M. Sc. Environmental Science Syllabus (CBCS)

Department of Environmental Science
Gauhati University

1. **Duration:** 4 Semesters, 2-year duration

2. **Eligibility Criteria for Admission:**

Students having general B.Sc. in 10+2+3 pattern with Major in any science subject securing a minimum of 50% marks or equivalent GP/CGPA in the major subject or B.E./B. Tech/B. Sc. Agriculture securing a minimum of 55% marks or equivalent GP/CGPA are eligible for admission into the M. Sc. course (CBCS) in Environmental Science. All candidates are required to appear in a written admission test based on general environmental issues (as per UGC syllabus on Environmental Studies) and basic sciences. The selection will be made on the basis of the performance in the Admission Test only. In finalizing the list, consideration will be made to ensure the representation of different subjects/disciplines in view of the multidisciplinary nature of the course and will be decided by the Departmental Advisory Committee (DAC) of the Department.

3. **Course Structure:**

FIRST SEMESTER									
Course Code	**COURSE NAME**	**Lecture**	**Tutorial**	**Practical**	**Credit**	**Hours**	**Total Marks**	**Course Type**	**Nature**
EVS 1013	Man, Environment and Environmental Issues	3	0	0	3	3	50	Core	Graded
EVS 1023	Environmental Biology	3	0	0	3	3	50	Core	Graded
EVS 1033	Environmental Chemistry	3	0	0	3	3	50	Core	Graded
EVS 1043	Environmental Soil Science	3	0	0	3	3	50	Core	Graded
EVS 1053	Environmental Earth Science	3	0	0	3	3	50	Core	Graded
EVS 1063	Analytical Methods for Environmental Monitoring	3	0	0	3	3	50	Core	Graded
EVS 1072	Practical – I: Ecology & Geosciences	0	0	3	2	6	40	Core	Graded
EVS 1082	Practical – II: Environmental Chemistry and Instrumental Analysis	0	0	3	2	6	40	Core	Graded
EVS 1092	Field Study (1 week duration)				2		20	Core	Graded
	Semester Total	18	0	6	24	30	400		
SECOND SEMESTER									
Course Code	**COURSE NAME**	**Lecture**	**Tutorial**	**Practical**	**Credit**	**Hours**	**Total Marks (Ext.+ Int.)**	**Course Type**	**Nature**
EVS 2013	Environmental Statistics and Data Analysis	3	0	0	3	3	50	Core	Graded

EVS 2023	Environmental Remote Sensing and GIS Applications	3	0	0	3	3	50	Core	Graded
EVS 2033	Environmental Pollution – Monitoring and Control Technologies	3	0	0	3	3	50	Core	Graded
EVS 2043	Ecosystem Dynamics, Biodiversity and Conservation Biology	3	0	0	3	3	50	Core	Graded
EVS 2053	Environmental Health and Eco-toxicology	3	0	0	3	3	50	Core	Graded
EVS 2063	Energy and Environment	3	0	0	3	3	50	Core	Graded
EVS 2072	Practical – III: Remote Sensing &GIS	0	0	3	2	6	40	Core	Graded
EVS 2082	Practical – IV: Pollution, Ecosystem & Toxicology	0	0	3	2	6	40	Core	Graded
EVS 2092	Summer Internship/Field Work (Minimum 10 days)				2		20	Core	Graded
	Semester Total	18	0	6	24	30	400		
THIRD SEMESTER									
Course Code	**COURSE NAME**	**Lecture**	**Tutorial**	**Practical**	**Credit**	**Hours**	**Total Marks**	**Course Type**	**Nature**
EVS 3013	Environmental Biotechnology and Microbiology	3	0	0	3	3	50	Core	Graded
EVS 3023	Eco-hydrology and Watershed Management	3	0	0	3	3	50	Core	Graded
EVS 3036	Natural Resource Management and Sustainable Development	6	0	0	6	6	100	Open/ In-house	Graded
EVS 3043	Environmental Hazards and their Mitigation (**Group A : Elective I**)	3	0	0	3	3	50	Elective	Graded
EVS 3053	Disaster Risk Reduction and Management (**Group A : Elective II**)	3	0	0	3	3	50	Elective	Graded
EVS 3063	Industrial Pollution Control and Waste Management (**Group B :Elective I**)	3	0	0	3	3	50	Elective	Graded
EVS 3073	Municipal Water Supply and Wastewater Treatment (**Group B : Elective II**)	3	0	0	3	3	50	Elective	Graded
EVS 3082	Practical – V: Environmental Biotechnology and Microbiology	0	0	3	2	6	40	Core	Graded
EVS 3092	Practical – VI: Eco-hydrology and Watershed Management	0	0	3	2	6	40	Core	Graded
EVS 3102	Project Seminar				2		20	Core	Graded
	Semester Total	18	0	6	24	30	400		

