

SYLLABUS OF B.Sc. (Hons.) ENVIRONMENTAL SCIENCE

As per

NATIONAL EDUCATION POLICY – 2020

(NEP-2020)



CURRICULAR FRAMEWORK FOR FOUR YEARS GRADUATE PROGRAMME IN

GURUKULA KANGRI (DEEMED TO BE UNIVERSITY) UNDER NEP-2020

in

ENVIRONMENTAL SCIENCE

DEPARTMENT OF ZOOLOGY & ENVIRONMENTAL SCIENCES

GURUKULA KANGRI (DEEMED TO BE UNIVERSITY)

HARIDWAR – 249404

(2022)

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CURRICULUM STRUCTURE FOR THE UNDERGRADUATE DEGREE PROGRAMME - B.Sc. (BASIC/HONS.)

Total Credits for the Programme: **192**

Starting year of implementation: **2022-2023**

Name of the Degree Programme: **B.Sc. (Basic/Hons.)**

Discipline/Subject: **Environmental Science**

Programme Articulation Matrix

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course(s)	Pedagogy	Assessment
1	BES-C-101 – Basics of Environmental Science	To develop the knowledge and understanding for Basic concepts of the Environment Science and applied ecology including the holistic relationship between them.	Intermediate or equivalent in Science subjects	Theory and course projects	Continuous internal assessment (Formative assessment) - 30%. End Semester Examination (Summative assessment) - 70%
	BES-C-151 – Lab Course	To provide the basic understanding of various ecosystem components and their on filed understanding.		Practical	

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
2	BES-C-201 – Natural Resource management	To develop the sound knowledge of Natural Resource and Application of various management practices.	-	Theory, case studies and course	Continuous internal assessment (Formative assessment) - 30%. End Semester Examination (Summative assessment) - 70%
	BES-C-251- Lab Course	To provide a basic understanding of various natural resources in India through map studies for regional and national knowledge.		Practical	

Exit option with Certificate in Science

Job opportunities for the Exit option with Certificate

- Sampling Assistant in wastewater treatment plants
- Analytical Assistant/Intern analyst in water testing laboratories
- Laboratory instructor in educational institutions
- Field Technician in mobile environmental laboratories
- Field Technician in Research institutions/NGOs involved in environmental monitoring/carbon credit establishment/productivity studies.
- Sampling and execution assistant in environmental auditing
- Garden/nursery Supervisor/Entrepreneurship
- NGOs/Consultancy firms
- Self-employment

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
3	BES-C-301- Environmental Pollution	To develop a sound knowledge of definition, types and control measures of different types of pollution.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	BES-S-302- Environment and public health	To develop the understanding and knowledge for public health in relation to environment including various types of diseases and their control measures.			
	BES-C-351- Lab Course	To provide the basic practical knowledge of air, water, soil and noise sampling and analysis.		Hands-on-training and field studies	
Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
4	BES-C-401- Solid Waste management	To provide the basic understanding of different types of Solid waste and management practices.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	BES-S-402- Environmental sustainability and Economics	To provide the knowledge and understanding on sustainable development, policies along with basics of environmental economics.			
	BES-C-451- Lab Course	To provide the practical knowledge for various types of solid waste and management techniques.		Hands-on-training and field studies	

Job opportunities for the Exit option with Diploma in Science

- Procurement, processing, value addition and Marketing of NTFPs - Executive/Entrepreneurship
- Procurement of Medicinal Plants – Marketing/Entrepreneurship
- Lab assistant in educational institutions/ Wildlife and Ecotourism guides
- Public Health/Waste Management Assistants in Municipalities
- Incinerator operators in small establishments
- NGOs/Consultancy firms/Self-employment

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
5	BES-C-501- Environmental Microbiology and Toxicology	To develop an understanding for Environmental microbiology, air, water, soil, and food-borne diseases including the basics of environmental toxicology.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination summative assessment) -70%
	BES-C-502- Environmental Chemistry and Instrumentation	To develop a sound knowledge and understanding of Environmental chemistry and the basics of environmental instrumentation			
	BES-E-503 Occupational Health & Safety	To develop a sound knowledge and understanding of occupational health and safety in different work places including various precautions and preventions			
	BES-C-551- Lab Course	To develop the practical knowledge for different instruments used for the environmental monitoring and microbiological techniques		Hands-on-training and field studies	
Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
6	BES-C-601- Environmental Laws	To develop a basic understanding for environmental conventions, policies, land ws with case studies.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	BES-C-602- Environmental Disasters	To create the knowledge and understanding of various disasters, prevention and management techniques with case studies.			
	BES-E-603 Environmental quality management	To develop knowledge and understanding for environmental quality management, quality standards, environmental friendly products and environmental auditing.			

