

- Enrich with fundamental concepts of environmental physics like black body, heat transfer, laws of thermodynamics, absorption, scattering and transmission of light, heat to earth conversion (Carnot Engine)
- Learn fundamental aspects of atmospheric chemistry, water chemistry and soil chemistry.

Theory 4 credits (60 Lectures)

Fundamentals of environmental physics (20 lectures)

Basic concepts of light and matter; quantum mechanics (relation between energy, wavelength and

frequency), black body radiation, Kirchhoff's law, Boltzmann equation, spectroscopic concepts:

Introduction to the concept of absorption and transmission of light, Beer–Lambert law, photovoltaic

and solar cells; scattering of light, Rayleigh and Mia scattering.

Basic concepts of pressure, force, work and energy; types of forces and their relation (pressure

gradient, viscous, Coriolis, gravitational, centripetal, and centrifugal force); concept of heat transfer,

conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); laws of

thermodynamics; concept of heat and work, Carnot engine, transmission of electrical power, efficiency of turbines, wind mills and hydroelectric power plants.

Movement of pollutants in environment (5 lectures)

Diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, mixing heights, hydraulic potential, Darcy's equation, types of flow, turbulence.

Fundamentals of environmental chemistry (20 lectures)

Atomic structure, electronic configuration, periodic properties of elements (ionization potential,

electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate

and

hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis.

Thermodynamic system; types of chemical reactions; acids, bases and salts, solubility products;

solutes and solvents; redox reactions, concepts of pH and pE, electrochemistry, Nernst equation,

electrochemical cells. Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organic functional groups, polarity of the functional groups, synthesis of xenobiotic compounds like pesticides and dyes, synthetic polymers.

Atmospheric chemistry (5 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

NO2 and SO2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

Water chemistry (5 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.

Soil chemistry (5 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.

PRACTICAL

BENVS 291: PHYSICS AND CHEMISTRY OF ENVIRONMENT

Credit: 2

1. Acidity, Alkalinity, Ca and Mg Hardness of Water, DO, COD, colorimetric estimation of iron & Cr.

Text/Reference Books:

1. Beard, J.M. 2013. Environmental Chemistry in Society (2nd edition). CRC Press.
2. Boeker, E. & Grondelle, R. 2011. Environmental Physics: Sustainable Energy and Climate Change. Wiley.
3. Connell, D.W. 2005. Basic Concepts of Environmental Chemistry (2nd edition). CRC Press.
4. Forinash, K. 2010. Foundation of Environmental Physics. Island Press.
5. Girard, J. 2013. Principles of Environmental Chemistry (3rd edition). Jones & Bartlett.
6. Harnung, S.E. & Johnson, M.S. 2012. Chemistry and the Environment. Cambridge University Press.
7. Hites, R.A. 2012. Elements of Environmental Chemistry (2nd edition). Wiley & Sons.
8. Manhan, S. E. 2000. Fundamentals of Environmental Chemistry. CRC Press.
9. Pani, B. 2007. Textbook of Environmental Chemistry. IK international Publishing House.

BENVS 202: ENVIRONMENTAL BIOLOGY

CREDITS – 4+2 = 6

(Lecture – 4 :: Practical – 2)

Course Outcome:

Students will be able to,

- Gather knowledge on morphological and taxonomical studies of flora and fauna.
- Develop concepts of ecology, ecosystem and biomes.
- Understand factors influencing the energy flow in ecosystem.
- Acquire idea on ecological succession and bio-geo chemical cycles.

Lecture: 4 Credits
Lectures - 60

Taxonomy: Definition of taxonomy, systematic and classification; Morphological and taxonomical studies of flora and fauna **(10)**

Concepts of Ecology: Subdivisions of ecology; Ecological classification (hydrophytes, xerophytes, halophytes, *etc*.) and their morphological, physiological and biochemical adaptation; Ecological factors - climatic, edaphic, physiographic and biotic; Limiting factor and Shelford's Law, Liebig law; Concept of Biological clock, circadian rhythm **(15)**

Concepts of Ecosystem and Biomes: Structural and functional aspects of major ecosystems (with special reference to freshwater, mangrove and desert); Trophic levels, Ecological pyramids, food chain and food webs; Energy flow in ecosystem - Energy flow models
Biomes: Concept, types and characteristics of biome types **(20)**

Biotic Community: Characteristics of population and community; Basic ideas on ecotone and edge effect, habitat and ecological niche, ecotypes, ecophene, ecological indicators; ecological succession; biogeochemical cycles, *e. g.,* N, C, S, P **(15)**

BENVS 292: ENVIRONMENTAL BIOLOGY PRACTICAL

Credit: 2

Practical: 2 Credits :: 30 h (Class)

1) Major Experiments:

a) Estimation of water parameters — BOD, Turbidity, Dissolve CO2 in water sample.

b) Staining of zooplankton and Identification.

c) Gram Staining.

d) Total coliform count.