FOURTH SEMESTER									
Course Code	**COURSE NAME**	**Lecture**	**Tutorial**	**Practical**	**Credit**	**Hours**	**Total Marks (Ext.+ Int.)**	**Course Type**	**Nature**
EVS 4013	Environmental Impact Assessment	3	0	0	3	3	50	Core	Graded
EVS 4023	Environmental Law and Management	3	0	0	3	3	50	Core	Graded
EVS 4033	Climate Change and Global Environment	6	0	0	6	6	100	Open/ In-house	Graded
EVS 4043	Seismology and Seismic Hazards in NE India (**Group A: Elective- III**)	3	0	0	3	3	50	Elective	Graded
EVS 4053	Flood Hydrology and Flood Hazards in NE India (**Group A: Elective –IV**)	3	0	0	3	3	50	Elective	Graded
EVS 4063	Solid and Hazardous Waste Management (**Group B: Elective- III**)	3	0	0	3	3	50	Elective	Graded
EVS 4073	Green Chemistry (**Group B: Elective – IV**)	3	0	0	3	3	50	Elective	Graded
EVS 4083	Project				6	12	100 (75+25)		
	Semester Total	18	0	0	24	30	400		
	Course Total	72			96	132	1600		

Specialization:

Students shall have to choose their specializations from **any one** of the following groups (Group A or Group B):

Group A: **Natural Hazards & Disaster Management**

- EVS 3043 (Elective - I)
- EVS 3053 (Elective - II)
- EVS 4043 (Elective –III)
- EVS 4053 (Elective – IV)

Group B: **Environmental Pollution – Monitoring, Control & Management**

- EVS 3063 (Elective- I)
- EVS 3073 (Elective - II)
- EVS 4063 (Elective –III)
- EVS 4073 (Elective – IV)

For the purpose of end semester examination, each Theory paper carrying 50 (40 +10) marks shall be of 3 hours duration and each Practical paper carrying 40 (32 + 8) marks shall be of 5 hours duration

COURSE OUTCOMES

Course Code	Course Title	Course Outcome
First Semester		
EVS 1013	Man, Environment and Environmental Issues	An attempt has been made to teach the students about overall background of the subject. Further, the students would be able to understand the man-environment relationships and the causes and consequences of environmental issues.
EVS 1023	Environmental Biology	Students will acquire knowledge on flora, fauna and biotic environment required for the study of the environmental status of a locality/region.
EVS 1033	Environmental Chemistry	The students would have background knowledge of chemistry required for the analysis of environmental samples for environmental monitoring and for handling environmental problems.
EVS 1043	Environmental Soil Science	The students will learn about the formation, characteristics and classification of soil. They will also understand the effects of human activity on soil quality and the causes of land degradation and its remedial measures.
EVS 1053	Environmental Earth Science	The knowledge on earth processes which are related with weather and climate, soil characteristics and natural hazards are very important for the environmental science students and this course will serve this purpose.
EVS 1063	Analytical Methods for Environmental Monitoring	The course is aimed to train the students for using different kinds of analytical instruments as well as methods used for the analysis of environmental samples.
EVS 1072	Practical – I: Ecology & Geosciences	It helps the students in their field study, especially for ecological analysis, soil analysis, etc.
EVS 1082	Practical – II: Environmental Chemistry and Instrumental Analysis	Students would get hands-on training on different equipments used for environmental sample analysis.
EVS 1092	Field Study (1 week duration)	It helps the students to learn the techniques for studying the environmental conditions/status of a locality.
Second Semester		
EVS 2013	Environmental Statistics and Data Analysis	The students would learn how to handle and analyse environmental data sets for drawing statistical inference and decision making.