BES-C-651- Lab Course	To create the practical knowledge and understanding on environmental management practices, natural disasters, auditing including case studies of Uttarakhand State.	Hands-on-training and field studies
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Job opportunities for the Exit option with Bachelor of Science Degree

- Assistants in Central and State Pollution Control Boards
- Environmental Health and Safety Assistant in industries
- Occupational Health and Safety Assistant in industries/theme parks
- Public Health/Waste Management Officers in Municipalities
- Wastewater Treatment Plant Managers
- Environmental/Production Quality Assurance Executive - Junior
- Environmental Analyst (Validation)
- Research Assistant/Staff
- R&D Lab Assistant
- Water testing labs or chemical suppliers/ Entrepreneurship
- Liaison Officer
- Watershed Management Assistant
- Mineral/Energy Resource Exploration Assistant
- Solar energy/alternate energy Executives
- Micro irrigation Executives
- Organic Farming Executives/Entrepreneurship
- NGOs/Consultancy firms
- Teachers in Schools
- Self-employment

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
7	BES-C-701- Himalayan Ecology and Biodiversity	To create an understanding and knowledge for the Himalayan region in context of ecology and Biodiversity	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination summative assessment) -70%
	BES-C-702- Climate change and its implication	To develop the knowledge and understanding of global climate change and their impact on different components of environment including climate change policies including mitigation and adaptation measures.			
	BES-C-703- Himalayan ecotourism	To create an understanding of Himalayan tourism, and economic growth – the livelihood of regional people as a part of skill development		Hands-on-training and field studies	
	BES-C-751- Lab Course	To provide the practical knowledge of Himalayan Region in context of flora and fauna, natural resources and eco-tourism			
Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
8	BES-C-801- Environmental Impact Assessment	To develop the knowledge and understanding of the process involved in Environmental Impact Assessment,	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (problem-solving assessment) - 70%
	BES-C- Environmental Biotechnology	To create the knowledge and understanding for environmental biotechnology in biodiversity conservation and the use of different technologies in resource conservation and management			

BES-C-803- Research Methods and biostatistics	To develop the skills in Biostatistics and Research Methodology to frame research query, develop methodology, Analyze the data, interpret the results and suggest suitable solutions and recommendations.
BES-C-851- Lab Course	To create the practical knowledge of implementation of EIA in different environmental components along with statistical analysis

Hands-on-training and field studies

Job opportunities for the B.Sc. (Hons.) Degree in Environmental Science

- Scientific Assistant in Research institutions
- Scientists in Central and State Pollution Control Boards
- Environment Health and Safety Officer in industries
- Environmental auditor I/Auditor II
- Environmental/Production Quality Assurance Officer
- Wastewater Treatment Plant Managers
- Sanitary landfill and Hazardous Waste Handling Experts
- Toxicology specialist
- Forensic Scientist
- Quality Control Executive
- Regulatory Affairs/Liaison Officer
- NGOs/Consultancy firms
- Project and Planning and Development Departments
- Watershed Management Professional
- Teachers in Schools
- Self-employment

S.No.	Subject Code	Subject Title	Period			Evaluation Scheme			Subject Total	
			L	P	Credit	Sessional		ESE		
B.Sc. I Year										
Semester – I										
DSC 1	BES-C-101	Basics of Environmental Science	4	2	4	20	10	70	100	
AECC		Environmental Science and Sustainable development/Language and Literature – I (English)	4		4	20	10	70	100	
SEC 1		NSS/NCC/Cultural (Music/Art/Painting/Dance) (Qualifying)	-		-	20	10	70	100	
VAC1		Yogic Science/Physical Education and Sports/Human Psychology	2		2	20	10	70	100	
	BES-C-151	Lab course			2	15	15	70	100	
Semester –II										
DSC 2	BES-C-201	Natural resource Management	4	2	4	20	10	70	100	
AECC		Environmental Science and Sustainable development/Language and Literature – I (English)	4		4	20	10	70	100	
SEC 2		NSS/NCC/Cultural (Music/Art/Painting/Dance) (Qualifying)	-		-	20	10	70	100	
VAC2		Yogic Science/Physical Education and Sports/Human Psychology	2		2	20	10	70	100	
	BES-C-251	Lab course			2	15	15	70	100	
Total						24				1000
B.Sc. II Year										
Semester-III										
DSC 3	BES –C-301	Environmental Pollution	4	2	4	20	10	70	100	
SEC 3	BES-S-302	Environment and Public Health	4		4	20	10	70	100	
VAC3		IT Skill, Data analysis/Digital Literacy and cyber security	2		2	20	10	70	100	
	BES-C-351	Lab course			2	15	15	70	100	
Semester –IV										
DSC 4	BES –C-401	Solid Waste Management	4	2	4	20	10	70	100	
SEC 4	BES-S-402	Environmental Sustainability & Economics	4		4	20	10	70	100	
VAC4		Language and Literature II (Sanskrit) 2	2		2	20	10	70	100	
	BES-C-451	Lab course			2	15	15	70	100	
Total						24				800

