THE UNIVERSITY OFBURDWAN

SYLLABUS FOR 3-YEAR DEGREE/4-YEAR HONS. IN

ENVIRONMENTAL SCIENCE
[SEM I TO SEM VIII]

Under

Curriculum and Credit Framework for Undergraduate Program

(CCFUP), as per N.E.P. 2020)

w.e.f 2023 – ’24

FINAL UG SYLLABUS FOR ENVIRONMENTAL SCIENCE [CODE: ENVSC]
UNDER THE UNIVERSITY OF BURDWAN, BURDWAN
[As per NEP 2020]

3-Year Degree/4-Year Hons.in Environmental Science

SEMESTER	Course Type	Code	Name of the Course	Credits	L – T - P	Marks	Marks Dist. Th – P - IA
I	Major/Core Course	**ENVSC 1011**	Environment &Ecology	4	3 – 1 - 0	75	60 – 00 - 15
	MinorCourse [for other disciplines]	**ENVSC 1021**	Environment &Ecology	4	3 – 1 - 0	75	60 – 00 - 15
	Multi-disciplinary Course [from pool of courses]	**ENVSC 1031**	Natural resources & Sustainable Development	3	2 – 1 - 0	50	40 – 00 – 10
	Ability Enhancement Course (AEC)	**AEC 1041**	MIL (L_1- 1): (from Hindi /Bengali/ Sanskrit/ Santali /Arabic /Urdu) OR Eq. course from SWAYAM/other UGC recogn. platforms	2	2 – 0 - 0	50	40 – 00 - 10
	SEC [from Major]	**ENVSC 1051**	Environmental Monitoring Techniques	3	2 – 1 – 0	50	40 - 00 – 10
	Value Added Course (VAC)	**CVA 1061**	Environmental Science/ Education	4	3 – 0 - 1	100	60 – 20 - 20
	Total			**20**		**400**	
II	Major/Core Course	**ENVSC 2011**	Ecosystem & Biomes	4	3 – 0 - 1	75	40 – 20 - 15
	Minor Course [for other disciplines]	**ENVSC 2021**	Ecosystem & Biomes	4	3 – 0 - 1	75	40 – 20 - 15
	Multi-disciplinary Course [from pool of courses]	**ENVSC 2031**	Biodiversity Conservation & Ecotourism	3	2 – 1 - 0	50	40 – 00 – 10
	Ability Enhancement Course (AEC)	**ENGL 2041**	MIL (L_2 -1): Functional English	2	2 – 0 - 0	50	40 – 00 - 10
	SEC [from Major]	**ENVSC 2051**	Human Health and Conservation & Ecotourism	3	2 – 1 – 0	50	40 - 00 – 10
	VAC	**CVA 2061**	Understanding India/Fitness & Hygiene & Yoga/Digital India	4	3 – 1 – 0 OR 3 – 0 - 1	100	80 – 00 – 20 OR 60 – 20 - 20
	Skill based Vocational additional Course Cr. 4 (During Summer term for 8 weeks for Certificate award) - Students who want to exit after securing Cr 40			4			
	Total			**20**		**400**	

SEMESTER	Course Type	Code	Name of the Course	Credits	L – T - P	Marks	Marks Dist. Th – P - IA
III	Major/Core Course	**ENVS C3011**	Environmental Resources	**5**	4 – 1 - 0	75	60 – 00 - 15
	Major/Core Course	**ENVS C3012**	Earth Science	**5**	4 – 0 - 1	75	40 – 20 - 15
	Minor Course (Voc. Edn. & Training)	**MSR 3021 Or HRM 3021 Or RSA 3021**	**Medical Sales Representative Or Human Resource Management Or Retail Sales Associate**	**4**	3- 1 - 0	75	60 - 00 - 15
	Multi-disciplinary Course	**ENVS C3031**	Climate Change & Climate Action	**3**	2 – 1 - 0	50	40 – 00 - 10
	AEC (MIL): (L_1 -2)	**3041**	MIL (from Hindi /Bengali/ Sanskrit/ Santali /Arabic /Urdu) OR Eq. course from SWAYAM/other UGC recogn. platforms	**2**	2 – 0 - 0	50	40 – 00 - 10
	SEC	**ENVS C3051**	RS & GIS and Resource Mapping	**3**	2 – 1 - 0	50	40 – 00 - 10
	Total			**22**		**375**	
IV	Major/Core Course	**ENVS C4011**	Environmental Chemistry & Physics	5	4 – 0 - 1	75	40 – 20 - 15
	Major/Core Course	**ENVS C4012**	Energy & Environment	5	4 – 1 - 0	75	60 – 00 - 15
	Major/Core Course	**ENVS C4013**	Ecotoxicology & Environmental Biotechnology	5	4 – 0 - 1	75	40 – 20 - 15
	Minor Course	**ENVS C4021**	Environmental Pollution & Measurement	4	3 – 1 - 0	75	60 – 00 - 15
	Minor Course	**….. 4021**	Other than Env Sc.	**4**	.. - .. - ..	75	.. – .. - 15
	AEC (English): (L_2 - 2)	**AEC 4041**	English	2	2 – 0 - 0	50	40 – 00 - 10
	Skill based Vocational additional Course Cr. 4 (During Summer term for 8 weeks for Diploma) - Students who want to exit after securing Cr 87						
	Total			**25**		**425**	

SEMESTER	Course Type	Code	Name of the Course	Credits	L – T - P	Marks	Marks Dist. Th – P - IA
V	Major/Core Course	**ENVSC 5011**	Environmental Pollution	5	4 – 0 - 1	75	40 – 20 - 15
	Major/Core Course	**ENVSC 5012**	Environmental Laws, Policies & EIA	5	4 – 1 - 0	75	60 – 00 - 15
	Major/Core Course	**ENVSC 5013**	Environmental Analysis (Practical)	5	0 – 0 - 5	75	00 – 60 - 15
	Minor Course (Voc. Edn. & Training)	**MSR 5021 Or HRM 5021 Or RSA 5021**	**Medical Sales Representative Or Human Resource Management Or Retail Sales Associate**	**4**	3- 1 - 0	75	60 - 00 - 15
	Internship for all	**INT 5081**		2	0 – 0 - 2	50	00 – 50 - 00
	Total			**21**		**350**	
VI	Major/Core Course	**ENVSC 6011**	Environmental Health & Stress Physiology	4	3 – 0 - 1	75	40 – 20 - 15
	Major/Core Course	**ENVSC 6012**	Environmental Engineering & Statistics	4	3 – 1 - 0	75	60 – 00 - 15
	Major/Core Course	**ENVSC 6013**	Environmental Economics & Management	4	3 – 1 - 0	75	60 – 00 - 15
	Major/Core Course	**ENVSC 6014**	Field visit Visit – 15 & Report - 60	4	0 – 0 - 4	75	00 – 60 - 15
	Minor Course (Voc. Edn. & Training)	**MSR 6021 Or HRM 6021 Or RSA 6021**	**Medical Sales Representative Or Human Resource Management Or Retail Sales Associate**	**4**	3- 1 - 0	75	60 - 00 - 15
	Total			**20**		**375**	
	Total (I+II+III+IV+V+VI)			**128**		**2325**	

SEMESTER	Course Type	Code	Name of the Course	Credit	L – T - P	Marks	Marks Dist. Th. – Pr. - IA
VII	Major/Core Course	ENVSC 7011	Research Methodology and Ethics	6	5-1-0	75	60 – 00 – 15
	Major/Core Course	ENVSC 7012	Advance Concepts in Ecology, Evolution, Ethology and Sustainability	6	5-0-1	75	40 – 20 – 15
	Major/Core Course	ENVSC 7013	Geochemical Processes, Climatic dynamics and Geohazard	6	5-0-1	75	40 – 20 – 15
	Major/Core Course	ENVSC 7014	Green Chemistry, Waste Management and Genetic Engineering	6	5-1-0	75	60 – 00 – 15
	Minor Course	ENVSC 7021	Environmental Perspective	4	3-1-0	75	60 – 00 – 15
	Total			**28**		**375**	
VIII Hons. With Research Project/ Dissertation	Major/Core Course	ENVSC 8011	Biostatistical Analysis and Instrumentation	6	5-1-0	75	60 – 00 – 15
	Minor Course	ENVSC 8021	Contemporary Environmental Issues	4	3-1-0	75	… – … – 15
	Research Project/ Dissertation	ENVSC 8091		12	0- 0- 12	225	Seminar Presentation, Preparation & Submission of Research Project/Dissertation -135 + Viva-90
	Total			**22**		**375**	

OR

VIII Hons.	Major/Core Course	ENVSC 8011	Biostatistical Analysis and Instrumentation	6	5-1-0	75	60 – 00 – 15
	Major/Core Course	ENVSC 8012	Advanced Ecotoxicology and Environmental Microbiology	4	3-0-1	75	40 – 20 – 15
	Major/Core Course	ENVSC 8013	Environmental Biotechnology, Environmental Laws and EIA techniques	4	3-1-0	75	60 – 00 – 15
	Major/Core Course	ENVSC 8014	Pollution Management and Emerging Environmental Issues	4	3-1-0	75	40 – 20 – 15
	Minor Course	ENVSC 8021	Contemporary Environmental Issues	4	3-1-0	75	60 – 00 – 15
	Total			**22**		**375**	
	Grand total (Sem. I -VIII)			**178**		**3075**	

SEMESTER-I
PAPER CODE: ENVSC1011[ENVSC Major: COURSE NO.1]
ENVIRONMENT & ECOLOGY
TOTALCREDITS:4

TIME:3Hours **MARKS:60**
Lectures:75

LearningObjectives:

- *To get knowledge on environmental education, concept of an ecosystem & component, disturbances and modification of environment and their effects*
- *Understanding on the biosphere & biotic community and biological invasions*
- *To get knowledge on Geological interaction with environment and its interactions with in geology*
- *Overall students will examine and explain how organisms modify their environments to sustain their needs*

Unit1: Environment
Concept/Definition and importance of environment;Types and components of environment ; Lithosphere, Atmosphere, Hydrosphere, Biosphere; Scope and multidisciplinary nature of the subject; Man-environment relationships; Environmental awareness **20**

Unit2: Environmental Education
Environmental education at primary, secondary and tertiary level; Goals of environmental education; Applications of and Career in Environmental Science **10**

Unit3: Concept of Ecology
Concepts of Ecology: Definition and divisions of ecology; Ecological classification: Aquatic, desert and marine (plants & animals) and their morphological, physiological and biochemical adaptation; Ecotype; Ecological factors - climatic, edaphic, physiographic and biotic; Limiting factor and Shelford's Law of tolerance, Liebig law of minimum; Concept of Biological clock, circadian rhythm **25**

Unit4: Geology and Ecology
Geological interaction with biodiversity/environment; Concepts of community and keystone species, and relationship with geology; Role of geology in ecological restoration **10**

Unit5: Biological Invasions
Concepts of exotic and invasive spices; Characteristics of invaders; Stages of invasion; Mechanisms of invasions **10**

Learning outcomes:

- *Understanding the different complex environmental issues and interdisciplinary perspective.*
- *Understanding the ecological and physical sciences and their application in environmental problem-solving*
- *Knowledge on major physical, chemical, and biological components of the earth's systems and show how they function*
- *Understanding the ethical, cross-cultural and historical context of environmental issues and their links between human and natural systems*

SEMESTER-I
PAPER CODE: ENVSC1021[ENVSCMinor:COURSENO.1] ENVIRONMENT & ECOLOGY
TOTALCREDITS:4

TIME:3 **MARKS:60**
Lectures:75

LearningObjectives:

- *Togetknowledgeonenvironmentaleducation,conceptofanecosystem&component, disturbances and modification of environment and their effects*
- *Understandingonthebiosphere&bioticcommunityandbiologicalinvasions*
- *TogetknowledgeonGeologicalinteractionwithenvironmentanditsinteractionswithingeology*
- *Overallstudentswillexamineandexplainhoworganismsmodifytheirenvironmentstosustaintheir needs.*

Unit1:Environment
Concept/Definition and importanceofenvironment;Typesandcomponentsofenvironment;Lithosphere, Atmosphere,Hydrosphere,Biosphere;Scopeandmultidisciplinarynatureofthesubject;Man-environmentrelationships;Environmentalawareness **20**

Unit2:EnvironmentalEducation
Environmental education at primary, secondary and tertiary level; Goals of environmental education; Applications of and Career in Environmental Science **10**

Unit3:ConceptofEcology
Concepts of Ecology: Definition and divisions of ecology; Ecological classification: Aquatic,desertand marine (plants & animals) and their morphological, physiological and biochemical adaptation; Ecotype; Ecological factors - climatic, edaphic, physiographic and biotic; Limiting factor and Shelford's Law of tolerance,Liebiglawofminimum;ConceptofBiologicalclock,circadianrhythm **25**

Unit4:GeologyandEcology:
Geological interaction with biodiversity/environment; Concepts ofcommunityandkeystonespecies,and relationship with geology; Role of geology in ecological restoration **10**

Unit5:BiologicalInvasions:
Concepts of exotic and invasive spices; Characteristics of invaders; Stages of invasion; Mechanisms of invasions **10**