Text/Reference Books:

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.

BENVS 203: ENVIRONMENT AND SOCIETY

CREDITS – 5+1 = 6

(Lecture – 5 :: Tutorial – 1)

Course Outcome:

Students will be able to,

- Learn man environment relationship and various social issues.
- Familiar with city urban environmental planning and ethics and need of environmental sustainability.
- Aware of basic idea about citizen science and citizen's role and responsibilities in EPA.

6 Credit **Lectures - 75**

Man-Environment Relationship: History and relationship; Need for public awareness; Deep ecology; Equitable use of natural resources; Ecosystem services to society; Environmentalism, Environmental refugees; Ecofeminism; Environmental movements in India; International and national environmental organizations; Human population growth and problems, regulation of population, Green politics **(30)**

Social Issues: Global environmental issues; Wasteland reclamation; Unsustainable to

Sustainable Development; Urban problems related to energy; Resettlement and rehabilitation of people: Citizens Actions and Action Groups; Environmental awareness; Environmental ethics; Women and Child welfare; Role of Information Technology in environment and human health

(25)

Environmental Sustainability: Concept of sustainable city, urban planning, social responsibility; International treaties & Conventions [Wetlands (Ramsar)], International Trade in Endangered Species (CITES), Biodiversity (CBD), Transboundary Movements of Hazardous Waste (Basal), Climate Change (Kyoto Protocol)

(20)

Text/Reference Books:

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.

BENVS 204: ENVIRONMENTAL STUDIES

CREDIT: 2

(Lecture: 2)

Course Outcome:

Students will be able to,

- Learn multidisciplinary nature of environmental studies.
- Realize scope and importance of environmental sustainability and natural resource conservation.
- Analyse level & threats of biodiversity.
- Analyse causes, effects and control of air water, soil and marine pollution.
- Enrich with basics of municipal, bio-medical and e-waste management.

Theory: 30 Classes

Introduction to environmental studies 4 lectures

•Multidisciplinary nature of environmental studies; •Scope and importance; Concept of sustainability and sustainable development.

Ecology and Ecosystems 6 lectures

•Concept of ecology and ecosystem, Structure and function of ecosystem; Energy flow in an ecosystem; food chains, food webs; Basic concept of population and community ecology; ecological succession. •Characteristic features of the following: a) Forest ecosystem

b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, wetlands, rivers, oceans, estuaries)

Natural Resources 4 lectures

• Concept of Renewable and Non-renewable resources • Land resources and land use change; Land degradation, soil erosion and desertification. •Deforestation: Causes, consequences and remedial measures •Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). •Energy resources: Environmental impacts of energy generation, use of alternative and nonconventional energy sources, growing energy needs.

Biodiversity and Conservation 8 lectures

•Levels of biological diversity: genetic, species and ecosystem diversity; • Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots •India as a mega-biodiversity nation; Endangered and endemic species of India •Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; •Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. •Ecosystem and biodiversity services: Ecological,

economic, social, ethical, aesthetic and

Informational value.

Environmental Pollution 8 lectures

• Environmental pollution: concepts and types, • Air, water, soil, noise and marine pollution-causes, effects and controls • Concept of hazards waste and human health risks • Solid waste management: Control measures of Municipal, biomedical and e-waste

Text/Reference Books:

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.

SEMSESTER III

BENVS 301: ATMOSPHERE & CLIMATE CHANGE

CREDITS – 4+2 = 6

(Lecture – 4, Practical:2)

Course Outcome:

Students will be able to,

- Update with earth's atmosphere and global energy balance and atmospheric circulation.
- Enlighten with global warming and climate change.
- Learn the causes and effects of ozone layer depletion.
- Aware of climate polices, international agreement and protocols.

4 Credit

Lectures – 60

Earth's Atmosphere: Concept; Evolution and development; Atmospheric structure and composition **(05)**

Global Energy Balance: Earth's energy balance; Energy transfers in atmosphere; Earth's radiation budget; Green house gases (GHGs); Greenhouse effect; Global conveyor belt **(10)**

Atmospheric Circulation: 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, effect of urbanization on micro climate **(10)**

Global Warming and Climate Change: Earth's climate through ages; Trends of global warming and climate change; Impact of climate change on atmosphere, weather patterns, sea level rise **(10)**

Ozone Layer Depletion: Ozone layer or ozone shield; Importance of ozone layer; Ozone layer depletion and causes; Ozone depleting substances (ODS); Effects of ozone depletion; Mitigation measures and international protocols **(15)**

Climate Change and Policy: Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change **(10)**

PRACTICAL

BENVS 391: ATMOSPHERE & CLIMATE CHANGE

Credit: 2

1. **Determination of Atmospheric Pressure, Relative Humidity, Rainfall, Insolation, Wind Speed and Solar Intensity.**
2. **Green-House Gas Analysis.**
3. **Estimation of trace metal pollutants by chemical and AAS method.**

Text/Reference Books:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff 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. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.