B.Sc. III Year									
Semester –V									
DSE 5	BES – E-501	Environmental Microbiology & Toxicology*	4	2	4	20	10	70	100
OR									
DSE 5	BES – E-502	Environmental Chemistry & Instrumentation*							
SEC 5	BES-S-503	Occupational Health & Safety	4		4	20	10	70	100
VAC 5		Innovation and Entrepreneurship/Data Science & Application/Vermi-Composting	2		2	20	10	70	100
	BES-C-551	Lab course			2	15	15	70	100
Semester –VI									
DSE 6	BES –C-601	Environmental Law *	4	2	4	20	10	70	100
DSE 6	BES –C-602	Environmental Disasters*							
SEC 6	BES – S - 603	Environmental quality control	4		4	20	10	70	100
VAC 6		Ethics and Culture/ The essence of Indian Traditional knowledge/ BKT/ Vedic Science	2		2	20	10	70	100
	BES-C-651	Lab course			2	15	15	70	100
Total 24									800
B.Sc. IV Year									
SEM. VII									
DSC 7	BES –C-701	Himalayan Ecology & Biodiversity	4	4	4	20	10	70	100
DSC 8	BES –C-702	Climate change and its implication	4		4	20	10	70	100
DSC 9	BES –C-703	Himalayan Eco-tourism	4		4	20	10	70	100
SEC 7	BES-S-704	Communication Skills and Personality Development	2		2	20	10	70	100
VAC 7	BES-V-705	Research Training/ Field Studies	6		6				
	BES-C-751	Lab Course			4	15	15	70	100
SEM. VIII									
			4	4					
DSC 10	BES –C-801	Environmental Impact assessment	4		4	20	10	70	100
DSC 11	BES –C-802	Environmental Biotechnology	4		4	20	10	70	100
DSC 12	BES –C-803	Research Methods and biostatistics	4		4	20	10	70	100
SEC 7	BES-S-804	Vedic Environment	2		2	20	10	70	100
VAC 8	BES-V-805	Research Project/ Dissertation	6		6				
	BES-C-851	Lab Course		4	15	15	70	100	
Total 48									1000
Grand Total									3600

B.Sc. (Hons.) Semester – I

BES-C-101 - Basics of Environmental Science

Unit – 1

Environmental Science: Definition, Aim of study and Scope and importance. Differences between Ecology and Environmental Science. Components of the Environment: Definitions of Atmosphere, Hydrosphere, Lithosphere and Biosphere - their complex interactions and significance.

Unit – 2

- Ecosystems – Definitions. Classification of the ecosystem – Terrestrial and Aquatic with their divisions. Structure of the ecosystem - Function of ecosystem - food chain – food web, Ecological pyramids. Energy flow in an ecosystem.

Unit – 3

Biotic and Abiotic factors: Influence Temperature, Wind and Water, Edaphic, Topographic on flora and fauna and their relationship.

Unit - 4

Ecological Niche: Concept and Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width – Niche Partitioning - Realized and Fundamental Niche. Biomes: Definition and concept. Classification of biomes.

Unit - 5

Ecological succession – Primary and Secondary succession – Natural and man-influenced succession, – Hydrarch and Xerarch - Climax vegetation and their theories; Ecotone and Edge effect; Ecological equivalents; Ecotypes and Ecophenes; Ecological indicators.