Learningoutcomes:

- *Understandingthedifferentcomplexenvironmentalissuesandinterdisciplinaryperspective.*
- *Understandingtheecologicalandphysicalsciencesandtheirapplicationinenvironmentalproblem-solving*
- *Knowledge on major physical, chemical, and biological components of the earth's systems andshow how they function*
- *Understanding the ethical, cross-cultural andhistoricalcontextofenvironmentalissuesandtheir links between human and natural systems*

SEMESTER-I
PAPERCODE:ENVSC1031[ENVSCMultidisciplinary:COURSENO.1]
NATURAL RESOURCES & SUSTAINABLE DEVELOPMENT

TOTALCREDITS:3

TIME:2Hours **MARKS:40**
Lectures:50

Learningobjectives

- *Explainthefundamentalsofnaturalresourcesandtheirdistribution*
- *Presentavailablenaturalresources.*
- *Describethejudicialusesofnaturalresources*
- *Outline&basicelementsofsustainabledevelopment*

Unit1:Naturalresources
Overviewofnaturalresources:Definitionofresources;Classificationofnaturalresources–bioticandabiotic, renewableandnon-renewable **05**

Unit2:Bioticandwaterresources
Majortypesofbioticresources:Forests,Grasslands,WildlifeandAquatic
Typesofwaterresources:Freshwaterandmarinewaterresources;Availabilityanduseofwaterresources; Conflictsoverwaterresource–InternationalandNationalperspectives **15**

Unit3:Soilandmineralresources
SoiltypesanddistributioninIndia;Majordegradationofsoil;MajormineralsinIndia;Overexploitationand environmentalproblems **10**

Unit4:Energyresources
Types of energy sources; Renewable resources (Solar, Hydro, Oceanandbiomass);Non-renewablesources(Coal, PetroleumandNuclearresources) **10**

Unit5:SustainableDevelopment
Concept,SDGs–Goals,Targets&Indicators;Challenges&strategiesofSDGsinIndia **10**

Learningoutcome(Aftercompletionofthisunitstudentswouldbeableto:)

- *Understandtheconceptofnaturalresources;identifytypesofnaturalresources,theirdistribution and use with special reference to India*
- *Discussthefactorsaffectingtheavailabilityofnaturalresources,theirconservationand management*
- *Explainsustainabledevelopment,itsgoal,targets,challengesandIndianstrategiesforSDGs*

Proposedfacultyinvolvement

Unit 1 & 2: Social Science/ Botany/ Zoology
Unit3:Geography/Botany/Zoology/History
Unit 4: Geography/ Social Science/ Physics
Unit 5: Political Science/Social Science

SEMESTER-I
PAPERCODE:ENVSC1051[ENVSCSkillEnhancement:COURSENO.1]
ENVIRONMENTAL MONITORING TECHNIQUES
TOTALCREDITS:3

TIME:2 **MARKS:50**
Lectures:65

Learningobjectives

- *To provide theoretical and practical knowledge on variousaspectsofenvironmentalmonitoring techniques*
- *Todevelopsamplingandanalyticalskillsforenvironmentalmonitoring*
- *Togetknowledgeonvariousstandardprotocolsusedinenvironmentalmonitoring*

Unit1:AirqualityMonitoring
Collection of air sample [High volume sampler, Glass fiber filter paper, $CO/CO_2/0_3$. meter, particulate matter(PM2.5,PM10)];ConceptofSPMauRSPM **10**

Unit2:Waterqualitymonitoring
Water quality parameters; Water sampling techniques & measurements and instruments (Titrimetric and Gravimetric methods, Portable pH meter, conductivity meter, Spectrophotometer); Calibration, Reagent blank,Referencematerial,standardcurve **15**

Unit3:SoilqualityMonitoring
Classification of texture (International pipette andHygrometermethod);Soilsamplingandmeasurement of different soil parameters [pH meter, conductivity meter, Soil organic carbon (Titrimetric method), Nitrogen(modifiedKjeldahl'smethod),&Flamephotometer] **10**

Unit4:Noisemonitoring Conceptof sound and noise, sound pressure; Instrumentation and measurement of noise (Noise meter); Equal loudnesscontours;PercentileIndicesofnoise **05**

Unit5:BiologicalandMicrobiologicalmonitoring
Bacteriological techniques: Preparation of media (solid and liquid media), identification [Principle of staining; Simple, negative and differential staining (Gram staining)], MPN technique, Sterilization; Inoculation and incubation;Preparationofslants;Pureculturetechniques(spreadplate,pourplate,streak plate); instrumentation (Principle of autoclave, laminar air flow, BOD incubator, Shaker, Centrifuge, Magnetic Stirrer, Concept of BLAST)
Biological monitoring: Quantification (Sedgwick Rafter counter) & qualification of freshwater plankton (phyto-&zoo-plankton),aquaticmacrophytesofimportance);Typesofplanktonnet **25**

Learningoutcomes

- *Undertakefieldandlaboratoryexperimentsinasystematicway*
- *Understanding of physicochemical and microbiological methods used to test air, water, soil or food for environmental health purposes*
- *Gettingtraininginanalyticalandconceptualskillsrequiredforenvironmentalmonitoring techniques and methods*

SEMESTER-II

PAPERCODE:ENVSC2011[ENVSCMajor:COURSENO.1] ECOSYSYTEM & BIOMES
TOTALCREDITS:4

TIME:2Hours **MARKS:40**
Lectures:60

Learningobjectives:

- *Understandingthefundamentalstructureandfunctionofanecosystemaswellaslevelsof ecological organization like organism, population, community, ecosystem, biome and biosphere*
- *Knowledgeonestablishmentofinteractionsandrelationships(e.g.,competition,predation,symbiosis) in an ecosystem*
- *Knowledgeonenergyflowsthroughanecosystem(e.g.,foodchains,foodwebs,energypyramids*
- *Understandthebiogeochemicalcyclesthroughanecosystem(i.e.,watercycle,carboncycle, oxygen cycle and nitrogen cycle)*
- *Understandingthemajorbiomesandthecommunities*

Unit1:ConceptofEcosystem

Ecosystems: Concept & classification (terrestrial and aquatic); Structure and function of ecosystems: trophic levels, food chain, food web and ecological pyramids; Energy flow in ecosystem: Energy flow models (single and double channel model); Productivity (concept & types: primary and secondary); Biogeochemical cycles (carbon, nitrogen and phosphorous cycle) **15**

Unit2:MajorEcosystemtypes

Terrestrial ecosystems (Grassland ecosystem, forest ecosystem, agro-ecosystem); Aquatic ecosystems (Lenticandloticecosystem,wetlandecosystem,estuarineecosystem,andmarineecosystem **10**

Unit3:Populationecology

Concept and characteristics of population (natality, mortality, age structure, population pyramids, population density, population dispersion, population growth, exponential, logistics, Density dependent, Limits of population growth; life table and survivorship curves; Population interactions (competition, predation, parasitism, symbiosis, commensalism, mutualism, and ammensalism) **15**

Unit4:Communityecology

Concept of community & classification; Community structure (horizontal and vertical stratification); Biomass, Keystone Species,EcotoneandEdgeeffects;EcologicalSuccession(concept,processes,stages andtypesofsuccessions);ConceptofClimax **10**

Unit5:Biomes

Concept and characteristics of biome; Types and distribution of major biomes (e.g., desert, grass lands, tropicalevergreenrainforestsandtundra);EndemismandendemicspeciesofIndia **10**

Learningoutcome

- *Understandthecomplexityofanecosystemandbiomes*
- *Understandtheenergycyclewithinecosystems*
- *Uniquefactsaboutthebiomesofourworld*
- *Understandingtheirlearningtothebalancerequiredinecosystems*

SEMESTER-II

PAPERCODE:ENVSC2011[ENVSCMajor:COURSENO.1]
ECOSYSYTEM&BIOMES[Practical]

TIME:2Hours **MARKS:20**

PRACTICAL

DescriptionofItems	**DistributionofMarks**	
1) OneMajorexperiment	:	07
2) Identification	:	03
3) LaboratoryNoteBook	:	05
4) *Viva-voce*	:	05

PRACTICALCOURSES

MajorExperiments:

1. Estimationofwaterparameters—pH,DO,FreeandCombinedCO_2,Hardness,Alkalinity, Acidity, Chloride
2. Estimationofsoilparameters—pH,Temperature,soilmoisture,Organiccarbon
3. Identification with reasons(at least one from each A & B must be set duringexamination):Study on Aquatic organisms (Plankton and Macrophytes)

SEMESTER-II

PAPERCODE:ENVSC2021[ENVSCMinor:COURSENO.1] ECOSYSYTEM & BIOMES
TOTALCREDITS:4

TIME:2Hours **MARKS:40**
Lectures:60

Learningobjectives:

- *Understandingthefundamentalstructureandfunctionofanecosystemaswellaslevelsof ecological organization like organism, population, community, ecosystem, biome and biosphere*
- *Knowledgeonestablishmentofinteractionsandrelationships(e.g.,competition,predation,symbiosis) in an ecosystem*
- *Knowledgeonenergyflowsthroughanecosystem(e.g.,foodchains,foodwebs,energypyramids*
- *Understandthebiogeochemicalcyclesthroughanecosystem(i.e.,watercycle,carboncycle, oxygen cycle and nitrogen cycle)*
- *Understandingthemajorbiomesandthecommunities*

Unit1:ConceptofEcosystem

Ecosystems: Concept & classification (terrestrial and aquatic); Structure and function of ecosystems: trophic levels, food chain, food web and ecological pyramids; Energy flow in ecosystem: Energy flow models (single and double channel model); Productivity (concept & types: primary and secondary); Biogeochemical cycles (carbon, nitrogen and phosphorous cycle) **15**

Unit2:MajorEcosystemtypes

Terrestrial ecosystems (Grassland ecosystem, forest ecosystem, agro-ecosystem); Aquatic ecosystems (Lentic and lotic ecosystem, wetland ecosystem, estuarine ecosystem, and marine ecosystem **10**

Unit3:Populationecology

Concept and characteristics of population (natality, mortality, age structure, population pyramids, population density, population dispersion, population growth, exponential, logistics, Density dependent, Limits of population growth; life table and survivorship curves; Population interactions (competition, predation, parasitism, symbiosis, commensalism, mutualism, and ammensalism) **15**

Unit4:Communityecology

Concept of community & classification; Community structure (horizontal and vertical stratification); Biomass, Keystone Species,EcotoneandEdgeeffects;EcologicalSuccession(concept,processes,stages andtypesofsuccessions);ConceptofClimax **10**

Unit5:Biomes

Concept and characteristics of biome; Types and distribution of major biomes (e.g., desert, grass lands, tropical evergreen rain forests and tundra); Endemism and endemic species of **10**

Learningoutcome

- *Understandthecomplexityofanecosystemandbiomes*
- *Understandtheenergycyclewithinecosystems*
- *Uniquefactsaboutthebiomesofourworld*
- *Understandingtheirlearningtothebalancerequiredinecosystems*

SEMESTER-II

PAPERCODE:ENVSC2021[ENVSCMinor:COURSENO.1]
ECOSYSYTEM&BIOMES[Practical]

TIME:2Hours **MARKS:20**

PRACTICAL

DescriptionofItems		**DistributionofMarks**
1) OneMajorexperiment	:	07
2) Identification	:	03
3) LaboratoryNoteBook	:	05
4) *Viva-voce*	:	05

PRACTICALCOURSES

MajorExperiments:

3. Estimationofwaterparameters—pH,DO,FreeandCombinedCO_2,Hardness,Alkalinity, Acidity, Chloride
4. Estimationofsoilparameters—pH,Temperature,soilmoisture,Organiccarbon

3. Identification with reasons(at least one from each A & B must be set duringexamination):Study on Aquatic organisms (Plankton and Macrophytes)

SEMESTER-II
PAPERCODE:ENVSC2031[ENVSCMultidisciplinary:COURSENO.1]
BIODIVERSITY CONSERVATION & ECOTOURISM
TOTALCREDITS:3

TIME:2Hours **MARKS:40**
Lectures:50

Courseobjectives

- *Conceptofbiodiversity*
- *Factorsaffectingbiodiversity*
- *Understandingthemajorconservationpolicies*
- *Gettingknowledgeonecotourismwithhome-staytourismapproach*

Unit1:Biodiversity&itsdistribution
Definition & Concept of biodiversity, levels and types of biodiversity; Biodiversity in India and the world;BiodiversityhotspotsandMegadiversitycountries **15**
Unit2:Threatstobiodiversity:
Types & causes of biodiversity loss - Land use and Land cover changes, commercial exploitation of species,invasivespecies,fire,disasterandclimatechange **10**
Unit3:Conservationpolicies
Importance & major policies – in situ and ex situ conservation; Major protected areas; National & International instruments for biodiversity conservation; Role of traditional knowledge for conservation; Community-based conservation, concept of Zoo management **15**
Unit4:Tourism&Leisure
Types of Tourism; Ecotourism – Concept, Growth and Developments; Impacts and management of ecotourism; Home stay tourism
10

Learningoutcome(Aftercompletionofthisunitstudentswouldbeableto:)