BENVS 302: BIODIVERSITY AND CONSERVATION

CREDITS – 4+2 = 6

(Lecture – 4 :: Practical-2)

Course Outcome:

Students will be able to,

- Learn levels of organization in living world.
- Understand biodiversity patterns and importance of biodiversity.
- Perform biodiversity estimation.
- Aware of biodiversity scenario in India.

4 Credits **Lectures – 60**

Levels of organization in living world (5 lectures)

From genes to ecosystems; tree of life; history of character transformation; organic evolution through geographic time scale; species concept – what's in a name?; how many species are there on earth?; concept and types of speciation.

Biodiversity patterns (5 lectures)

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

Biodiversity estimation (8 lectures)

Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity; molecular techniques: RAPD, RFLP, AFLP; NCBI database, BLAST analyses.

Importance of biodiversity (10 lectures)

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

Threats to biodiversity (10 lectures)

Natural and anthropogenic disturbances; habitat loss, habitat degradation, and habitat fragmentation; climate change; pollution; hunting; over-exploitation; deforestation; hydropower development; invasive species; land use changes; overgrazing; man wildlife conflicts; consequences of biodiversity loss; Intermediate Disturbance Hypothesis.

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), role of local communities and traditional knowledge in conservation; biodiversity hotspots; IUCN Red List categorization – guidelines, practice and application; Red Data book; ecological restoration; afforestation; social forestry; agro forestry; joint forest management; role
of remote sensing in management of natural resources.

Biodiversity in India (10 lectures)

India as a mega diversity nation; phytogeographic and zoogeographic zones of the country; forest types and forest cover in India; fish and fisheries of India; impact of hydropower development on biological diversity; status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.

BENVS 392: BIODIVERSITY AND CONSERVATION PRACTICAL
CREDIT: 2

1. **Identification of Flora & Fauna.**
2. **List of specimens with ecological & economic significance.**
3. **Biodiversity assessment in field, calculation of parameters, frequency, density, abundance and indices (Simson Index)**

Text/Reference Books:

1. Anne E. Magurran. 2003. Ecological diversity and its measurements. Blackwell Publications.
2. J.S.Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment and Resource Conservation. Anamaya Publications (New Delhi).
3. V.H. Heywood and Watson R.T. (Ed). 1995. Global Biodiversity Assessment: UNEP. Cambridge University Press

BENVS 303: WATER RESOURCE MANAGEMENT
CREDITS– 4+2 = 6
(Lecture – 4, Practical:2)

Course Outcome:
Students will be able to,

- Understand the classification of water resources and hydrological cycle.
- Learn physical, chemical and biological properties of water.
- Gather Knowledge on the characteristics of surface & ground water, water quality standards and demand for water in various sectors.
- Realise the Indian water resource scenario and reasons for water resource conflicts between India and her neighbours.

Credit 4
Lectures: 60

Water: Sources and types of water; Hydrological cycle; Precipitation, runoff, infiltration, evaporation, evapo-transpiration; Classification of water resources (oceans, rivers, lakes and wetlands) **(10)**

Properties of Water: Physical water: Temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: Major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes **(15)**

Surface and Subsurface Water: Characteristics of surface and ground water; Surface and ground water pollution; Formation and properties of aquifers; Watershed and drainage basins; Importance of watershed and watershed management; Rain water harvesting in urban settings **(15)**

Water Resource in India: Demand for water (agriculture, industrial, domestic); Overuse and depletion of surface and ground water resources; Water quality standards in India; Hot spots of surface water **(10)**

Water Resources Conflicts: Water resources and sharing problems; Multi-purpose river valley projects in India and their environmental and social impacts; International conflicts on water sharing between India and her neighbours **(10)**

PRACTICAL

BENVS 393: WATER RESOURCE MANAGEMENT
Credit:2

1. **Salinity of Water through chloride estimation, CO2 in water, Iron & residual Chlorine Content in water.**
2. **Measurement of nitrate in water.**
3. **Demonstration of water conservation techniques.**
4. **sewage/waste water treatment plant & recycling.**

Text/Reference Books:

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 Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.
7. Schward& Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.
8. Souvorov, A.V. 1999. Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management. Elsevier Publications.
9. Vickers, A. 2001. Handbook of Water Use and Conservation. WaterPlow Press.

BENVS 304: ENVIRONMENTAL POLLUTION

CREDITS– 5+1 = 6

Course Outcome:

Students will be able to,

- Learn different types and sources of pollutants.
- Realize the effects and impacts of pollutants on air pollution, water pollution and soil pollution.
- Gather knowledge on thermal pollution, vehicular pollution and fireworks pollutions.