BES - C - 151: Lab Course

TIME: 6-8 HOURS

Max. Marks: 100

Sessional: 30 ESP: 70

A. Ecosystem Studies (2 exercise will be given)	10 + 10 = 20
1.To study and enlist various biotic and abiotic components of forest Ecosystem.	
2.To study and enlist various biotic and abiotic components of Desert Ecosystem.	
3.To study and enlist various biotic and abiotic components of Grassland Ecosystem	
4.To study and enlist various biotic and abiotic components of Aquatic Ecosystem	
B. To study the structure of Atmosphere	10
C. To study the different food chains & ecological pyramid of different ecosystem	10
D. Collection of different species of aquatic macrophytes in River Ganga	10
E. Viva Voce	10
F. Practical record/Chart/Model	5
G. Assignments	5
Total	70

Semester - II

BES-C – 201: Natural Resource Management

UNIT 1:

Natural Resources: Introduction, types - renewable and non-renewable; resource conservation; resource availability and factors influencing its availability; Resource and resource degradation.

UNIT 2:

Forest Resources: Importance, types of forest, forest products, Non-timber forest products. Deforestation (forest fires, forest land degradation, Illicit felling, grazing, shifting cultivation etc.), Forest conservation measures– Social forestry (Farm forestry, village forestry, agroforestry, extension forestry).

UNIT 3:

Water resources: Importance, types of water resources, water resources of India, freshwater (groundwater, surface water), Marine water (Saline and brackish Water), depletion of water resources, Overexploitation of water resources, Water conservation, Rain water harvesting.

UNIT 4:

Energy Resources: Renewable and non-renewable energy resources. Solar Energy, Wind energy, biomass energy, hydrothermal energy. Fossil fuels, coal, petrol and natural gases, biogas and green energy.

UNIT 5:

Land Resources: types, food resources, mineral resources and reserves, ocean ore and recycling of resources, Environmental impact of exploitation, processing and smelting of Mineral, oceans as need areas for exploitation of Mineral resources.

BES - C - 251: Lab Course

TIME: 6-8 HOURS

ESP: 70

Max. Marks: 100

Sessional : 30

A. Map studies	10 + 10 = 20
a. Different forest types of India	
b. Different mineral reserves of India	
B. Map studies (any two)	10 + 10 = 20
a. Different freshwater river systems of India	
b. Different freshwater lake/reservoir system of India	
c. Different brackish water systems of India	
d. Different wetlands of India	
C. To map study the protected area networks of India	10
D. Viva Voce	10
E. Practical record/Chart/Model	5
F. Assignments	5
Total	70

Semester – III

BES –C-301: Environmental Pollution

Unit – 1

Environmental pollution: Definition, Types. Environmental contaminants and environmental pollutants. Classification of pollutants – on the basis of physical properties and forms of their existence. Primary and secondary pollutants, degradable and non-degradable, point and non-point sources of pollution.

Unit – 2

Air pollution: Definition, sources of air pollution and their effects on flora, fauna, human beings and materials. Indoor pollution, automobile pollution, ozone depletion and recovery, global warming and climate change.

Unit - 3

Water pollution: Definition, types (Surface, groundwater, marine) and sources of water pollution and their effects. Water quality criteria – specifications for drinking and inland surface waters. Water Quality Indices.

Unit - 4

Soil pollution: Definition, sources and types, Soil pollutants, Effects of pollution on soil health and productivity. Effects of pesticides on soil, Soil erosion, types and control.

Solid waste pollution: Definition, origin, classification and characteristics of solid waste. Segregation, collection, transportation and disposal of solid waste.

Unit - 5

Noise pollution: Definition, sources and effects. Noise-induced hearing loss. Decibel scale. Noise control measures.

E-waste: Definition, sources, composition, recycling and disposal methods. Hazardous waste: Definition, Sources, classification, effects and disposal methods.

Unit – 1

Environment and public health: Definitions of health and disease. Perspectives on individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health.

Unit - 2

Diseases in contemporary society: Need for good health - factors affecting health. Types of diseases - deficiency, infection, pollution diseases - allergies, respiratory, cardiovascular and cancer. Personal hygiene- food- balanced diet.

Unit - 3

Malnutrition: Vitamin deficiency diseases and Mineral deficiency diseases; Folic acid requirement during pregnancy; Food Safety- Adulterants and preservatives; Pesticide Toxicity: Endosulfan and DDT.

Unit - 4

Non-communicable diseases and Lifestyle diseases - Diabetes and Hypertension. Communicable diseases: Definition, mode of transmission – pandemic, epidemic and endemic diseases.