- *Understandtheconceptsofbiodiversityandconservation*
- *Understandthefactorsimpactingbiodiversitylossin IndiaandtheWorld*
- *Majorconservationstrategiestakenin India*
- *Ideasonecotourismwithspecialemphasisonhome-staytourism*

Proposedfacultyinvolvement

Unit1&2&3:SocialScience/Botany/Zoology/PoliticalScience/History Unit 4: Management/ Economics/ Commerce/ Humanities subjects

SEMESTER-II

PAPERCODE:ENVSC2051[ENVSCSkillEnhancementCourse:COURSENO.1] HUMAN HEALTH AND CONSERVATION & ECOTOURISM

TOTALCREDITS:3

TIME:2Hours **MARKS:40**

Lectures:60

Learningobjectives

- *Tounderstandthebasicconceptofhealth&disease,andimmunologyandimmunodeficiency diseases*
- *Understandingthediagnosisandpreventionofinfectiousdiseasesincludingimmunization vaccination for the prevention of communicable diseases and health programme in India*
- *Knowledgeofimportanceofnaturalresourceconservation,benefitsandsustainabletourism development*
- *Understandingthedangersandlimitationsofecotourism*

Unit1:HumanHealth

Concept of health and disease; Principles of epidemiology and epidemiological methods; Health ProgramsinIndia;Nutritionandhealth;Healtheducation **15**

Unit2:Diseases

Concept on air, water, vector borne diseases; some communicable diseases (Viral hepatitis, dengue); Non-communicable diseases (cardiovascular, diabetes); Immunology- elementary ideas about antigens andantibody;Immunodeficiencydiseases **15**

Unit3:Conservation

Concept of Wildlife Conservation - Reserves design, survey techniques of tiger, birds, elephants and insect; Major conservation policies: *in-situ* and *ex-situ* approaches; Major protected areas; National and International instruments forbiodiversityconservation;Roleoftraditionalknowledge;Communitybased conservation;Genderandconservation;ConceptofZoo **20**

Unit4:Ecotourism

Tourism andLeisure; Types of Tourism; Ecotourism – Growth and developments, Impact and management of ecotourism; Home stay tourism;ElementaryideaofRuraltruism,Roleofecotourismfor addressingSustainable Development Goals (SDGs) **10**

Learningoutcome:

- *Knowledgetorelatetotheinternal,externalandenvironmentalfactorsthatimpactonhealthand well-being of individuals as well as health programmes in India*
- *Understandingonthereasonsofoccurrenceofdiseases*
- *Knowledgeonconservationmethodsofbiodiversity*
- *Understandingtheecotourismandthemajorchallengesinsustainabletourism*
- *Knowledgeonroleofnutrientsanditsrelationshipwithhealth*

SuggestedreadingsforEnvironmentalScience(SEMI&II)

1. Gore,A.2009.OurChoice:APlantoSolvetheClimateCrisis,RodaleBooks
2. Girardet,H.2007.SurvivingtheCentury:FacingClimateChaosandOtherGlobalChallenges,EarthScan
3. Plimer,I.2005.HeavenandEarth:GlobalWarming–TheMissingScience,ConnorCourtPublishing.
4. Thunberg,G.2022.TheClimateBook,PenguinRandomHouse.
5. WorldMeteorologicalOrganization(2012).GreenhouseGasBulletins.
6. Lawson,N.2008.AnAppealtoReason:ACoolLookatGlobalWarming,OverlookDuckworth(UK).
7. CambridgeUniversity(2013).ClimateChange:Action,TrendsandImplicationsforBusiness.IISD,UNITAR& UNEP (2009).
8. IEATrainingMaterial:VulnerabilityandClimateChangeImpactAssessmentforAdaptation.
9. IPCC(2013).ClimateChange2013.ThePhysicalScienceBasis-SummaryforPolicymakers.
10. OECD(2009):GuidanceonIntegratingClimateChangeAdaptationintoDevelopmentCo-operation.11. UNEP (2009). Climate Change Science Compendium
12. UNEP(2009).ClimateinPeril,aPopularGuidetotheLatestIPCCReport.
13. UNFCCC(2008).CompendiumonMethodsandToolstoEvaluateImpactsof,andVulnerabilityand Adaptation to, Climate Change.
14. UNFCCC(2006).UNFCCCHandbook.
15. WorldBankReport(2012).TurnDowntheHeat.

Naturalresources:

Brebbia,C.A.2013.*WaterResourcesManagementVII*.WITPress.
CEA.2011.*WaterResourcesandPowerMapsofIndia*.CentralBoardofIrrigation&Power. Dasgupta and Heal (1979): Economic Theory of Exhaustible Resources; CUP
Groom.B.&Jenkins.M.2000.*GlobalBiodiversity:Earth'sLivingResourcesinthe21stCent Ury*
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SEMESTER-III
PAPERCODE:ENVSC3011[ENVSCMajor:COURSENO.3]
ENVIRONMENTAL RESOURCES
TOTALCREDITS:5(Theory)
TIME:3HourMARKS:60

Lectures–75

LearningObjectives:

- Togetknowledgeaboutdifferentnaturalresources,viz.,water,soil,forest,minerals
- Tounderstandingontheirdifferentaspectswithsuitableexamples
- Todescribetheinterconnectionbetweennaturalresourcesandsustenanceoflife
- Togetanideaaboutaccountingfornaturalresources,includingthedepletion

Subjectcontents[Theoretical]

Introduction: Concept and classification of natural resources; renewable and non-renewable resources; Depletion and degradation of natural resources; resource conservation; ecological, social and economic dimensionofresourcemanagement **10**

Water resource: Surface and Ground water resources importance and uses; Recharge of groundwater table; Hydrological cycles, geological formation as aquifers, Types and characteristics of aquifers; Groundwater plume; Darcy's law; Depletion of groundwater; Artificial recharging of groundwater; Demand for water (agriculture, industrial, domestic); Overuse and depletion of surfaceandgroundwater resources;WaterqualitystandardsinIndia;HotspotsofsurfaceWater **20**

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 Indiaandherneighbours **10**

Soil resource: Concept, weathering and soil formation; Basic concept of physical, chemical and mineralogical composition of soil; Soil humus; Soil profile; Types of soil; porosity, permeability ; Soil erosion(causesandtypes);Soilconservation **10**

Forest resource: Concept and major forest types and their distribution; Causes and consequences of deforestation; Timber and non-timber forest products; Agro- forestry; Shifting cultivation; Management and conservation of forests: Sustainable forest management, Forest Protection Committee **10**

Mineral resources: Categories of Mineral Resources; Mineral Deposits:Metallic,Nonmetallic.Mining: Open Pit, Strip and Underground. Environmental Effects of extracting and using mineral resources; Distributionofnative,sulfideandoxidegroupofmineralsinIndia **15**

Learningoutcomes

Specifically,studentsshouldbeableto–

Learnthedifferentkindofearthresourcesandtheirsources,uses,methodsofconservation Understand the reasons of depletion of natural resources
Learnthestrategiesoftheirprotection

SEMESTER-III

PAPERCODE:ENVSC3012[ENVSCMajor:COURSENO.4] EARTH SCIENCE

TOTALCREDITS:5(Theory+Practical)

TIME:3Hours **MARKS:40**

Lectures–60

LearningObjectives:

- ToidentifyanddescribethecomponentsofthephysicalEarthasasystem
- To get explanation about the factors, including radiation, aerosols, volcanism, continental movements, and oceanic current changes alter atmospheric conditions, including the greenhouse effect, global warming, El Niño/La Niña and sea level
- Tounderstandthenaturaldisaster,hazardsemphasizetheirmodeoforiginandconsequences

Earth Processes: Origin and evolution of earth; Big Bang theory, Geological time scale; Major rock forming minerals (silicate, carbonate and sulfide groups) and rock types, classification and structures of rocks; rock cycle;Continentaldrifttheory,Platetectonictheoryandmajorplatesandhotspots,Originof oceans, continents and mountains (Himalaya, Western and Eastern Ghat) **25**

Earth'sEnvironmentProcesses: OriginofEarth'sAtmosphere,LithosphereandHydrosphere**05**

Geomorphology/ Landscape Processes: Evolution of land forms inFluvial, Aeolian, Coastal, Glacial Karst **10**

Hydrologic process: Global hydrological cycle – impact of urbanization and global warming, physiographic of the Oceans, physical and chemical properties of oceans water, Oceans circulation – Pacific and Atlantic, Concept of EEZ and major Ocean mineral resources **20**

Learningoutcomes

Uponsuccessfulcompletionofthecourse,studentswillbeableto–

Developskillorientedsmallprojectsbasedonearthprocessesaswellasonglobalenergybudget and climate change

Developskill-orientedmitigationstrategiesfornaturaldisastermanagement

SEMESTER-III

PAPERCODE:ENVSC3012[ENVSCMajor:COURSENO.4] EARTH SCIENCE

Practical:2Credits::30h(Class)

TIME:2Hours **MARKS:20**

PRACTICAL

DescriptionofItems		**DistributionofMarks**
1)OneMajorexperiment	:	06
2)Identification	:	04
3)LaboratoryNoteBook	:	05
4)*Viva-voce*	:	05

PRACTICALCOURSES

MajorExperiments

1. MeasurementofClimaticParameters:Windspeed&direction,Relativehumidity&temperature

2. Identificationofmajorlandformsinthearea.

2.Identificationofrocks[Granite,Marble,Basalt,Gneiss,Sandstone,Shale,Pyrite,etc.]andmineral [Quartz, Gypsum Talc, Feldspar] specimens and their characteristics.

SEMESTER-III

PAPERCODE:ENVSC3031[ENVSCMultidisciplinary:COURSENO.3]
CLIMATE CHANGE & CLIMATE ACTION
TOTALCREDITS:3

TIME:2Hours **MARKS:40**
Lecture:50

Learningobjectives

- Explainthefundamentalsofclimatechangescience
- Present the international climate change legalandpolicyframeworkandexplainkeyissuesunder negotiation
- Describetheexpectedconsequencesofclimatechangeandtheroleofadaptation
- Providearationalforclimatechangemitigationandproposeactionsinkeysectors
- Outlinebasicelementsofplanningprocessestodeliverclimatechangeaction

The Science of climate change: Atmosphere of the Earth; Global temperature – Pastandpresenttrend, Green house effects; Global energy balance: Greenhouse gases and aerosols; its effects on global warming **15**

Climate change and its effects: Impact of climate change on the perspective of biodiversity, ocean, natural hazards, health risk, food supply, poverty, environmental refugee **10**

Climate action: Climatechange-adoption,Vulnerabilityassessment-IPCCFramework(AR5andAR6); Identifyingandselectingadaptationoption,linkingadaptationanddevelopmentPlanning **10**

Policy and mitigation: Policy approaches for mitigation and Low Carbon Development; Role of NationalandSectorialInstitutionsinclimatechangeplanning,NationalActionPlanonClimate**15**

Learningoutcome

Aftercompletionofthiscoursestudentsshouldlearnabout-

Fundaments of climate changescienceaswellasknow-howoftheequipmentwithtechniquesfor adaptation and vulnerability assessment
Knowledgeandunderstandingonfutureimplementationoflowcarbondevelopmentpolicy

Proposedfacultyinvolvement

Unit 1 & 2: Social Science/
Botany/Zoology
Unit3:Geography/Botany/Zoology/History
Unit4: Geography/ Social Science/ Physics
Unit 5: Political Science/Social Science

SEMESTER-III
PAPERCODE:ENVSC3051[ENVSCSkillEnhancement:COURSENO.3] RS& GIS AND RESOURCE MAPPING
TOTALCREDITS:3

TIME:2Hours **MARKS:40**
Lectures:50

Learningobjectives

- ToacquiresomeskillsinremotesensingandGIS
- To learn the visualization techniques of satellite image interpretation in understanding differentprocesses of the earth system
- Tobuildup theirconceptregardingitsapplicationtovariousenvironmentalissues

SubjectContents[Theoretical]

Fundamental Concepts of Remote Sensing: Early History; Definition, sourceofenergy,EMR,Energy interactions with the atmosphere and Earth's surface materials; Principle of Remote sensing, Platforms; Types of Satellite, concept of orbit; Sensor systems used in remote sensing- active, passive & their advantage disadvantages, resolution; Earth observation satellites- IRS and Landsat OLI; Concept of digital images- pixel, bands, file format; Visual image interpretation **20**

GIS: Definitions; components; advantages; Concept of raster and vector data and attribute; their advantages & disadvantages; Different types of file formats; RS & GIS software- open sourcesand commercial;itsadvantages&limitations **15**

Map: Conceptofmap;Mapscale;Typesofmap;Geographicalcoordinatesystem **05**

Application: Application of remote sensing and GIS to landuse/landcover change detection, forestry, agriculture and hydrology **10**

Learningoutcomes

Aftercompletionofthiscoursestudentsshouldlearn-

- *Tounderstandthebasicconceptsandprinciplesofremotesensingand GIS*
- *Tostudythebasicsofdigitalimageandvisualizationtechniques*
- *TounderstandtheconceptGISandvariousGISprocessingsoftware*