6 Credit

Lectures - 60

Pollution: Fundamentals Pollution; Types of pollutants and pollution, Radioactive Pollutants. **(05)**

Air Pollution: Air pollutants—sources and effects of primary and secondary pollutants, particulate matters, indoor pollutants; Global climate change; Photochemical smog **(10)**

Water Pollution: Sources-direct and indirect sources and their impact on water bodies, *viz*., marine, coastal, wetlands; groundwater pollution; Eutrophication, Lake acidification, salt water intrusion **(10)**

Soil Pollution: Sources, types and effects of soil pollution **(10)**

Thermal Pollution: Definition, nature of pollutants, environmental effects of coal ash **(10)**

Vehicular Pollution: Characteristics of automobile emissions, effects of automobile pollutants **(10)**

Fireworks Pollution: Definition, characteristics, composition; Pollution and effects; Safety and laws **(05)**

Text/Reference Books:

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 (23rd edition). Banarsidas Bhanot 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.

BENVS 305: REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM (GIS
CREDITS – 2

Course Outcome:
Students will be able to,

- Understand principle and properties of electromagnetic radiation and its interaction with atmosphere.
- Acquire knowledge on different data acquisition platforms, satellite geometry and sensors.
- Enrich with special data model and attribute data management using GIS.

2 Credit
Lectures – 30

Remote Sensing: Principles, properties; Electromagnetic radiation and its interaction with atmosphere; Spectral reflectance of Earth's surface features; Types and characteristics of different data acquisition platforms; Satellite geometry, sensors and resolutions; Data products and their characteristics; Basic principle of visual interpretation **(20)**

GIS: Concept of GIS; Spatial data model; Attribute data management; Process of GIS **(10)**

Text/Reference Books:

1. Zar, J.H. 2010. Biostatistical Analysis (5th edition). Prentice Hall Publications.
2. Edmondson, A. & Druce, D.1996.Advanced Biology Statistics. Oxford University Press.
3. Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.
4. Richards, J. A. & Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.
5. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.

SEMESTER IV

BENVS 401: GREEN CHEMISTRY AND TECHNOLOGICAL APPLICATION

CREDITS – 4+2 = 6

Course Outcome:

Students will be able to,

- Understand the principle and application of green chemistry and directions in practicing green chemistry.
- Enlighten with green technology in integrated management of waste water, industrial wastes and hazardous chemicals.
- Learn green synthesis of chemicals, polymers, bio fuels.
- Principles of different advanced analytical and instrumental techniques.

4 Credits
Lectures - 60

Green Chemistry: Concept, principles, applications of green chemistry, *e. g.,* use of CO_2, H_2O_2, TiO_2;Chitin; Concept of octane number and antiknock compounds; Directions in practising green chemistry

(15)

Green Technology: Green technology in waste management, Integrated Waste Management (IWM); Supercritical water oxidation (SCWO) of wastes; Rhizosphere in biodegradation of organic wastes; Green techniques in water treatments: Deionization, Desalinizatation, Electrodialysis, Reverse osmosis; Green sources of energy; Green treatments of industrial effluents - Cyanide, Chromate

(20)

Green Synthesis of Chemicals: Methyl methacrylate, polyurethane, paracetamol; Production of 3^{rd} & 4^{th} generation pest controller, Integrated Pest Management (IPM); Biodiesel, Biopolymers, Bioplastics; Alternative Fluorocarbons (AFCs) **(20)**

Instrumental Methods: Chemical analysis of environmental samples; Principles of AAS, DTA, FTIR, Gas Chromatography

(20)

PRACTICAL

Credit: 2

BENVS 491: GREEN CHEMISTRY & ENVIRONMENTAL APPLICATIONS

a) Estimation of Fe by $K_2Cr_2O_7$ titration.
b) Estimation of Cu by Iodometric Titration.
c) Estimation of Pb, Al, Zn by complexometric EDTA titration.
d) Sampling and Application of Complexometric, Gravimetric, pH metric titrations.
e) Applications of UV-Vis spectrophotometry, Flame Photometry, X-Ray Fluorescence Microscopy, Data Analysis & errors.

Text/Reference Books:

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.
5. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press.

BENVS 402: ECOTOXICOLOGY & ENVIRONMENTAL BIOTECHNOLOGY

CREDITS – 4+2 = 6
(Lecture – 4, Practical:2)

Course Outcome:
Students will be able to,
* Learn on mechanism of toxicity and interactions in toxicology and concept of bio-accumulation
* Gather knowledge on bio-assay , fermentation techniques. Vermicomposting and bioleaching.
*Enlighten with application of biotechnology in environmental field.
* Understand the advantages of biofertilizer, bio pesticides, biogas.
* Identify bioremediation processes to treat contaminated soils and ground water.