Unit - 5

Vector borne diseases: Plague and Malaria; emerging diseases: Dengue, Chikungunya, Zika, Ebola, Swine Flu, Bird Flu, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS); Zoonosis- Leptospirosis; Kyasanur Forest Disease (KFD) Toxoplasmosis and Nipah.

BES - C - 351: Lab Course

TIME: 6-8 HOURS

Max. Marks: 100

Sessional: 30 ESP: 70

A. Air Sampling Techniques for gases and particulate matter	10
B. Water Sampling Techniques	10
- Sampling design (water samplers)	
- Water Temperature	
- pH	
- Turbidity/Transparency	
- Hardness	
C. Soil Sampling Techniques	10
- Sampling design	
- Soil Temperature	
- pH	
- Bulk Density	
- Water holding Capacity	
D. Noise sampling Techniques and observations on different sites	10
(Railway Station/National Highway/University campus/Residential area)	
E. Survey from the local hospitals for communicable and non-communicable diseases among patients	10
H. Viva Voce	10
I. Practical record/Chart/Model	5
J. Assignments	5
Total	70

BES – C- 401 Solid Waste Management

UNIT 1:

Sources, generation, classification & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermi composting, Incineration, energy recovery from organic waste.

Unit - 2

Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

UNIT 3

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

UNIT 4

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

Concept of waste-to-energy (WTE), energy recovery from waste; different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification

UNIT 5

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

BES – S- 402 Environmental Sustainability and Economics

Unit - I

Sustainable Development – scope & definition, parameters of sustainability, Population stabilization, integrated land use planning, conservation of biological diversity, control of pollution, development of non-polluting renewable energy systems.

Unit - II

Recycling of wastes/residues, ecologically compatible human settlement and slum improvement, environmental education and awareness.

Unit - III

Sustainability of Water Resources, Sustainable Management of Forests, sustainable agricultural rotation of crops, organic farming. Urbanization and its impact on Environment.

Unit – IV

Environmental movements and role of NGO's in sustainable development. Global policy for sustainable development – world summits. Rural and Urban planning for sustainable development.

Unit - 5

Fundamentals and theories of environmental economics: Principles of cost-benefit analysis, Joint forest management for optimal property rights, economics of forest products in India. Environmental Statement (ES), ES of Government of India and its contents, Introduction to environmental audit: Guidelines and methodology, purpose and needs;

BES - C - 451: Lab Course

TIME: 6-8 HOURS

Max. Marks: 100

Sessional: 30 ESP: 70

A. To segregate and composition percentage of (any two)	10 + 10 = 20
- domestic solid waste	
- Hospital solid waste	
- Industrial solid waste	
B. Preparation of biogas from sewage-sludge (field vist)	10
or	
Listing of different NGO's working in Environmental Activities at Haridwar	
C. To study the SDG goals in context of India	10
D. Site visit and report for Municipal Solid waste management plant	10
diseases among patients	
E. Viva Voce	10
F. Practical record/Chart/Model	5
G. Assignments	5
Total	70

UNIT – I

Environmental Microbiology: Introduction, Microorganisms in the environment, role of microbes in ecosystem, Air microbiology, Introduction, microorganisms in air, role of microbes in atmosphere.

UNIT – II

Soil microbiology: Introduction, microorganisms in soil, role of microbes in biogeochemical cycles (Oxygen, carbon-dioxide, Nitrogen, Sulphur and phosphorous). Water microbiology; introduction, microorganisms in water, Role of microbes in the water environment.

UNIT – II

Microbiological analysis, laminar air flow, autoclaving, preparation of culture media, microorganisms and diseases: epidemiology, modes of transmission, controls of communicable diseases, air-borne diseases (tuberculosis, chicken-pox), soil-borne diseases (tetanus and gas-gangrene). Anti-microbial agents and their significance.

UNIT – III

Water and food-borne diseases (Cholera, Typhoid, Amoebiasis), Contamination of food, microbial spoilage of food, Role of microbes in oil-pollution control and chemical pollution control, Ecological and public health impacts of raw sewage and domestic liquid discharge.

UNIT – IV

Toxicology – Definitions, Classification, Toxic chemicals in the environment. Mode of entry of toxic substance, Heavy metals toxicity, Epidemiological issues goiter, fluorosis, arsenic poisoning.

UNIT – V

Xenobiotics in the environment. Pesticides – Classification of pesticides, Bioaccumulation, Biotransformation, toxic effects of pesticides in the environment. Detoxification.