SEMESTER-IV

PAPERCODE:ENVSC4011[ENVSCMajor:COURSENO.5]
ENVIRONMENTAL CHEMISTRY & PHYSICS
TOTALCREDITS:5(Theory+Practical)

TIME:3Hours **MARKS:40**
Lectures:60

Learningobjectives:

- Toacquireknowledgeonbasicsofatomicstructure,chemicalbondandperiodicpropertiesof elements
- Togetafundamentalknowledgeofenvironmentalphysicsspeciallythermodynamicprinciples and electromagnetic spectrum
- Togetaknowledgeonthemovementofenvironmentalpollutantsandradioactivity

Fundamentals of Environmental Chemistry: Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic,covalent,coordinateandhydrogenbonds);Moleconcept,MolarityandNormality;Valency, oxidation state, oxidation and reduction reaction, metals and non-metals; Thermodynamic system; types of chemical reactions; acids, bases and salts, solubility products; Concepts of pH
Basic concepts of organic chemistry; Aliphatic and aromatic compounds; Hydrocarbons: Saturatedand unsaturatedhydrocarbons **25**

Fundamentals of Environmental Physics: Basic concepts of light and matter; Quantum mechanics (relation between energy, wavelength and frequency), Beer-Lambert's law; Laws of thermodynamics, entropy, enthalpy, heattransferprocesses,Gibb'sfreeenergy;Waterpotentialchangesinplasmolysisand deplasmolysis; Concept of heattransfer,conduction,convection;Conceptofadiabaticlapserate(dryand moistadiabatic) **15**

Movement of Pollutants in Environment: Diffusion and dispersion, point and area source pollutants, pollutantdispersal;Mixingheights **10**

Radioactivity: Definition, types and units; Characterization of radioactive materials; Measurement of radioactivity;Radioactivehazards **10**

Learningoutcomes

Aftercompletionofthiscoursestudentsshouldlearn-

Tounderstandthefundamentalsofchemicalbond,atomicstructure,molarity,molality,solubility etc.
Toabletoexplainthebasicsofenvironmentalphysicsincludingthelawsofthermodynamics, heat transfer, etc.
Togetknowledgeondispersionofpollutants
Tolearnaboutradioactivityanditsmeasurement

SEMESTER-IV

PAPERCODE:ENVSC4011[ENVSCMajor:COURSENO.5]
ENVIRONMENTALCHEMISTRY&PHYSICS
(Practical)

TIME:2Hours **MARKS:20**

PRACTICAL

DescriptionofItems		**DistributionofMarks**
1)OneMajorexperiment	:	07
2)OneMinorexperiment	:	03
2)LaboratoryNoteBook	:	05
3)*Viva-voce*	:	05

PRACTICALCOURSES

a) MajorExperiments:

i) Preparationof0.1MNa_2CO_3and4mMH_2SO_4fromsuppliedwatersample

ii) PreparationofMolarSolutionandNormalSolution(NaOH&H_2SO_4)

b) Minor Experiments

i) PreparationofWindRosemodel

ii) Calculationofmixingheight

SEMESTER-IV

PAPERCODE:ENVSC4012[ENVSCMajor:COURSENO.6] ENERGY &ENVIRONMENT
TOTALCREDITS:5(Theory)

TIME:3Hours **MARKS:60**
Lectures:75

Learningobjectives:

- Togetknowledgeontypesofenergyresources,theirnature,etc.
- Tolearntheconceptofconventional,non-conventionalandrenewablesourcesofenergy
- Tolearnthesustainableusesofenergyresourcesforfutureconservation

EnergyResources:Classification-Conventional,non-conventional,greenenergy,renewable, non-renewable,carbonfootprintandecologicalfootprint,globalenergyresources**10**

Fossil Fuels:Coal(composition, origin, mining and classification); Petroleum (origin, extraction,chemical composition,classification);Naturalgas(conceptonLNG,CNG,LPG);Oil(origin,utilization)
10

Renewable Resources: Solar energy (PV cells, PG cells); Geothermal energy (origin, utilization),tidal energy, wind energy, Ocean energy, Biomass energy, Hydroelectricity – origin, mode of operation, advantagesanddisadvantages **20**

Nuclear energy: Nuclear fission and fusion; Nuclear fuel cycle, Nuclear reactors (PWR, BWR, Gas CooledBreeder)andnuclearpower–origin,modeofoperation,advantagesanddisadvantages
10

Alternate Sources of Energy:Process of energy extraction from waste; Basic concept of petro-plants, biomass energy, geothermal energy, biofuel - origin, mode of operation, advantages and disadvantages
10

Energy demand: Global energy demand: Historical and currentperspectives;energydemandandusein domestic, industrial, agriculture and transportation sector; Generation and utilization in rural and urban environments;changesindemandinmajoreconomies;energysubsidies;environmentcosts**15**

Learningoutcomes

Aftercompletionofthiscoursestudentsshouldlearn-

Tounderstandtheglobalenergyresources
Togetanideaaboutadvantagesanddisadvantagesofdifferenttypesofenergyresources To learn the sustainability and environmental development
Tounderstandingtheneedofconservation

SEMESTER-IV

PAPER CODE: ENVSC4013 [ENVSC Major: COURSE NO. 7]
ECOTOXICOLOGY&ENVIRONMENTALBIOTECHNOLOGY
TOTALCREDITS:5(Theory+Practical)

TIME:2Hours **MARKS:40**
Lectures:60

Learningobjectives:

- Togetknowledgeonoveralleffectsoftoxicchemicals
- Tounderstandingthemechanismofecotoxicology
- Togetanideaaboutbiotechnologicalaspectanddifferenceapplicationinrelationtoenvironment

Toxicchemicals:
Toxicchemicalsinair,soil,waterandwastewater;ToxicMetals:Biologicaleffectsofheavymetals (cadmium,arsenic,chromium,mercury) **15**

Ecotoxicology:
Definition and Concept; Branches of toxicology; Concept of Dose-Response relationship, LD_{50}, LC_{50}, Threshold Limit Value (TLV), Therapeutic index; Toxicological interactions with ecosystem; Basic conceptonbioaccumulation,biomagnification,bioconcentration **15**

EnvironmentalBiotechnology:
Concept and scope of environmental biotechnology; Applications of biotechnology in environment: Fermentation technique, composting, vermicomposting, bioleaching, bio-augmentation; Genetically modifiedorganisms **15**

Bioremediation: Concept and definition; *In-Situ* and *Ex-Situ* bioremediation techniques; Super bugs in bioremediation **15**

Learningoutcomes
Aftercompletionofthiscoursestudentsshouldlearn–

Understandingnatureandpropertiesofcontaminants
Knowledge on different aspects of toxicants in relation to ecosystem
Understandingonecotoxicologicalparametersofevolutionthetoxicity
Knowledgeondifferentmethods/techniquesofapplicationofbiotechnologyincludingorganism

SEMESTER-IV

PAPERCODE:ENVSC4013[ENVSCMajor:COURSENO.7]
ECOTOXICOLOGY&ENVIRONMENTALBIOTECHNOLOGY
(Practical)

TIME:2Hours **MARKS:20**

PRACTICAL

DescriptionofItems		**DistributionofMarks**
1)OneMajorexperiment	:	07
2)OneMinorExperiment	:	03
3)LaboratoryNoteBook	:	05
4)*Viva-voce*	:	05

PRACTICALCOURSES

a) **MajorExperiments:**

Estimate the LD50 for salt (NaCl) of germinated Mung bean (Vigna radiate L.) seeds. Support your answer with data.

[Note: The LD50 is 12.5 % salt water solution]
OR
Industryvisit/Fieldvisit

b) **Minor Experiments:**
PreparationofFlowchartonanykindofbiotechnologicaltechniqueslikecomposting/ vermicomposting/ bioleaching/ bio-augmentation

SEMESTER-IV

PAPERCODE:ENVSC4021[ENVSCMinor:COURSENO.5]
ENVIRONMENTAL POLLUTION & MEASUREMENT
TOTALCREDITS:4

TIME:3Hours **MARKS:60**
Lectures:60

Learningobjectives:

- Tounderstandthedifferenttypesofpollutantsandrelatedphenomenon
- Togetexclusiveideaaboutsources,effects,etc.,ofpollutants
- Tounderstandthemeasurementtechniques,samplingetc.

Understanding Pollution (Fundamentals):Pollution,poverty, andpopulation**04**

Air Pollution: Air pollutants: Sources and effects of primary and secondary pollutants, particulate matters,indoorpollutants;Globalclimatechange;Photochemicalsmog **06**

Water Pollution: Sources - direct and indirect sources and their impact on water bodies, *viz*., marine, coastal,wetlands;groundwaterpollution;Eutrophication,Lakeacidification,saltwaterintrusion **05**

SoilPollution:Sources,typesandeffectsofsoilpollution **05**

Thermal Pollution: Definition, nature of pollutants, environmental effects of coal ash **05**

VehicularPollution:Characteristicsofautomobileemissions,effectsofautomobilepollutants **05**

FireworksPollution:Definition,characteristics,composition;Pollutionandeffects;Safetyandlaws **05**

Radiation Pollution: Nature and types of radiation; Radiation hazards; Measurement of radioactivity;Nuclearaccidents **05**

PesticidePollution:Sources,categories;Pesticidaleffectsinwater;ElementaryideaonIPML **05**

MetalPollution:Metalsinsoil,foodandwater;ElementaryideaonLeadandCadmiumpollution **05**

Analytical Techniques and Tools of Measurement: Sampling, preservation and storage techniques; Principle,applicationandlimitationsoftitrimetric,gravimetryandpotentiometry **10**

Learningoutcomes

Aftercompletionofthiscoursestudentsshouldlearn-

Tolearnthepropertiesofpollutantsandtheirmodeofaction
Tocreateasocialawarenessonthesepollutantsandtheireffects
Tolearntheoperationalpartofdifferenttechniquesandsamplingmethods

SuggestedReadingsforSEMIII&IV

1. Bansil,P.C.2004.*WaterManagementinIndia*.ConceptPublishingCompany,India.
2. Brebbia,C.A.2013.*WaterResourcesManagementVII*.WITPress.
3. CEA.2011.*WaterResourcesandPowerMapsofIndia*.CentralBoardofIrrigation&Power.
4. Grumbine,R.E.&Pandit,M.K.2013.*ThreatsfromIndia'sHimalayadams*.*Science*339:36-37.
5. Loucks,D.P.,Stedinger,J.R.&Haith,D.A.1981.*WaterResourceSystemsPlanningandAnalysis*. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W.2006. *WaterResources Sustainability*.The McGraw-HillPublications.
7. Schward&Zhang,2003.*FundamentalsofGroundwater*.JohnWilleyandSons.
8. Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics ofMarineNaturalResource Management*. Elsevier Publications.
9. Barry,R.G.2003.*Atmosphere,WeatherandClimate*.RoutledgePress,UK.
10. Keller,E.A.2011.*IntroductiontoEnvironmentalGeology*(5thedition).PearsonPrenticeHall.
11. Krishnan,M.S.1982.*GeologyofIndiaandBurma*.CBSPublishers&Distributors.
12. Leeder,M.,Arlucea,M.P.2005.*PhysicalProcessesinEarthandEnvironmentalSciences.*
13. BlackwellPublishing.
14. LalD.S.2006,*Climatology,*ShardaPustakBhawan,Allahabad
15. SinghS.2009,*Climatology,*PrayagPustakBhawan,Allahabad
16. SiddharthaK.2005,*Atmosphere,WeatherandClimate*,KisalayaPublicationsPvt.Ltd,NewDelhi
17. Hardy,J.T.2003.*ClimateChange:Causes,EffectsandSolutions*.JohnWiley&Sons.
18. SinghR.B.(ed.),2006:*NaturalHazardsandDisasterManagement*:VulnerabilityandMitigation, Rawat Publications, New Delhi
19. KellerE.A.andBlodgettR.H.,2006:*NaturalHazards: Earth's Processes as Hazards, Disasters and Catastrophe*, Prentice Hall, New Jersey
20. MajidH.*FundamentalofPhysicalGeography*,Rawatpublications
21. MontgomeryW.*EnvironmentalGeology*,McGrewHill
22. Bhatta,B.(2008).*RemotesensingandGIS*.OxfordUniversityPress,USA
23. Lillesand, T., Kiefer, R. W.,&Chipman,J.(2015).*Remotesensingandimageinterpretation*.JohnWiley & Sons.
24. Campbell,J.B.,&Wynne,R.H.(2011).*Introductiontoremotesensing*.GuilfordPress.
25. Panda,B.C.,&Panda,B.C.(2005).*Remotesensingprinciplesandapplications*.VivaBooksPvt. Limited.
26. AnjiReddy,M.(2008).*RemoteSensingandGeographicalinformationsystems*.BSPublications

SEMESTER- V

PAPER CODE: ENVSC5011 [ENVSC MAJOR: COURSE NO. 8]
ENVIRONMENTAL POLLUTION
TOTAL CREDITS: 5 (Theory+Practical)

TIME: 2 Hours **MARKS: 40**
Lectures: 60

Learningobjectives

- *To get knowledge on different types of pollutants and levels of pollution with effects w.r.t air, water, soil and noise*
- *To understand the other pollution sources and nature of pollution of thermal, vehicular, fireworks and radioactive materials*
- *To get knowledge about the health effects of these pollutional hazards*