4 Credit
Lectures – 60

Ecotoxicology: Definition and Concept; mechanism of toxicity; Branches of toxicology; Types of interactions in toxicology; Concept of Dose-Response relationship, LD_{50}, LC_{50}, Threshold Limit Value (TLV), Therapeutic index; Basic concept on Bioaccumulation, Biomagnifications, Bio-concentration factor; Ames test, Bio assay technique **(25)**

Environmental Biotechnology: Concept on Environmental biotechnology, Fermentation techniques, composting, vermicomposting, bioleaching; Application of biotechnology in environmental field **(20)**

Biotechnological Approaches: Definition, types, applications and advantages of biofertiliser, biopesticide, biofuel, and biogas

(15)

BENVS 492: ECOTOXICOLOGY & ENVIRONMENTAL BIOTECHNOLOGY PRACTICAL
Credit: 2

1. **Study of microbial activity in soil respiration.**
2. **LC50/LD 50 calculation by probit analysis.**
3. **Demonstration of a biogas plant.**
4. **Preparation of Bio-Assay Report for wastewater toxicity.**

Text/Reference Books:

1. A. K. De. (3rd Ed). 2008 Environmental Chemistry. New Age Publications India Ltd.
2. I. C. Shaw and J. Chadwick. 1997. Principles of Environmental Toxicology. Taylor& Francis Ltd.
3. S.C. Santra. 2011. Environmental Science. New Central Book Agency.
4. Ira. S. Richards. 2008. Principles and Practices of Toxicology in Public Health. Jones and Barlett Publications.

SEMESTER- IV
BENVS 403: ENVIRONMENTAL ENGINEERING & POLLUTION CONTROL MEASURES
CREDITS – 4+2 = 6

Course Outcome:
Students will be able to,

* Learn fundamentals of environmental engineering modelling.
* Gather knowledge on rain water harvesting, water ,waste water and sludge treatment processes.
* Enrich with integrated pollution control in chemical industry, thermal power plant and management of radio active wastes
* Familiar with control measures for particulate, gaseous pollutants and automobile emissions

Theory: Credit:4

Lectures – 60

Environmental Engineering: Material cycling in ecosystems; Hydraulic gradient; Rain water harvesting, Water shed management; Municipal waste water and treatment processes; Point-source Gaussian Plume Model in air pollution; Global initiatives on atmospheric changes; Waste-to-Energy combustion **(20)**

Environmental Modelling: Mathematical models; Steps in modelling approaches; Limitations of model application, fate of chemicals, sophistication levels in modelling **(15)**

Pollution Management: Management of radioactive pollutants, Noise level measurement techniques, Instrumentation for environmental pollution, Monitoring and audit, Instrumentation setup for pollution abatement. Noise pollution and its effects, social and political involvement in the pollution management system **(20)**

Pollution Control Technologies: Pollution control technology as an interdisciplinary approach. Process integrated pollution control in chemical industry. Unit operations/processes for water and wastewater treatment. Sludge treatment and disposal. Wastewater reuse. Control devices for particulate and gaseous air pollutants. Gravitational settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostatic precipitators. Adsorption, absorption, condensation, combustion, automobile emission control. **(20)**

ENVIRONMENTAL ENGINEERING & POLLUTION CONTROL MEASURES PRACTICAL

Credit:2

Experiments:

- Demonstration of vermicomposting technique.
- Visit to plastic wastes recycling plant and fly-ash brick making plants and submission of report.

BENVS 404: OCEANOGRAPHY & COASTAL MANAGEMENT
CREDIT: 5+1=6

Course Outcome:
Students will be able to,
* Learn basics of physical and geological oceanography, classification of seacoast and estuaries
* Assimilate coastal waves, current, sediment transport , marine mineral Energy sources and coastal defence.
*aware of coastal hazards,anthropogenic impacts and laws of sea & coastal regulation zone.

4 Credit
Theory 75
Basics of Oceanography: Definition, nature, scope of oceanography and relationship with other subjects, Historical development of oceanography, Historical development of oceanography in India
Physical Oceanography: Salinity, conductivity, temperature, density, light and pressure, etc. of sea water, Waves: definition, classification and different types of waves, origin of surface waves, forms and characteristics, growth and dissipation of wind waves, breakers and surfs, Tides: definition, classification, causes and types of tide, storm surges, seiches, and Tsunami, Currents: definition, classification, causes and types of current, major surface current system of the World Ocean, atmospheric circulation, global wind pattern, Ekman spiral, Ekman transport and upwelling
Chemical Oceanography: water molecule, dissolving power of Seawater, composition of sea water
Biological Oceanography: Plankton, Nekton, Benthos
Geological Oceanography: Marine sediments, types of sediment based on sources and origins
Coastal management : Indian Scenario - Classification of Harbours. Introduction - wind and waves - Sea and Swell - Introduction to small amplitude wave theory - use of wave tables- Mechanics of water waves - Linear (Airy) wave theory, Introduction to Tsunami
Wave properties and analysis : Behaviour of waves in shallow waters, Introduction to non-linear waves and their properties - Waves in shallow waters - Wave Refraction, Diffraction and Shoaling -Hindcast wave generation models, wave shoaling; wave refraction; wave breaking; wave diffraction random and 3D waves- Short term wave analysis - wave spectra and its utilities - Long term wave analysis- Statistics analysis of grouped wave data.
Coastal sediment transport : Dynamic beach profile; cross-shore transport; along shore transport (Littoral transport), sediment movement
Coastal defence : Models, groins, sea walls, offshore breakwaters, artificial nourishment - planning of coast protection works - Design of shore defence structures -Case studies.