BES – E – 502 Environmental Chemistry and Instrumentation

UNIT – I

Fundamentals of environmental chemistry: Stoichiometry, Gibbs' energy, Henry's law, chemical potential, chemical equilibria, acid-base reactions, carbonate system, the solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbons.

UNIT – II

Chemical composition of Air: Classification of elements, chemical speciation, particles, ions and radicals in the atmosphere, Transport media, transport of pollutants in the air.

UNIT – III

Water chemistry: Chemistry of water, the concept of DO, BOD, COD, dispersion of pollutants in groundwater, biochemical processes in water involving microorganisms.

UNIT – IV

Inorganic and organic components of soil, Nitrogen pathways, NPK in soil and their interaction. Soil pollution control. Industrial waste/ effluents and heavy metals in soil and their interactions.

UNIT – V

Principles of analytical methods: Microscopy (Scanning & Transmission) Colorimetry, Flame photometry. Spectrophotometry, Chromatography Atomic Absorption Spectrophotometry, Electrophoresis and Respirable Dust Sampler (RDS) .

BES – E – 503 Occupational Health & Safety

Unit - I

Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety. Importance of Industrial safety, the role of safety department, Safety committee and Function Organising for safety, Health and Environment.

Unit – II

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 - 2000
OSHA, Process Safety Management (PSM) as per OSHA, PSM principles,
OHSAS – 18001, EPA Standards, Performance measurements to determine the effectiveness of PSM

Unit III

Safety protocol: used in Grinding, Shearing, Bending, Boring, mining, Shaping Safe use of hand tools, non-sparking tools, portable power tools. Guarding of different types of machinery including special precautions for paper, rubber and printing machinery, wood working.

Unit - IV

Operation, inspection and maintenance of industrial trucks, loose gears conveyors, Safe working load for mechanical material handling equipments. Employee participation in safety - Role of Trade union in safety, health and environment. Safety promotion and safety awards, safety, competitions, audio visual publication.

Unit – V

Factories Act, 1948, Workman's Compensation Act, 1948, Employees State Insurance Act, 1948. Mines and minerals (regulation and development) Act 1957. The factories rules, History, Provisions under the factories Act and rules made there under with amendments, Functions of safety management.

BES - C - 551: Lab Course

TIME: 6-8 HOURS

Max. Marks: 100

Sessional:30 ESP: 70

A. Principle and functioning of following instruments	5 + 5 + 5 = 15
(Three exercise to be given)	
- pH meter	
- hydrometer	
- turbidymeter	
- secchi disk	
- Noise meter	
- Lux meter	
- Anemometer	
- Rain Gauge	
B. Microbiological Techniques (streaking, pouring, inoculation)	10
C. Preparation of Culture Broth	10
D. Study of any industry visit for observing occupational incidents	10
E. Calculation of LC50 and LD50 for toxicity experiments	5
F. Viva Voce	10
G. Practical record/Chart/Model	5
H. Assignments	5
Total	70

BES –C-601 Environmental Law

UNIT 1:

Constitution of India; fundamental rights; fundamental duties; National Green Tribunal. 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 2:

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;

UNIT 3:

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;

UNIT 4

Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Convention on Biological Diversity, Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits.

UNIT 5:

Role of Ministry of Environment, Forests & Climate; role of central and state pollution control boards. National Green Tribunal: Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988, Environmental Policy of India

BES – C – 602 Environmental Disasters

UNIT 1

Hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: landslides, landslide analysis; drought: types of drought - meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF);

UNIT 2

Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, mangroves destruction; role of construction along river banks in elevating flood hazard; disturbing flood plains.

UNIT 3

Deforestation and landslide hazards associated with it; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.

UNIT 4

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

Concept of mitigation; types of mitigation: use of technologies in mitigations such as barrier, deflection and retention systems; importance of planning, exercise, and training in preparedness; role of public and media in hazard preparedness.

BES – S – 603 Environmental quality management

Unit I

Environmental management system (EMS), Principle and components of EMS and quality management, Scope of EMS, environment and business schools, Application and Significance of EMS

Unit II

Certification for EMS, Environmental Standards, Basic Principles of ISO 9000 & ISO 14000 series, Bureau of Standards (BIS), Quality control, Environmental accounting, Environment management and evaluation

Unit III

Corporate environmental responsibility (CER), Corporate Social/Education/Health Responsibility, corporate mergers, approaches to corporate ethics.