Unit-1: Understanding Environmental Pollution

Environmental pollution: Concept and definition; Pollutants: Classification: primary and secondary, biodegradable and non-biodegradable; point and non-point sources of pollution **10**

Unit-2: Air Pollution Sources and effects of primary and secondary pollutants; Particulate pollutants, aerosols; Consequences of air pollution; Indoor air pollution

Vehicular Pollution: Characteristics of automobile emissions, effects of automobile pollutants

Fireworks Pollution: Definition, characteristics, composition; Pollution and effects; Safety and laws **10**

Unit 3: Water Pollution

Concept and definition; Types and sources of water pollutants; Surface water and groundwater pollution; Lake acidification; Marine pollution: Oil spills; Salt water intrusion; Eutrophication **10**

Unit 4: Soil Pollution

Sources, types and effects of soil pollution; Chemical and biological agents and their effects on soil; salinization of soil **10**

Unit 5: Noise Pollution

Sources of noise pollution; Measurement of noise pollution; Effects of noise pollution of human health **10**

Unit 6: Emerging Environmental pollution

Thermal Pollution: Definition, nature of pollutants;causes and environmental effects of coal ash

Radioactive Pollution: Radioactivity; Radioactive decay; Units of measurement of radiation; Half-life period; Kinds and sources of radiation; Effects of ionizing and non-ionizing radiation; Prevention and remedial measures **10**

Learning outcome

- *Understanding the types and nature of pollutants and their sources*
- *Understanding the different types of pollution, sources of emission and/ or effluents and finally their effects on human being as well as environment*
- *Understanding the specific effects of coal ash, automobile exhausts, firework and radioactive materials*

SEMESTER- V

PAPER CODE: ENVSC5011 [ENVSC Major: COURSE NO. 8]
ENVIRONMENTAL POLLUTION

TIME: 2 Hours **MARKS: 20**

PRACTICAL

Description of Items		**Distribution of Marks**
1) One Major experiment	:	10
2) Laboratory Note Book	:	05
3) *Viva-voce*	:	05

PRACTICAL COURSES

Major Experiments:

1. Measurement of dust fall through gravimetric method
2. Estimation of oil/grease through gravimetric method
3. Estimation of Nitrate-nitrogen, Phosphate, Chloride from water sample
4. Measurement of Vehicular noise
5. Measurement of soil properties: Nitrogen, Phosphate and Potassium

SEMESTER- V

PAPER CODE: ENVSC5012 [ENVSC MAJOR: COURSE NO. 9]
ENVIRONMENTAL LAWS, POLICIES & EIA
TOTAL CREDITS: 5 (Theory)

TIME: 3 Hours **MARKS: 60**
Lectures: 75

Learningobjectives

- *To get knowledge on Indian Constitution, Articles, Laws, rules, policies, etc.*
- *To understand about environment laws for protection of environment and role of different agencies in India*
- *To get knowledge on different Acts in India relating to environment*
- *To know the fundamentals of EIA*

Unit 1: 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 and SPCB) **20**

Unit 2: 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; Green Bench **25**

Unit 3: Environmental Impact Assessment (EIA)

Basic ideas and definition; Goals of impact assessment, evolution of impact assessment with respect to India, technology assessment; Environmental inventory; Techniques and methods of EIA **30**

Learning outcome

- *Understanding the public involvement and environmental provisions on environmental laws and policies adopted in India*
- *Understanding the different bodies responsible for enacting the environmental acts, laws*
- *Understanding the importance and need of EIA before any project implementation*

SEMESTER- V

PAPER CODE: ENVSC5013 [ENVSC MAJOR: COURSE NO. 10]
ENVIRONMENTAL ANALYSIS
TOTAL CREDITS: 5 (PRACTICAL)

TIME: 6 Hours **MARKS: 60**

PRACTICAL

Description of Items		**Distribution of Marks**
1) One Major experiment	:	15
2) One Minor experiment	:	10
3) Laboratory Note Book	:	10
4) Submission of Report	:	15
5) *Viva-voce*	:	10

PRACTICAL COURSES

a) Major Experiments

i) Estimation of Protein, Total chlorophyll, Phenol, Proline, Ascorbic acid, and Sugar from plant material

ii) Basic Histological and Cytological Techniques: Fixation and Fixatives; Tissue-processing andMicrotomy; **Staining**

b) Minor Experiments

i) Interpretation of Satellite Imagery**:** Stereoscopic study and visual interpretations of satellite imagery and airborne image

ii) Biological Analysis: Collection and preservation of plankton; Enumeration of net plankton, Counting in Sedgwick Rafter cell

c) Submission of Report on

i) Meteorological study: Air temperature, Relative Humidity, and Average Rainfall

ii) Principle and Monitoring technique of air quality (SOx, NOx, SPM)

iii) Noise measurement in residential/commercial area

iv) Model of Rain Water Harvesting

v) Microscopy: Components of microscope; Types of microscope – Light, Electron, Phase, Polarised, Fluorescence

SEMESTER- VI

PAPER CODE: ENVSC6011 [ENVSC MAJOR: COURSE NO. 11]
ENVIRONMENTAL HEALTH & STRESS PHYSIOLOGY
TOTAL CREDITS: 5 (Theory+Practical)

TIME: 2 Hours **MARKS: 40**
Lectures: 60

Learning objectives

- *To understand the link between public health and epidemiological problem in society*
- *To understand the principle and science behind communicable and non-communicable diseases*
- *To explore the design, implication of the health programmes and modern advancements*
- *To understand major stress factors and their regulation in plant growth*

Unit 1: Environmental Health and Diseases

Concept of health and disease; Principles of epidemiology and epidemiological methods, aims of epidemiology;

Concept on air, water, vector borne diseases; Communicable diseases- Viral hepatitis, dengue, Leishmaniasis; Non-communicable diseases - cardiovascular, diabetes **30**

Unit 2: Health Programs

Health Programs in India; Demography and family planning; Nutrition and health; Health education; World health report; Health impact assessment; Role of Information Technology in environment and human health **15**

Unit 3: Environmental Stress Physiology

Concept and fundamentals; Photoinhibition and photoacclimation; Stress-agents like temperature, oxygen, salinity on plants **15**

Learning outcome

- *Understand the industrial activity with inputs on health and safety*
- *Knowledge on internalize ISO 14001 and its implications for an industry*
- *Understand the issues related to occupational health and hazards*
- *Development of Protocolforanindustryondisasterprevention,healthissues,safetymeasures and environmentmanagement.*

SEMESTER- VI

PAPER CODE: ENVSC6011 [ENVSC Major: COURSE NO. 11]
ENVIRONMENTAL HEALTH & STRESS PHYSIOLOGY
TOTAL CREDITS: (Practical)

TIME: 2 Hours **MARKS: 20**

PRACTICAL

Description of Items		**Distribution of Marks**
1) One Major experiment	:	10
2) Laboratory Note Book	:	05
4) *Viva-voce*	:	05

PRACTICAL COURSES

Major Experiments:

1. Assessment of salt/temperature stress on germination of horse gram seeds.
2. Estimation of Proline/Ascorbic acid under heat/heavy metal stress.

SEMESTER- VI

PAPER CODE: ENVSC6012 [ENVSC MAJOR: COURSE NO. 12]
ENVIRONMENTAL ENGINEERING & STATISTICS
TOTAL CREDITS: 4 (Theory)

TIME: 3 Hours **MARKS: 60**
Lectures: 75

Learning objectives

- *To understand how different materials one form to another form*
- *To understand water harvesting and watershed management*
- *To understand various modeling aspects related to environmental pollution*
- *To understand basic statistical calculation and their application towards environmental sample assessment*

Unit 1: 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 **25**

Unit 2: Environmental Modelling

Mathematical models; Steps in modelling approaches; Limitations of model application, fate of chemicals, sophistication levels in modeling **15**

Unit 3: 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 **15**

Unit 4: 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**

Learning outcome

- *Understanding of entire life cycle of different materials*
- *Learn how to manage wastewater and how to convert waste to energy*
- *Learn how to gather field data and how to process the data through different statistical calculation*

SEMESTER- VI

PAPER CODE: ENVSC6013 [ENVSC MAJOR: COURSE NO. 13]
ENVIRONMENTAL ECONOMICS & MANAGEMENT
TOTAL CREDITS: 4

TIME: 3 Hours **MARKS: 60**
Lectures: 75

Learningobjectives:

- *The course is designed to give a learner a basic knowledge of Environmental Economics i.e. economics of pollution control, NRA etc.*
- *It is also designed to have a knowledge on accounting and auditing in Environmental Science*
- *To get an idea of environment management system and how the management of pollution could be executed in environmental surroundings and to have a basic idea GAP and YAP etc.*

Unit 1: 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; Natural resource accounting (NRA) (concept and methods of NRA) **15**

Unit 2: Environmental Accounting and Auditing

Environmental accounting--objectives, financial accounting, social accounting; Basic steps and process of environmental audit; Life cycle assessment **10**

Unit 3: Principles of Management

Definition and concept on environmental management; Environmental quality measurement (ISO:14000), Environmental management system; Implication of Agenda-21; Functions of management--forecasting, planning, organizing, motivating, coordinating, controlling, and communicating, leadership, directing, and decision making **20**

Unit 4: Management of Pollution

Management of air pollution, water pollution, noise pollution in respect to Indian scenario; Concept, types, importance of Desalination Process; Waste Water Treatment; Strategies for sustainable Water Management; Drinking Water Standard; Ganga Action Plan (GAP), Yamuna Action Plan (YAP); NamamiGange, concept of Smart city **30**

Learning outcome

- *This course offers a students an understanding of experiential learning on the basic concept of ecological economics, economics of pollution control*
- *Students will also learn the application of accounting and auditing in environment, Environmental management system and also the different models of management regarding different types of environmental pollution especially- waste water.*
- *They will also learn about GAP and YAP*

SEMESTER- VI

PAPER CODE: ENVSC6014 [ENVSC MAJOR: COURSE NO. 14]
FIELD VISIT
TOTAL CREDITS: 4
MARKS: 75
Field: [Visit: 15+Report: 60]

Preparation of report on field visit (Forest/mountain/coastal area/industries/mining/water/sewage treatment plant etc). Students have to prepare a field report for submission after visit and necessary evaluation during Semester –VI.

1. **Field visit: 15**
2. **Submission of report 60**

Semester VII
ENVSC7011 [Major/Core]
Total lecture hours:90
Credits:6::Marks:75[I.A.(15)+Th.(60)]
[Research Methodology and Ethics]

Lectures:90 **Credit:6**

Course Objectives:

- To introduce students to the fundamental concepts, objectives, and significance of research and research methodology.
- To develop the ability to identify, define, and formulate research problems effectively.
- To provide knowledge of research design, sampling techniques, and data collection methods.

I. **Research Methodology**: Basic Concept on research methodology: Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Research and Scientific Method; Importance of Knowing How Research is Done; Research Process; Criteria of Good Research; Problems Encountered by Researchers in India. [10]

II. **Defining Research Problem**: Definition of Research Problem; Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem. [5]

III. **Research Design**: Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs. [10]

IV. **Sampling design**: Census and Sample Survey; Implications of a Sample Design; Steps in Sampling Design; Criteria of Selecting a Sampling Procedure; Characteristics of a Good Sample Design; Different Types of Sample Designs; Selection of a Random Sample; Random Sample from an Infinite Universe; Complex Random Sampling Designs. [10]

V. **Measurement and Scaling techniques**: Measurement in Research; Measurement Scales; Sources of Error in Measurement; Tests of Sound Measurement; Technique of Developing Measurement Tools; Scaling; Meaning of Scaling; Scale Classification Bases; Important Scaling Techniques; Scale Construction Techniques. [10]

VI. **Methods of Data Collection**: Collection of Primary Data; Observation Method; Interview Method; Collection of Data through Questionnaires; Collection of Data through Schedules; Difference between Questionnaires and Schedules; Some Other Methods of Data Collection; Collection of Secondary Data; Selection of Appropriate Method for Data Collection. [10]

VII. **Interpretation and Report Preparation**: Meaning of Interpretation; Need of Interpretation; Technique of Interpretation:; Precaution in Interpretation; Significance of Report Writing; Different Steps in Writing Report; Layout of the Research Report; Types of Reports; Oral Presentation; Mechanics of Writing a Research Report; Precautions for Writing Research Reports; Developing Research Projects & Proposals. [15]

VIII. **Publication ethics**: Introduction of philosophy: Definition, Nature and scope, concept, branches; Ethics: Definition, moral philosophy, nature f moral judgements and reactions; Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconducts: Falsification an, Fabrication, and Plagiarism (FFP); Redundant publications: Duplicate and overlapping publications, Salami Slicing; Selective reporting and

mispresentation of data; Publication ethics: Definition, introduction and importance; Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.; Conflicts of interest; Publication misconduct: Definition, concept, problems that lead to unethical behavior and viceversa, types; Violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals. [20]

Course Outcome:

- Students will be able to understand and apply various research methodologies and scientific approaches.
- Students will be able to formulate research problems and design appropriate research plans.
- Students will gain skills in sampling, data collection, and use of measurement and scaling techniques.