Text/Reference Book

1. Pickard, GL 1963. Description Physical Oceanography. Pergamon Press, London.
2. Yasso, WE 1965. Oceanography. Holt, Rinehert and Winston, Inc., New York.

3. King. CAN 1966. An Introduction to Oceanography. McGraw Hill Book Co, New York.
4. Pickard GL and WJ Emery, 4th enlarged, 1982. Descriptive Physical Oceanography. Pergamon Press, Oxford.
5. Weisberg, J and H Parish. 1974. Introduction to Oceanography. McGraw-Hill Kogakusha, Ltd., Tokyo
6. Introduction to coastal engineering and management, J.W.Kamphuis, 2nd Edition, 2000 World Scientific Company Ltd.

BENVS 405: ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT
CREDIT: 2
(Lecture – 2)

Course Outcome:

Students will be able to,

* Learn scope and methodologies of EIA.
* Identify and predict environmental management plan.
* Conduct strategic and social impact assessment , life cycle assessment and cost - benefit analysis.
* Aware of EIA regulation and legal framework in India.

Theory (30 Lectures)

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

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

Unit 3: EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects/ thermal projects.

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

Text/Reference Books:

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.

SEMESTER-V

BENVS 501: ENVIRONMENTAL LEGISLATION AND POLICY

CREDITS– 5+1 = 6

(Lecture – 5 :: Tutorial – 1)

Course Outcome:

Students will be able to,

*Gather knowledge on laws, acts, policies , treaties and provisions in Indian constitution regarding pollution control.

* Learn principles and objectives of number of
Environmental protection acts like air pollution control act, water control act noise pollution control act.

*Enlighten with wild life protection act, forest conservation act , national green tribunal act, bio diversity act, EIA status and regulations in India

6 Credit
Lectures – 75

Environmental Laws and Policies: Basic concept on law, rules, act, treaty; Public Policy and PILs; Environmental provisions in the Indian Constitution- Article 48A, 51A(g); Powers and Functions of Govt. Agencies for pollution control (CPCB & SPCB) **(20**

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Environmental Acts: Objectives & Principles of The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and Control of Pollution) Act, 1974; The Noise Pollution (Regulation and Control) Act, 2000; The Wild Life (Protection) Act, 1972; The Forest (Conservation) Act, 1980; The National Green Tribunal Act, 2010; The Biological Diversity Act, 2002; Public Liability Insurance Act, 1991 **(25)**

Environmental Impact Assessment (EIA): Basic ideas and definition; Goals of impact assessment, evolution of impact assessment, technology assessment; Environmental inventory; Techniques and methods of EIA **(30)**

Text/Reference Books:

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, Materials and 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.
7. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International.
8. Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd.

BENVS 502: NATURAL HAZARDS & DISASTER MANAGEMENT

CREDITS – 4+2 = 6

(Lecture – 4, Practical:2)

Course Outcome:

Students will be able to,

* Iearn types , causes, ,consequences and mitigation of natural hazards like earth quake, Tsunami, cyclone, flood, drought land slide etc.
* Familiar with concept, vulnerability , risk of disaster management.
* Gather knowledge on characterisation ,evaluation and disposal of toxic and radio active substances.
* Aware of the role of govt and non- govt agencies in disaster management

4 Credit
Lectures – 60

Natural Hazards: Definition, concept and types; Causes, distribution, consequences and mitigation measures and for Earthquake, Tsunami, Cyclone, Flood, Drought and Landslide**(10)**

Disaster Management: Definition and concept, vulnerability, capacity and risk; Disaster management cycle **(10)**

Institutional Framework: Constitutional frameworks in India – Role of Governments, Non- Governments and State Government agencies **(10)**

Risk Assessment: Concept and evaluation of risk; Hazard identification; Exposure assessment; Hazard assessment; Risk characterization; Man-made Environmental degradation; Problems related to toxic wastes and chemicals and radioactive substance disposal **(15)**

BENVS 592: NATURAL HAZARDS & DISASTER MANAGEMENT PRACTICAL
Credit:2

1. **Preparation of project report based on field study such as Flood & Water logging, Cyclone, Earthquake, Fire hazards, Industrial accidents.**

Text/Reference Books:

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.