Unit IV

Eco-labeling and Eco-mark, criteria for eco-labeling and eco-mark - uses and applications, GATT, WTO provision, Trade rules, Green Marketing and funding.

Unit – V

Environmental Audit, introduction, principle and component of environmental audit, different green audit variables: water, air, green and landscape, energy, solid waste, transport and human activities.

BES - C - 651: Lab Course

TIME: 6-8 HOURS

Marks: 100

Max.

Sessional: 30 ESP: 70

A. Management practices of following Natural disasters:	5+5+5=15
(Three exercise to be given)	
- Earth quake	
- Volcanic eruption	
- Land slides	
- Tsunami	
- Floods/Cloud burst	
- Forest fire	
- Avalanches	
B. Environmental audit	10
(One exercise to be given)	
Prepare an environmental audit of hostel/institutes/industrial area/city.	
C. Report on environmental case studies related with Uttarakhand	10
- River Ganga pollution	
- All weather road	
- Riverbed mining	
D. Visit to any hydropower plant/barrage/mining area	10
E. Visit to any forest range of Rajaji National Park and report with reference to Forest Act/ Forest conservation Act 1980	5
F. Viva Voce	10
G. Practical record/Chart/Model	5
H. Assignments	5
Total	70

BES –C-701 **Himalayan Ecology & Biodiversity**

UNIT 1

Geological features of rocks: Types of mountains and their physiographic features with special reference to Himalayas, Seismicity and Neotectonics in the Himalayas and their effect on the environment.

UNIT 2

Climate of the Himalayas and the influence of the Himalayas on the climate of India, Forests and Forestry in Himalayan region (Introduction, Floristics, Forest influences, forest destruction and denudation), Forest types and productivity, Carbon sequestration, Forest base industries, Shifting cultivation, Migratory grazing).

UNIT 3

Economic values – medicinal plants, drugs, fisheries and livelihoods; ecological services, Economically important flora of the Himalayan region with special reference to food, fodder, fibre, timber and medicinal importance.

UNIT 4

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

UNIT 5

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), India as a mega diversity nation; National Biodiversity Action Plan.

BES –C-702 **Climate change and its implication**

Unit – 1

Climate Change: Definition, scope and facts of climate change. Origin and evolution of the earth's atmosphere. Weather and climate. Introduction to the effects of various anthropogenic activities on earth's atmosphere.

Unit - 2

Monsoons – Definition, Indian monsoons – seasons: Cold weather season (Winter), the hot weather season (Summer), season of advancing monsoon (The rainy season) and season of retreating monsoon (The transition season). Cyclones of the Indian region; El-Niño, La Nina and their impacts.

Unit - 3

Greenhouse effect and global warming: Definition, impacts, major greenhouse gases, sources and sinks of greenhouse gases; Urban Heat Islands; Ozone layer depletion and recovery, issues and remedies; ground-level ozone and air pollution; global dimming. Carbon footprint.

Unit - 4

Impacts of global climate change: Increased surface mean temperature, insect outbreaks, loss of biodiversity and extinction of species, sea-level rise. Climate change and food security.

Unit - 5

Climate change and policy frameworks – History of international climate change policies. UNFCCC, IPCC, MoEF&CC, NAPCC, The Kyoto protocol, Paris agreement. Evolution of climate change negotiations.

BES – C – 703

Himalayan Eco-Tourism

Unit – I

Tourism definition – components of tourism - types of tourism - scope and importance of wild life tourism in India- global market size of wild life tourism - potential for growth contribution in GDP – impacts of wild life tourism – positive impacts - negative impacts

Unit – II

WILD LIFE OF Himalayan Region - species and plants in brief list

Unit – III

Wild life sub regions of Himalayas –Himalayan mountain system- western Himalaya, eastern Himalaya (flora, fauna)

Unit – IV

Define national parks - wild life sanctuaries – important national parks and sanctuaries in Himalayas

Unit – V

Himalayan Eco-tourism concepts and range of activities jungle safari- elephant safari - tiger safari-bird watching – general wild life viewing-visiting zoos and aquaria – recreational fishing, wildlife photography