Semester VII
ENVSC 7012 [Major/Core]
Total lecture hours:75
Credits:6::Marks:75[I.A.(15)+T.(40)+ P (20)]
[Advance Concepts in Ecology, Evolution, Ethology and Sustainability]

Lectures75hrs **Credit:5**

Course Objectives:

- To provide comprehensive knowledge of ecological principles, including environment–population interactions, community dynamics, and ecosystem functioning.
- To develop an understanding of evolutionary biology, behavioural ecology, and mechanisms shaping biodiversity and species interactions.
- To introduce concepts of sustainability, conservation, and applied ecology in the context of global environmental challenges and human development.

I. Environment and Population: Climate regulators; Aquatic environment: variation of light, temperature and oxygen; Terrestrial environment: plant cover and light distribution, soil properties influencing life and soil formation; plant adaptation to environment; Animal adaptation to environment; Metapopulation dynamics and Levin's metapopulation model; Mechanism of population equilibrium; Human population growth, expansion and its causes; consequences of population growth; Human demography, promotion and development, demographic transition model; Future of human population. [10]

II. Community ecology: Factors influencing the structure of communities; models of community dynamics, species diversity in communities: measurement and interpretation, landscape dynamics, community restoration, Species interaction, population dynamics and natural selection; Interspecific competition; Prey-Predator interaction; coevolution of prey-predator systems; Host-parasite interaction and population regulation; chaos and limit cycles, community stability. [10]

III. Ecosystem and energetics: Concept of Gaia Hypothesis; Concept of ecosystem; Ecosystem energetics; Ecosystem structure and functional aspects; Decomposition; Ecosystem services-MEA and recent concepts; Distribution of tropical and temperate vegetation at global scale and regulating factors; Lakes, Oceans, Coral reefs; Coastal and wetland ecosystem,; Extreme environments: cave, hydrothermal vents, polar regions. [10]

IV. Evolution: History of Evolutionary thought: Lamarckism; Darwinism; Modern Synthesis Fundamentals: Variation; heritability; natural selection; fitness and adaptation; types of selection (stabilizing, directional, disruptive) Diversity of life: Origin and history of life on earth; diversity and classification of life; systems of classification (cladistics and phenetics) Life history strategies: Allocation of resources; tradeoffs; r/K selection; semelparity and iteroparity Interactions: Co-evolution (co-adaptations, arms race, Red Queen hypothesis, co-speciation); Mimicry, crypsis, etc.; Population and Quantitative genetics: Origins of genetic variation; Mendelian genetics; Hardy Weinberg equilibrium; drift; selection (one-locus two-alleles model); population genetic structure (panmixia, gene flow, FST); polygenic traits; gene-environment interactions (phenotypic plasticity); heritability Molecular evolution and phylogenetics: Neutral theory; molecular clocks; rates of evolution; phylogenetic reconstruction; molecular systematics Macroevolution: Species concepts and speciation; adaptive radiation; convergence; biogeography. [15]

V. Behavioural ecology: Classical Ethology: Instinct; fixed action patters; imprinting; learnt

behavior; proximate and ultimate questions Sensory ecology: Neuroethology; communication (chemical, acoustic and visual signaling); recognition systems Foraging ecology: Foraging behaviour; optimal foraging theory Reproduction: Cost of sex; sexual dimorphism; mate choice; sexual selection (runaway selection, good-genes, handicap principle, etc); sexual conflict; mating systems; parental care. Social living: Costs and benefits of group-living (including responses to predators); effect of competition (scramble and contest) on group formation; dominance relationships; eusociality; kin selection; altruism; reciprocity; human behavior. [15]

VI. **Sustainability and applied ecology:** Invasive species; endemism; conservation genetics (genetic diversity, inbreeding depression); DNA fingerprinting and DNA barcoding disease ecology and evolution: epidemiology; zoonotic diseases; antibiotic resistance; vector control plant and animal breeding: marker assisted breeding; genetic basis of economically important traits. Large scale patterns of biological diversity; IPP and IPR in conservation; global climate change: Important drivers, impact on ecosystem, mitigation pathways; Net-zero emission; Sustainable development goals and its application in aquaculture, agriculture, industry, urban system, forestry and renewable resources; global and national strategies on sustainable development. [15]

Course Outcomes:

- Students will be able to explain ecological processes, population dynamics, and ecosystem structure and functions.
- Students will analyze evolutionary mechanisms, behavioural adaptations, and biodiversity patterns using scientific approaches.
- Students will apply ecological and conservation principles to address real-world issues such as climate change, biodiversity loss, and sustainable development.

Semester VII
ENVSC 7012 [Major/Core] Practical
Total hours:30
Credit:1::Marks:20
[Practical on Environment and Ecology]

Practical : 30 hrs **Credit : 1**

Course Objectives

- To acquire hands-on experience in measuring and analyzing oxygen profiles and biotic components of aquatic ecosystems
- To learnto collect, observe, and identifypond biota, including plankton and macrophytes, and apply staining techniques for microscopic analysis
- To conduct physicochemical analysesof waterand soil, andessential soil nutrients, and interpret environmental quality

1. Measurement and preparation of Oxygen Profile in aquatic ecosystem
2. Estimation of abundance: Quadrate counts, line transects and distance method
3. Spatial pattern analysis and indices of dispersion
4. Determination of species diversity by diversity indices
5. Lay out of experimental design (RBD; split-plot etc.,); Cluster analysis; Sampling techniques and statistical analysis of experimental design
6. Study of pond biota – phytoplankton, zooplankton and macrophytes diversity; and staining of plankton
7. Soil parameters: Electrical Conductivity (EC), Bulk density and Particle density, Porosity and Texture, Cation Exchange Capacity (CEC)
8. Laboratory Note book
9. *Viva-voce*

Course outcomes:

- Measureand interpret theoxygen profileof aquaticecosystemsand relate it to ecosystemhealth and productivity
- Identify and analyze phytoplankton, zooplankton, and macrophytes in freshwater systems, and apply staining techniques for enhanced observation
- Students will learn and analyzekeysoilparameters

Semester VII
ENVSC 7013 [Major/Core]
Total lecture hours:75
Credits:6::Marks:75[I.A.(15)+Th.(40)+ Pract. (20)]
[Geochemical Processes, Climatic dynamics and Geohazard]

Lectures 75hrs **Credit:5**

Course Objectives

- To develop a strong foundation in geochemical processes, including element distribution, geochemical cycles, and hydrogeochemistry with emphasis on environmental issues.
- To provide knowledge of climatological principles, atmospheric processes, climate systems, and climate change dynamics.
- To introduce geohazards, their causes, impacts, risk assessment, and mitigation strategies in the context of environmental management.

I. Geochemical Processes

Geochemical classification of elements; Abundance of elements in bulk Earth, crust, hydrosphere and biosphere; Partitioning of elements during surficial geologic processes; Geochemical recycling of elements; Paleoclimate; Hydrogeochemistry: The aquifer geochemical system; solution, redox, and gas exchange processes; Water/rock interaction; geochemistry of contaminant mobility (Fluoride, arsenic in Indian context) [25]

II. Climatology

Elements of climate: Earth's radiation balance, latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation; Earth's thermal environment and seasons; Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind. Climates of India, western disturbances, Indian monsoon, *El Nino*, *La Nina*, ENSO,QBO; Classification of climate-Koppen's and Thornthwaite' scheme.

Climate change - past and future; Atmospheric stability diagrams, turbulence, diffusion, mixing height, specific gas constant, adiabatic and iso entropic processes, dry and moist air parcel, thermodynamic diagram (T- phigram); Influence of stability on stack effluents; Topography and plume, plume rise, dispersion of plume. [25]

III. Geohazards

Introduction to Geohazards: Definition and classification of geohazards; historical examples of environmental and societal impacts of geohazards; Geological processes leading to geohazards (e.g., earthquakes, volcanoes, landslides). Seismic and Volcanic Hazards: Seismic hazards: Earthquake mechanisms, fault systems, and assessment of risk; Tsunamis: Definition, causes of tsunami generation, propagation and warning systems, impact and mitigation; Volcanic hazards: Types of volcanoes, volcanic eruptions, monitoring, and prediction. Mass Movement Hazards: Landslides and slope stability: Introduction, factors contributing to landslides, types of landslides, rockfall and rockslides, methods for slope stability assessment and mitigation measures for landslides and slope stabilization; Coastal and riverine hazards: Coastal erosion and sea-level rise, flooding (riverine and flash floods), coastal protection and flood management strategies. Climate Change and Geohazards: The impact of climate change on geohazards; Predicting future geohazard risks in a changing climate; Geohazard monitoring, early warning systems, and disaster preparedness. Geohazard Risk Assessment and Mitigation: Geohazard risk assessment: Quantification, risk matrices, and modelling; Geohazard mitigation strategies: Building design, land use planning, and disaster management. [25]

Course Outcomes:

- Students will be able to explain geochemical cycles, element behavior, and groundwater geochemistry in environmental contexts.
- Students will analyze climatic processes, atmospheric dynamics, and interpret climate variability and change.
- Students will evaluate geohazard risks and apply appropriate mitigation and disaster management strategies.

Semester VII
ENVSC 7013 [Major/Core] Practical
Total hours:30
Credits:1::Marks:20

[Practical on Climatology and Geohazard assessment and Green Chemistry]

Practical : 30 hrs **Credit : 1**

Course Objectives

- To develop practical skills in handling climatic datasets, statistical analysis, and graphical representation of meteorological parameters.
- To provide hands-on experience in climatological tools, indices calculation, and interpretation of atmospheric data and diagrams.
- To introduce field exposure, disaster management analysis, and sustainable practices such as biofuel and eco-friendly material production.

1. Retrieval of climatic dataset (IMD/NOAA)
2. Computation of mean, median, standard deviation; Rainfall Variability Index; Coefficient of Variation
3. Preparation of isohyetal, isotherm and isobar map
4. Draw and interpret wind roses to understand prevailing wind directions and frequencies (Indian Context)
5. Time series analysis of temperature and rainfall (Linear and Moving average)
6. Calculation of Potential Evapotranspiration (PET) and Moisture Index as per Thornthwaite's scheme.
7. ENSO, El Niño, La Niña and QBO indices calculation, diagrammatic representation, and interpretation.
8. Interpretation of T-φ gram/Tephigram
9. Visit to an automated weather station
10. Case study on disaster risk mitigation project
11. Critical review of disaster management plan of a State, District and City
12. Preparation of Biodiesel from Vegetable/Waste Cooking Oil
13. Bio-fabrics from weeds

Course Outcomes:

- Students will be able to analyze climatic data using statistical techniques and prepare thematic maps and diagrams.
- Students will interpret atmospheric processes, climate indices, and time-series data for understanding climate variability.
- Students will apply practical knowledge in disaster risk assessment, environmental sustainability, and field-based observations.

Semester VII
ENVSC 7014 [Major/Core]
Total lecture hours:90
Credits:6::Marks:75[I.A.(15)+Th.(60)]
[Green Chemistry, Waste Management and Genetic Engineering]

Lectures:90hrs **Credit:6**

Course Objectives

- To introduce the principles of green chemistry, sustainable practices, and environmentally friendly technologies in chemical processes.
- To provide comprehensive knowledge of solid, hazardous, and electronic waste management, including treatment, recycling, and disposal techniques.
- To develop understanding of genetic engineering, environmental mutagenesis, and their applications in pollution control and resource conservation.

I. **Green chemistry and Sustainability**: Need for emergence of green Chemistry, Chemistry in everyday life, Concept of green chemistry, Twelve Principles of Green Chemistry, Greener solvents [Water, Supercritical Fluids (SCFs), Ionic Liquids, Liquid Polymers, Bio-Based Renewable Solvents], Concept, green catalyst; Material life cycle and application of green chemistry; chemical reactions; Rate of reaction, rate law, adsorption chemistry- physisorption and chemisorption, adsorption-isotherms, organic compounds – hydrocarbons and polymer chemistry; Biological chemistry – chemistry of carbohydrate, nucleic acids, enzymes. Earth friendly plastics: Plastics-the Biggest Source of Pollution, Greening of Plastics, Environmentally Benign Pesticides: Effect of Synthetic Pesticides on Human Health and Environment, Search for Environmentally Benign Pesticides [Microbial Pesticides, Plant-pesticides, Biochemical Pesticides], Natural Home-made Solutions for Pest-control, chemistry of green hydrogen, hydrogen as renewable fuel. [15]

II. **Solid Waste** - types and sources; Solid waste characteristics; generation rates, solid waste components, proximate and ultimate analyses of solid wastes. Solid waste collection and transportation: container systems - hauled and stationary, layout of collection routes, transfer stations and transportation. Municipal solid wastes, biomedical, hospital, sewage, agricultural, industrial and mining wastes; Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Composting, vermicomposting, pyrolysis, biomethanation; Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste. [20]

III. **Hazardous waste** – Types, characteristics and health impacts. Hazardous waste management: reduction and recycling; Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal; waste to energy ; valorization . [15]

IV. **e-waste**: classification, methods of handling and disposal. [5]

V. **Fly ash and Plastic waste**: Sources, composition and utilization of fly ash; Plastic waste- sources, consequences and management; Microplastics; microbeads-sources, occurrence and distribution; types and classification; environmental effects and toxicity. [10]

VI. **Principle of genetic engineering**: Concept, cell cycles: molecular mechanism, gene cloning; genetics responses of microorganisms with reference to pollutants; GMO and its merits and demerits; Conservation of gene resources; Recombinant DNA technology and its applications and limitations; Nif gene and biological nitrogen fixation. [15]

VII. **Environmental mutagenic and genetic disorders:** Mutagenesis mechanism: UV-induced (cyclobutane type pyrimidine dimmers), single strand DNA breaks, chemical induced DNA alkylation, abduct formation, intra- and inter-strand cross-linking; Enzyme mediated photorepair and excision repair. [10]

Course Outcomes:

- Students will be able to explain green chemistry concepts and apply sustainable approaches in chemical and environmental systems.
- Students will analyze different types of waste, evaluate management strategies, and propose effective waste treatment and resource recovery methods.
- Students will understand genetic engineering techniques, assess environmental mutagens, and evaluate their impacts on ecosystems and human health.