BENVS 503: ENERGY AND ENVIRONMENT
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Course Outcome:

Students will be able to,

* Learn about global energy resources scenario, conventional and renewable distribution and availability.
* gather knowledge on present and future energy demand and consumption break up in domestic, transport, industrial and agricultural sectors
* Aware of over -energy consumption & wastage of energy and it's impact on Environment and economy.
* Stress for conservation of energy and strive for Renewable Energy**.**

6 Credit
Lectures – 75

Introduction (10 lectures)

Defining energy; forms and importance; energy use from a historical perspective: discovery of fire, discovery of locomotive engine and fossil fuels, electrification of cities, oil wars in the Middle East, advent of nuclear energy; sources and sinks of energy; energy over-consumption in urban setting

Energy resources (12 lectures)

Global energy resources; renewable and non-renewable resources: distribution and availability; past, present, and future technologies for capturing and integrating these resources into our energy infrastructure; energy-use scenarios in rural and urban setups; energy conservation.

Energy demand (10 lectures)

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.

Energy, environment and society (15 lectures)

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.

Energy, ecology and the environment (10 lectures)

Energy production as driver of environmental change; 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.

Text/Reference Books:

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 (2nd 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.

BENVS 504: ENVIRONMENTAL INSTRUMENTATION TECHNIQUES
CREDIT:6
(Lecture – 5+1)

Course Outcome:
Students will be able to,
*Learn about various advance instruments used in detecting and controlling atmospheric pollution , water and wastewater pollution .
* Gather knowledge on instrumentation for analysis and control of industrial effluents.

6 Credit **Theory: 75 Classes**

Air Pollution control instrumentation: Impact of man of the environment: An overview, Air pollution sources and effects, Metrological aspect of air pollutant dispersion, Air pollution sampling and measurement, Air pollution control methods and equipment, Air sampling techniques, soil pollution and its effects, Gas analyzer, Gas chromatography, Control of specific gaseous pollutants, Measurement of automobile pollution, Smoke level meter, CO/HC analyzer.

Water pollution control instrumentation: Sources And classification of water pollution, Waste water sampling and analysis, marine pollution, Waste water sampling techniques and analyzers, Gravimetric, Volumetric, Calometric, Potentiometer, Flame photometry, Atomic absorption spectroscopy, Ion chromatography, Instruments used in waste water treatment and control, Solid waste management techniques.

Pollution Management: Management of radioactive pollutants, Noise level measurement techniques, Instrumentation for environmental pollution, Monitoring and audit, Instrumentation setup for pollution abatement. Noise pollution and its effects, social and political involvement in the pollution management system

Text/Reference Books:

1. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.
2. H. H. Rump. 2000. Laboratory Manual for the Examination of Water, Waste water and soil. Wiley-VCH.
3. R. K. Sapru. 1987. Environmental Management in India (Vol. I & II). Ashish Publishing House.

SEMESTER- VI

BENVS 601: ENVIRONMENTAL ECONOMICS & STATISTICS

CREDITS – 4+2= 6

(Lecture – 4 :: Practical – 2)

Course Outcome:

Students will be able to,

- Learn Statistical concepts, sampling, graphical representation of statistical data.
- Gain Knowledge on economics of pollution control, cost benefit analysis, monitoring economic and environmental terms to improve environment quality.
- Enrich with concepts and guidelines of environmental accounting and auditing, perform detailed study and submission green audits.

4 Credits

Lectures – 60;

Environmental Economics: Concept, scope; Concept of supply and demand; Ecological economics; Environmental Kuznets's Curve; Economics of pollution control; Cost: Benefit analysis; Polluter's Pay Principle

(10)

Environmental Accounting and Auditing: Environmental accounting--objectives, financial accounting, social accounting; Basic steps and process of environmental audit; Life cycle assessment

(10)

Environmental mathematics and statistics: Basics of Set theory, AP, GP, Infinite Series, Binomial Series, Permutation – Combination, logarithm, exponential series, Series of the form (1+x) –n. Representation of data by different charts and graphs. Measures of central Tendency, Dispersion, skewness and Kurtosis. Basics of Probability distribution, Correlation, Regression **(15)**

Statistical Concept: Concept of statistics, population, sampling, sampling area, sampling unit, types of data, types of sampling, advantages of sampling; Graphical representation of statistical data **(20)**

Measurement: Mean, Median, Mode; Mean deviation, Standard deviation, Standard error; Correlation and Regression; Estimation of sample size, basic information on probability,

testing of hypothesis, Null and alternate hypothesis, Skewness, Kurtosis, t – test, chi – square test **(20)**

BENVS 691: ENVIRONMENTAL ECONOMICS & MANAGEMENT
PRACTICAL
CREDIT: 2

1. **Numerical problems on chi square test and biostatistics..**
2. **Study of microbial activity of vermicompost.**
3. **Study and Submission of green audit report.**

Text/Reference Books:

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.