BES - C - 751: Lab Course

TIME: 6-8 HOURS

Max. Marks: 100

Sessional: 30 ESP: 70

A. Map Studies in Himalayan Region:	5+5+5=15
(Three exercise to be given)	
- Protected Areas Network	
- Water resources	
- Mineral Resources	
- Tourism and Pilgrimage Sites	
B. Wildlife in Himalayan Region (Map Studies)	20
- Flora (endangered, threatened - endemic & exotic species)	
- Fauna (endangered, threatened - endemic & exotic species)	
C. List of freshwater fishes (endangered, threatened - endemic & exotic species)	10
D. Visit to Science Museum, UCOST/WII/FRI/Rajaji National Park/ Corbett National Park	5
E. Viva Voce	10
F. Practical record/Chart/Model	5
G. Assignments	5
Total	70

BES –C-801 Environmental Impact assessment

UNIT 1

Environmental impact assessment (EIA): definitions, introduction and concepts; rationale and historical development of EIA; scope and methodologies of EIA. Cost-Benefit analysis

UNIT 2

Life cycle assessment; environmental appraisal; environmental management – principles, problems and strategies; environmental planning; environmental audit; introduction to ISO 14000; sustainable development.

UNIT 3

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 4

EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects/ thermal projects. Rapid EIA; Strategic Environmental Assessment; Social Impact Assessment;

Unit – 5

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.

UNIT – I

Environmental biotechnology: Introduction, scope of environmental biotechnology; Application of biotechnology in environment, Basic concept of genetic engineering of plants and its applications. Biotechnology strategies in forestry and wasteland management. Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA Banks. Genetically modified organisms.

UNIT – II

Biofertilizer technology: Introduction, Role of microorganisms in production of biofertilizers, Rhizobium culture, Blue-green algae culture, *Azolla* culture, and *Micorrhizea* culture. Benefits and significance of biofertilizers in agriculture.

UNIT – III

Fermentation technology. Introduction, types of fermenters, Role of microorganisms in production of alcohol, and pharmaceutical products, biomass (*Spirulina* culture) production and bio-fuel production.

UNIT – IV

Bioremediation technology: Introduction, types of remediation, biotransformation, bioconversion, bioremediation, phytoremediation technology, Bioremediation of metal contaminated soils, chemical and oil pollution control using microorganisms. Phytoremediation of wastewater.

UNIT – V

Bioenergy technology: Introduction, bioethanol and biogas technology, plant design, construction, operation, biogas from organic wastes, water weeds, landfills, microbiology of anaerobic fermentation, Liquid waste treatment and energy recovery.

Unit - I

Research definition, Scientific research; Selection of the research problem, designing of research, observational, interventional, descriptive, analytical, qualitative and quantitative research.

Unit – II

Scientific documentation: Methods of literature collection, design, planning and execution of investigation, Preparation of scientific documents, general articles, research papers, review articles, editing of research papers, methods of citation, Plagiarism and copyright act. Presentation techniques.

Unit - III

Survey for field study, Sources of primary and secondary research data, Laboratory experiments and protocol, Field experiments, sample size & design, selection criteria of sampling sites, Methods of data collection and validation.

Unit - IV

Introduction to Biostatistics; Development, Definition, Characteristics, Importance and limitations, Preliminary concept (variables and constants, Testing hypothesis). Primary and secondary data, sources and presentation of data, Graphical representation, Mean, Mode and Median, standard deviation

Unit - V

Elementary knowledge of probability, Correlation and Linear regression, Measure of central tendencies. Distribution- Normal, Binomial and Poisson, Analysis of Variance, test of Significance: t-test, F- test and Chi-square test, ANOVA

BES - C - 851: Lab Course

TIME: 6-8 HOURS

Marks: 100

ESP: 70

Max.

Sessional: 30

A. Hypothetical EIA of following:	10 + 10 = 20
(Two exercises to be given)	
- Urbanization	
- Dam construction	
- Hydroelectric power generation	
- Tourism	
- Sugar mills	
- Road construction	
- Industry	
- Railway track	
B. Preparation of Biofertilizer (Expertment of Azolla Culture, Blue green Algae)	10
C. Bio-statistics Exercise	5 + 5 = 10
(Two exercise to be given)	
- To calculate the standard deviation of given samples.	
- To find out association between two species using Chi-Square method.	
- To calculate correlation coefficient of given samples.	
D. Visit to biocompost unit/constructed wetland/STP plant	10
E. Viva Voce	10
F. Practical record/Chart/Model	5
G. Assignments	5
Total	70

Subject Expert Committee Members actively participated in the preparation of curriculum for four years B.Sc. (Basic/Hons.) degree in Environmental Science. BOS meetings conducted physically with subject committee experts; and the curriculum is approved by the Chairpersons, External subject experts and committee members of Department of Zoology and Environmental Science.

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