Semester VII
ENVSC 7021 [Minor]
Total lecture hours:60
Credits:4::Marks:75[I.A.(15)+Th.(60)]
[Environmental Perspective]

Lectures:60 hrs **Credit:4**

Course Objectives:

- To develop understanding of environmental issues, ethics, climate change, and sustainable environmental practices.
- To provide knowledge of medical geology, environmental health, and the role of microorganisms in diseases and environmental interactions.
- To familiarize students with environmental regulations, public health systems, and waste management practices in India.

I. **Environmental Issues:** Basic ideas on ecosystem and community; Environmental issues; Conservation and environmentalism; Environmental ethics and philosophy; Environmental education; Ecofeminism, environmental agenda; Concept on climate change and its conventions. [10]

II. **Medical Geology:** Perspectives and concepts; Geological sources of nutrients, mineral elements needed for good health; Dietary sources of essential mineral elements; Pathways and exposure with reference to arsenic and fluoride in groundwater. [10]

III. **Emerging contaminant pollution, health implications:** Micro- and nano-plastics (MNPs), Pharmaceuticals and personal care products, Per- and poly-fluoroalkyl substances (PFAS), Endocrine-disrupting chemicals (EDCs), Sources and pathways of PPCPs in the environment, Environmental and health implications, Routes and health effects of EDCs introduction in the environment. [10]

IV. **Environmental Health and Diseases:** Concept on health and diseases; Principle of communicable and non-communicable diseases; Chemicals in food-preservatives, artificial sweetening agents, elementary idea of antioxidants, antibiotics, antacids; Health programmes in India; Hospital waste management. [10]

V. **Medical Microbiology:** Concept of pathogens; Infection and intoxication; Epidemics & Pandemics; Causative agents, symptoms, mode of transmission, prevention and treatment. [10]

VI. **Environmental regulations:** Constitutional provisions and Rules & Regulations; Statutory boards of pollution control, *viz*., CPCB, SPCB, Green Tribunal. [10]

Course Outcomes:

- Demonstrate an understanding of ecological concepts and contemporary environmental issues, and critically evaluate ethical perspectives including ecofeminism and environmentalism
- Explain the role of geological factors in human health, particularly the health impacts of naturally occurring elements like arsenic and fluoride, describe the characteristics, transmission, and control of microbial diseases, and assess strategies for managing epidemics and pandemics
- Identify major communicable and non-communicable diseases and describe the impact of environmental and chemical factors on human health, including hospital waste and food safety practices.Interpret environmental laws, policies, and the roles of regulatory bodies such as CPCB, SPCBs,and the National Green Tribunal, in safeguarding environmental and public health

Semester VIII
ENVSC 8011 [Major/Core]
Total lecture hours:90
Credits:6::Marks:75[I.A.(15)+Th.(60)
[Biostatistical Analysis and Instrumentation]

Lectures:90 hrs **Credit:6**

Course Objectives

- To provide a strong foundation in statistical concepts, biostatistics, and their applications in biological and pharmaceutical research.
- To develop skills in data analysis, hypothesis testing, regression modeling, and experimental design using statistical tools and software.
- To introduce advanced analytical techniques and instrumentation used in research, industrial applications, and clinical trials.

I. **Basics of Statistics**: Statistics, Biostatistics, Frequency distribution; Descriptive statistics- Tabulation, variance, population variance, sample variance, Graphical representation of data; Measures of disperseon-Dispersion, Range, standard deviation, Pharmaceutical problems; Non-parametric Method: Signed-ranked test Kruskal-Wallis test. Mann-Whitney test. Spearman Rank Correlation. Pearson correlation, Multiple correlation – Pharmaceuticals. [15]

II. **Application of statistics in Biology Population and sample**: Sampling distribution, discrete and continuous distribution, Normal distribution. Introduction to probability. Types of Data, Types of groups, one sample, two samples, and more than two samples**;** Hypothesis testing: Types of testing, type I error, type II error, One tail and two tail, power of testing, effect size (Cohen's D) ;Study design and determination of Sample size: Factors associated with sample size determination, Calculating sample size for single group experiment, for continuous variables, for repeat studies. Various study design (observational design, experimental design, etc. [15]

III. **Regression and Probability:** Curve fitting by the method of least squares, fitting the lines y= a + bx and x = a + by, Multiple regression, standard error of regression - Pharmaceutical Examples**;** Probability**:** Definition of probability, Binomial distribution, Normal distribution; Poisson's distribution, properties – problems; Sample, Population, large sample, small sample, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, Error-I type, Error-II type, Standard error of mean (SEM) - Pharmaceutical examples; Inferential Statistics : What is inferential statistics ? Parametric Method One-sample t-test, two-sample t-test, paired t-test. Least Significance difference, One-way ANOVA, Two-way ANOVA ANOVA on ranks. [15]

IV. **Non Parametric tests:** Wilcoxon Rank Sum Test, Mann-Whitney U test, Kruskal-Wallis test, Friedman Test; Graphs**:** Histogram, Pie Chart, Cubic Graph, response surface plot, Counter Plot graph; Designing the methodology**:** Sample size determination and Power of a study, Report writing and presentation of data, Protocol, Cohorts studies, Observational studies, Experimental studies, Designing clinical trial, various phases; Application in research- Need for research, Need for design of Experiments, Experiential Design Technique, plagiarism. [15]

V. **Regression modeling:** Hypothesis testing in Simple and Multiple regression models; Introduction to Practical components of Industrial and Clinical Trials Problems**:** Statistical Analysis Using Excel, SPSS, MINITAB®, DESIGN OF EXPERIMENTS, R - Online Statistical Software's to Industrial and Clinical trial approach; Blocking and confounding system for Two-level factorials. [10]

VI. **Design and Analysis of experiments:** Factorial Design**-** Definition, 2^2, 2^3 design. Advantage of factorial design; Response Surface methodology- Central composite design, Historical design, Optimization Techniques. [10]

VII. **Instrumentation**: Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM. [10]

Course Outcomes:

- Students will be able to apply statistical methods to analyze biological and pharmaceutical data and interpret results effectively.
- Students will design experiments, perform hypothesis testing, and use regression models and statistical software for research applications.

- Students will understand and utilize modern analytical instruments and techniques for data generation and scientific investigations.

Semester VIII
ENVSC 8021 [Minor]
Total lecture hours:60
Credits:4::Marks:75[I.A.(15)+Th.(60)]
[Contemporary Environmental Issues]

Lectures:60 hrs **Credit: 4**

Course Objectives:

- To provide knowledge of global and national environmental issues, including climate change, biodiversity loss, and ozone depletion.
- To develop understanding of national missions, policies, and sustainable development initiatives in India.
- To familiarize students with environmental disasters, forest and wildlife conservation efforts, and strategies for sustainable habitat and resource management.

I. **Global Environmental Issues**: Biodiversity loss, Climate change, Ozone layer depletion. Sea level rise. International efforts for environmental protection. [5]

II. **National Action Plan and Policies (National missions)** : National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change); Net-Zero Emission; Viksit Bharat. [10]

III. **Current Environmental Issues in India:** Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States**;** Water conservation-development of watersheds, Rain water harvesting and ground water recharge; National river conservation plan – Namami Gange and Yamuna Action Plan; Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India; Soil erosion, reclamation of degraded land, desertification and its control. [15]

IV. **Climate change and sustainable habitat**- adaptability, energy security, food security and sustainability; Carbon sequestration and carbon credits; Swachha Bharat Abhiyan; Sustainable Habitat: Green Building, GRIHA Rating Norms; Current policies of Government of India on renewable resources. [10]

V. **Forest Conservation** – Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement. People Biodiversity register; Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision. [10]

VI. **Environmental Disasters**: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011; Present Cyclonic events-Aila, Umphunetc. [10]

Course Outcomes:

- Students will be able to analyze global and national environmental challenges and their ecological, social, and economic impacts.
- Students will evaluate government policies, national action plans, and conservation programs for promoting sustainability.
- Students will assess environmental disasters, forest conservation movements, and wildlife protection projects, and propose strategies for mitigation and sustainable management.

Semester VIII
ENVSC 8091
Credits:12:Marks:225[Dissertation: 135+ Viva: 90]

[Research Project/Dissertation]

Students who will take admission in B.Sc. Environmental Science Hons. with Research will directly opt ENVSC 8091 paper after completing the paper ENVSC 8011.

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OR

Semester VIII
ENVSC 8011 [Major/Core]
Total lecture hours:90
Credits:6::Marks:75[I.A.(15)+Th.(60)
[Biostatistical Analysis and Instrumentation]

Lectures:90 hrs **Credit:6**

Course Objectives

- To provide a strong foundation in statistical concepts, biostatistics, and their applications in biological and pharmaceutical research.
- To develop skills in data analysis, hypothesis testing, regression modeling, and experimental design using statistical tools and software.
- To introduce advanced analytical techniques and instrumentation used in research, industrial applications, and clinical trials.

I. **Basics of Statistics**: Statistics, Biostatistics, Frequency distribution; Descriptive statistics- Tabulation, variance, population variance, sample variance, Graphical representation of data; Measures of dispersion- Dispersion, Range, standard deviation, Pharmaceutical problems; Non-parametric Method: Signed-ranked test Kruskal-Wallis test. Mann-Whitney test. Spearman Rank Correlation. Pearson correlation, Multiple correlation – Pharmaceuticals. [15]

II. **Application of statistics in Biology Population and sample**: Sampling distribution, discrete and continuous distribution, Normal distribution. Introduction to probability. Types of Data, Types of groups, one sample, two samples, and more than two samples**;** Hypothesis testing: Types of testing, type I error, type II error, One tail and two tail, power of testing, effect size (Cohen's D) ;Study design and determination of Sample size: Factors associated with sample size determination, Calculating sample size for single group experiment, for continuous variables, for repeat studies. Various study design (observational design, experimental design, etc. [15]

III. **Regression and Probability:** Curve fitting by the method of least squares, fitting the lines y= a + bx and x = a + by, Multiple regression, standard error of regression - Pharmaceutical Examples**;** Probability**:** Definition of probability, Binomial distribution, Normal distribution; Poisson's distribution, properties – problems; Sample, Population, large sample, small sample, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, Error-I type, Error-II type, Standard error of mean (SEM) - Pharmaceutical examples; Inferential Statistics : What is inferential statistics ? Parametric Method One-sample t-test, two-sample t-test, paired t-test. Least Significance difference, One-way ANOVA, Two-way ANOVA ANOVA on ranks. [15]

IV. **Non Parametric tests:** Wilcoxon Rank Sum Test, Mann-Whitney U test, Kruskal-Wallis test, Friedman Test; Graphs**:** Histogram, Pie Chart, Cubic Graph, response surface plot, Counter Plot graph; Designing the methodology**:** Sample size determination and Power of a study, Report writing and presentation of data, Protocol, Cohorts studies, Observational studies, Experimental studies, Designing clinical trial, various phases; Application in research- Need for research, Need for design of Experiments, Experiential Design Technique, plagiarism. [15]

V. **Regression modeling:** Hypothesis testing in Simple and Multiple regression models; Introduction to Practical components of Industrial and Clinical Trials Problems**:** Statistical Analysis Using Excel, SPSS, MINITAB®, DESIGN OF EXPERIMENTS, R - Online Statistical Software's to Industrial and Clinical trial approach; Blocking and confounding system for Two-level factorials. [10]

VI. **Design and Analysis of experiments:** Factorial Design**-** Definition, 2^2, 2^3 design. Advantage of factorial design; Response Surface methodology- Central composite design, Historical design, Optimization Techniques. [10]

VII. **Instrumentation**: Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM. [10]

Course Outcomes:

- Students will be able to apply statistical methods to analyze biological and pharmaceutical data and interpret results effectively.
- Students will design experiments, perform hypothesis testing, and use regression models and statistical software for research applications.
- Students will understand and utilize modern analytical instruments and techniques for data generation and scientific investigations.