BENVS 602: ENVIRONMENTAL ANALYTICS
CREDITS: (4+2)

Course Outcome:

Students will be able to,

- Prepare environmental database and socio economic data card.
- Apply data science for environmental modelling and statistical analysis of grouped wave data.
- Handle files containing environmental data using MATLAB software.
- Motivate social and public involvement in pollution management system.

Theory: 60
Credit: 4

Environmental Modelling: Mathematical models; Steps in modelling approaches; Limitations of model application, fate of chemicals, sophistication levels in modelling

Socio-environment report cards: As invaluable tools that enhance environmental intelligence, the conceptualization of socio-environmental systems, selection of indicators and benchmarks, data analysis, communication of results, and leveraging the report card to make real change.

Environmental Database Resource and Reports: Types of reports. With and without interpretation, search of environmental records, two levels of database reports: the **Radius Report** and the **Rec / RecCheck Search Report.**

Data science for environmental modelling and renewables: Time series analysis, quantile regression and extremes, spatial modelling, open data and citizen science, ARMA, ARIMA, ARCH, GARCH models for weather, climate forecasting

PRACTICAL
BENVS 692: ENVIRONMENTAL ANALYTICS
CREDIT :2

Introduction to Programming in R: Basics of R, Linear Regression, Logistics Regression, Random Forest, Support Vector Machine, Decision Tree, K -means clustering.

Introduction to MATLAB: Basics of MATLAB, How to work with Mathematics/statistics in MATLAB, Trigonometric Function, Vector, Matrices etc. in MATLAB. Graphs and plots in MATLAB. Functions in MATLAB, Working with files containing environmental data.

Text/Reference Books:

Methods of Environmental Data Analysis, Springer
Environmental Data Analysis Methods and Applications Zhihua Zhang,
https://doi.org/10.1515/9783110424904
Data Science for Environmental Modeling and Renewables, online course University of Glasgow

BENVS 603: WASTES MANAGEMENT

CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Course Outcome:
Students will be able to,

- Learn about basic concepts of generation, classification and composition of wastes.
- Understand the effect of waste disposal on environment.
- Gather knowledge on characterisation of municipal wastes, hazardous wastes, bio-medical wastes as well as integrated waste management technologies.
- Enlighten with conversion of waste to energy and waste to wealth.

6 Credit
Lectures: 75

Basic concept of waste management: Concept of waste management; Classification of wastes; Waste minimization technologies; Industrial waste water quality control and management; Reduce, reuse and recycle of waste; Integrated waste management.
Hazardous waste: Resource, conservation and recovery; Land disposal; Alternatives; Ocean dumping; Handling and management of radioactive waste; Environmental impacts.
Municipal solid waste management: Composition; Onsite disposal; Incineration; Open dumps; Sanitary land-fills; Environmental consequences.
Bio medical waste: Generation; Segregation; Colour codes; Disposal and treatments; Health consequences.
E-waste: Generation; Segregation; Disposal and treatments; Environmental impacts.
Waste to wealth: Energy from waste; Value added products from waste; Fly ash utilization and disposal Garbage farming; Sewage fed fisheries; Composting.
Waste Disposal: Criteria for waste disposal in riverine, marine and coastal system; Waste handling, transportation, compaction and disposal.

Text/Reference Books:

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.

BENVS 604: ENVIRONMENTAL POLLUTION AND PUBLIC HEALTH

CREDITS – 5+1 = 6

(Lecture – 5 :: Tutorial – 1)

Course Outcome:

Students will be able to,

- Learn about principle and objective of epidemiology as well as epidemiological methods.
- Gather knowledge on deadly diseases like air borne, water borne, vector borne, communicable and non-communicable diseases, allergy and immunology.
- Aware of health programs, environmental stress, physiology, agents and nutrition-health education.

6 Credit

Lectures - 75

Environmental Health: Concept of health and disease; Principles of epidemiology and epidemiological methods, aims of epidemiology **(15)**

Diseases: Concept on air, water, vector borne diseases; Some communicable diseases--Viral hepatitis, dengue, Leishmaniasis; Non-communicable diseases - cardiovascular, diabetes; Immunology- elementary ideas about antigens and antibody, autoimmunity; Immunodeficiency diseases; Allergy – Antibody-mediated hypersensitivity, hypersensitivity pneumonitis, allergic rhinitis, ingestant allergy, dermatitis, drug sensitivity **(30)**

Health Programs: Health Programs in India; Demography and family planning; Nutrition and health; Health education; World health report; Health impact assessment **(15)**

Environmental Stress Physiology: Concept and fundamentals; Photoinhibition and photoacclimation; Stress-agents like temperature, oxygen, salinity on plants **(15)**

Text/Reference Books:

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 (23rd edition). Banarsidas Bhanot 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.