Semester VIII
ENVSC 8012 [Major/Core]
Total lecture hours:45
Credits:4::Marks:75[I.A.(15)+Th.(40)+ Pract (20)]
[Advanced Ecotoxicology and Environmental Microbiology]

Lectures: 45 hrs **Credit:3**

Course Objectives:

- To understand the core principles of ecotoxicology & environmental toxicology, ideas on toxicants, including types of toxicity, dose-response relationships
- To analyze the biochemical behavior and toxic effects of heavy metals in biological systems, and explore appropriate mitigation and remediation strategies, to study the metabolism and biochemical mechanisms of toxicants including tissues
- To understand the environmental microbiology in soil, water, food, etc. To understand the implications of some industrial microbiology & biotechnology

I. Ecotoxicology: Fundamentals: Classical, ecotoxicology, and environmental toxicology; Elements and areas of toxicology; Acute and chronic toxicology; Classes of contaminants: Inorganic - Metals & Metaloids, etc., Organic contaminants – hydrochlorofluorocarbons, organochlorine alkanes, polycyclic aromatic hydrocarbons, etc.; Routes of entry of toxicants [7]

II. Metabolism of toxicants: Disposition of toxicants: Absorption, distribution, excretion, *etc.*; metabolism of toxicants: types of metabolic changes, toxication vs. detoxification, factors affecting metabolism, *viz*., chemical, biological factors; biochemical mechanisms of toxicity: Chemical carcinogenesis, tissue lesions like liver, kidney, nerve, multi-organ toxicity, *etc*. [7]

III. Toxicological chemistry of some specific industrial toxicants: Toxic substances & their toxicology: Sources, distribution, mechanism of exposure, effects and remedial measures of some specific toxicants like PTMs (arsenic, cadmium, lead, mercury, aluminium, chromium), MIC, pharmaceutical active compounds (PACs), estrogenic substances, households, etc. [7]

IV. Environmental Microbiology: Microbial flora in soil – biogeochemical role, biochemical transformations like nitrogen, carbon, sulfur and their compounds; aquatic ecosystems – distribution, techniques and role of aquatic microbial ecosystem; microorganisms in wastewater – determination of sanitary quality, wastewater treatment & disposal [7]

V. Microbiology of foods – Sources in food, growth in foods, microbial spoilage & food poisoning, fermented foods, food preservation; food-borne diseases (*Clostridium* sp., *Salmonella* sp., *E. coli*, etc.), microbiological quality of milk, pasteurization; microorganisms as food, e.g., single-cell proteins; food safety & Standard Act (2006) [5]

VI. Industrial microbiology and Microbial transformations – Industrial uses of bacteria, yeasts, molds; major products of industrial microbiology, microbiology & mining Microbial transformations of heavy metals, pesticides and herbicides; Basics and fundamental reactions of metabolism; microbial immobilization and transformation [5]

Course Outcomes:

- Students will be able to explain the principles of ecotoxicology, including sources, classification, metabolism, and effects of environmental toxicants.
- Students will analyze the impact of toxic substances and microorganisms on environmental and human health, including food safety and industrial applications.
- Students will apply knowledge of environmental and industrial microbiology for pollution control, waste treatment, and bioremediation processes.

Semester VIII
ENVSC 8012 [Major/Core] Practical
Total hours: 30
Credits:4::Marks:75[I.A.(15)+Th.(40)+ Pract (20)]
[Practical on Ecotoxicological Measurements]

Practical: 30 hrs **Credit : 1**

Course Objectives:

- To understand the impact of agrochemicals on different types of plants including hydrophytes, xerophytes, and mesophytes
- To develop practical skills in the analysis of key water quality parameters such as salinity, conductivity, sulfate, phosphate, nitrate-nitrogen, ammoniacal-nitrogen, residual chlorine, sodium, and potassium
- To assess the effects of pesticides on biochemical constituents of crops, focusing on total sugar and protein content

1. Effect of pesticides and heavy metals on total sugar content/ total protein/ opening and closing of stomata of different crops.
2. Serial dilution technique, plate count of microbes, MPN
3. Measurement of LC_{50}/LD_{50} and safe concentration of toxicants
4. Study on chronic toxicity
5. Study on toxicological biomarkers *viz*., Histopathological, Morphoanatomical (GaSI, GSI, HIS, RLG, Fecundity)
6. Study on toxicological response through biochemical tests *viz*., amylase, lipase, protease activity etc.
7. Laboratory Note book
8. *Viva-voce*

Course Outcomes:

- Analyze the physiological and biochemical impact of agrochemicals on hydrophytes, xerophytes, and mesophytes
- Accurately measure and interpret critical water quality parameters that influence ecosystem health
- Quantify changes in total sugar content in crops exposed to pesticide treatments, linking biochemical changes to ecotoxicological stress. Assess the toxicological effects of pesticides and heavy metals on protein content in plants and aquatic animals, understanding the implications for food safety and ecosystem health

Semester VIII

ENVSC 8013 [Major/Core]

Total lecture hours: 60

Credits:4::Marks:75[I.A.(15)+Th.(60)]

[Environmental Biotechnology, Environmental Laws, EIA and Indian Knowledge System]

Lectures:60 hrs **Credit: 4**

Course Objectives:

- To provide fundamental knowledge of environmental microbiology, including microbial diversity, structure, and their roles in environmental processes.
- To develop understanding of biotechnological applications such as biosensors, biofertilizers, and pollution control techniques.
- To familiarize students with environmental laws, international conventions, and environmental impact assessment (EIA) processes and Indian Knowledge System.

I. **Microbes in relation to environment**: Virus, bacteria, fungi, algae, lichen, protozoa microbial groups; General idea about bacterial morphology -- shape, size, structure; Chemistry and function of capsule, pilus, membrane, cell wall, plasmid and chromosome, replication of bacterial nucleus; fungal morphology; Distinctive properties of virus, nucleic acids, life cycle pattern of bacteriophages bacteriology of water and sewage-Methods for differentiating faecal from Sewage organisms and their characters; Practical utility of viruses- Bioinsecticides, phase topping. [10]

II. **Microbial culture techniques and biosensors**: Isolation and characterization; Preservation of microorganisms; Microbial growth curves; Gene sequencing and phylogenetic tree analysis; Biotechnological methods**:** Pollution detection and abatement. Biosensors; Enzyme electrode, immobilized cell biosensor, optical biosensor, ISFET based devices, H_2O_2 biosensor, microbial biosensor, gas phase biosensor, nanobiosensor, amphoteric biosensor, environmental application of biosensor. [10]

III. **Agricultural biotechnology:** Biofertilizer - Types and application in agriculture; Biopesticides; biocomposting; Integrated pest management - concept, technology involved in agriculture and forestry. [5]

IV. **Overview of Environmental Laws in India and EIA**: Wildlife Protection Act (amendments 2022), Motor Vehicle Act, 1988, The Hazardous and Other Waste (Management and Transboundary Movement)

Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, Coastal Regulation Zones (CRZ) 1991 amended from time to time; National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006; Food Safety and Standards Act, 2006; Plant Quarantine (Regulation of Import into India) Order, 2003; EIA techniques and its evaluation of methodologies, EIA and planning and management; Prediction and assessment of impacts on the air, water, soil, and noise environment; Process of reviewing EIA of developmental projects [15]

V. **Environmental Conventions and Agreements**: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP. [10]

VI. **Indian Knowledge System (IKS) in Environmental Science**: Introduction to Indian Knowledge Systems (IKS) and their relevance to Environmental Science, Vedic and Upanishadic perspectives on nature, ecology, and sustainability, Concept of Panchamahabhuta (five elements) and ecological balance, Traditional water conservation systems (e.g., stepwells, tanks, rainwater harvesting), Sacred groves, biodiversity conservation, indigenous and community conservation practices, Sustainable agriculture: Vrikshayurveda, organic farming, and natural farming and agro-ecology, Environmental ethics in Indian philosophies (Buddhism, Jainism, Hinduism), Folk traditions, festivals, and community-based resource management, Integration of IKS with modern environmental management and policy. [10]

Course Outcomes:

- Students will be able to explain microbial diversity, culture techniques, and their environmental and industrial applications.
- Students will analyze and apply biotechnological tools such as biosensors and biofertilizers for environmental monitoring and management.
- Students will evaluate environmental policies, global conventions, and conduct basic environmental impact assessments for sustainable development and gain knowledge on IKS in Environmental Science.

Semester VIII
ENVSC 8014 [Major/Core]
Total lecture hours: 45
Credits:4::Marks:75[I.A.(15)+Th.(40)+ Pract (20)]
[PollutionManagement and Emerging Environmental Issues]

Lectures: 45 hrs **Credit: 3**

Course Objectives

- To develop comprehensive knowledge of air, water, soil, noise, and thermal pollution, including their sources, impacts, monitoring, and control measures.
- To provide understanding of environmental standards, national policies, and pollution management strategies in India.
- To introduce current environmental issues, disaster events, and sustainable resource management practices.

I. **Air Pollution**: Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); period, frequency and duration of sampling. Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Control devices for particulate matter: Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality. [10]

II. Noise Pollution:Weighting networks, measurement of noise indices (Leq, L10, L90, L50, LDN, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health. [5]

III. Water Pollution:Types of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant. [5]

IV. Soil Pollution: Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers. [5]

V. Thermal, Marine Pollution and Radioactive: Heat Islands, causes and consequences. Methods of Abatement of Marine Pollution. Coastal management. Radiation exposure and radiation standards, radiation protection. [5]

VI. National Action Plan and Policies (National missions) : National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change); Viksit Bharat; Emerging mineral reservoirs [5]

VII. Current Environmental Issues in India: Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States**;** Water conservation-development of watersheds, Rain water harvesting and ground water recharge; National river conservation plan – Namami Gange and Yamuna Action Plan; Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India; Soil erosion, reclamation of degraded land, desertification and its control. Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011; Present Cyclonic events-Aila, Umphun etc., Highrise buildings, Urban and rural sanitation in India, Urban slums [10]

Course Outcomes:

- Students will be able to analyze different types of pollution, their measurement techniques, and control technologies.
- Students will evaluate environmental policies, standards, and national action plans for pollution mitigation and sustainable development.
- Students will assess real-world environmental problems, including disasters and resource management issues, and propose appropriate solutions.

Semester VIII
ENVSC 8014 [Major/Core] Practical
Total hours: 30
Credits:1::Marks:75[I.A.(15)+Th.(40)+ Pract (20)]
[Practical on Emerging Environmental Pollution]

Practical : 30 hrs **Credit: 1**

Course Objectives:

- To provide hands-on experience in environmental sampling and monitoring of air, water, and soil.
- To develop skills for identification and analysis of microplastics and microbial populations in different environmental matrices.
- To familiarize students with techniques for measuring environmental parameters such as noise levels in compliance with standards.

1. Microplastics identification

2. Collection, isolation and population study of microorganism in air, water and soil
3. Ambient air sampling, monitoring and analysis
4. Measurement of noise level by dB meter in different zones (as per CPCB guidelines)
5. Laboratory Note book
6. *Viva-voce*:

Course Outcomes:

- Students will be able to collect, isolate, and study microorganisms from air, water, and soil samples.
- Students will be able to identify and quantify microplastics in environmental samples.
- Students will measure, analyze, and interpret ambient air quality and noise levels following standard guidelines.

Semester VIII
ENVSC 8021 [Minor]
Totallecturehours:60
Credits:4::Marks:75[I.A.(15)+Th.(60)]
[Contemporary Environmental Issues]

Lectures: 60 hrs **Credit: 4**

Course Objectives:

- To provide knowledge of global and national environmental issues, including climate change, biodiversity loss, and ozone depletion.
- To develop understanding of national missions, policies, and sustainable development initiatives in India.
- To familiarize students with environmental disasters, forest and wildlife conservation efforts, and strategies for sustainable habitat and resource management.

VII. **Global Environmental Issues** : Biodiversity loss, Climate change, Ozone layer depletion. Sea level rise. International efforts for environmental protection. [5]

VIII. **National Action Plan and Policies (National missions)** : National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change); Net-Zero Emission; Viksit Bharat. [10]

IX. **Current Environmental Issues in India:** Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States**;** Water conservation-development of watersheds, Rain water harvesting and ground water recharge; National river conservation plan – Namami Gange and Yamuna Action Plan; Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India; Soil erosion, reclamation of degraded land, desertification and its control. [15]

X. **Climate change and sustainable habitat**: Adaptability, energy security, food security and sustainability; Carbon sequestration and carbon credits; Swachha Bharat Abhiyan; Sustainable Habitat: Green Building, GRIHA Rating Norms; Current policies of Government of India on renewable resources. [10]

XI. **Forest Conservation**: Major movements-Chipko, Appiko, Silent Valley and Gandhamardhan. People Biodiversity register; Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision. [10]

XII. **Environmental Disasters**: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011; Present Cyclonic events-Aila, Umphunetc. [10]

Course Outcomes:

- Students will be able to analyze global and national environmental challenges and their ecological, social, and economic impacts.
- Students will evaluate government policies, national action plans, and conservation programs for promoting sustainability.
- Students will assess environmental disasters, forest conservation movements, and wildlife protection projects, and propose strategies for mitigation and sustainable management.