EVS 2023	Environmental Remote Sensing and GIS Applications	Remote sensing is an important tool for environmental data acquisition. So, the students must have background knowledge on different kinds of remote sensing techniques and they must be well acquainted with the use of remote sensing data processing and analysis softwares. Students would learn how to collect both spatial and non-spatial data and would be able to analyse these data by using GIS software.
EVS 2033	Environmental Pollution – Monitoring and Control Technologies	The students would be able to understand the problem of environmental pollution and have a background for monitoring environmental pollution.
EVS 2043	Ecosystem Dynamics, Biodiversity and Conservation Biology	The course is aimed to familiarise the students about the functioning of ecosystems, human impact on ecosystems and the students would gather knowledge for maintaining an ecosystem.
EVS 2053	Environmental Health and Eco-toxicology	The students would be well acquainted with environment related diseases and their causes so that they would be able to participate in the environmental management of these diseases. Moreover, the students would acquire knowledge about the toxicants and their route of entry to the environment and its consequences.
EVS 2063	Energy and Environment	The students would be able to know the different kinds of energy resources, their availability and utility as well as their environment related aspects.
EVS 2072	Practical – III: Remote sensing &GIS	The students would get hands-on training for the use of remote sensing and GIS softwares.
EVS 2082	Practical – IV: Toxicology	The students would get hands-on training on toxicological analysis
EVS 2092	Summer Internship/Field Work (Minimum 10 days)	The students would get an exposure on environmental management practices in developmental projects, factories, industries etc.
Third Semester		
EVS 3013	Environmental Biotechnology and Microbiology	Aim of this course is to flourish the students in value based system by exploring and nurturing their potential to discover novel bio products and to extend services of whole living system and the environment and making them technologically and ethically of high quality to serve the society and to develop their skill as per present needs of biotechnology and microbiology.
EVS 3023	Eco-hydrology and Watershed Management	Aim of this course is to make aware the students regarding the ecological aspects of hydrology so that their knowledge can be used for watershed management practices for the proper use of water resource available in a basin.

EVS 3036	Natural Resource Management and Sustainable Development	Natural resources represent a potentially transformational opportunity to support development, but they are ultimately finite. So, by this course attempts have been made to teach the students about the complex and interwoven aspects of natural resources and to make the learners committed to harnessing the transformational impacts of the natural resource with sustainability aspects.
EVS 3043	Environmental Hazards and their Mitigation (**Group A : Elective I**)	Indian subcontinent, especially the N.E region is highly exposed to natural l hazards like earthquake, floods, droughts, landslides, soil erosion, cyclones etc. and so the students should be educated with the in-depth knowledge about these hazards and their mitigation measures.
EVS 3053	Disaster Risk Reduction and Management (**Group A : Elective II**)	The Course will enable the students to prepare distaster management plan, generate risk maps using qualitative and quantitative methods, mitigate hazard impacts, develop and implement policies and effective corporate governance related to the disaster. It also provides guidance on effective communication, co-ordination, collaboration and co-operation in performing roles and responsibilities in times of disaster in order to build community resilience and ensure that impacts are minimized by an efficient and effective disaster response.
EVS 3063	Industrial Pollution Control and Waste Management (**Group B :Elective I**)	The aim of the course is to produce competent professionals with a strong foundation of industrial pollution control and waste management processes and applications to be suitable for critical situations.
EVS 3073	Municipal Water supply and Wastewater Treatment **(Group B:Elective II)**	Human health is directly related to the drinking water quality especially in the urban municipal areas because of various environmental pollution aspects. So, students can learn the sources, causes and consequences of water used in different municipal areas and the water born diseases suffered by the citizens. Hence the present course has been formulated so that it can provide the basic knowledge of the municipal water supply scenario and waste water treatment processes in different municipal areas.
EVS 3082	Practical – V: Environmental Biotechnology and Microbiology	Students will get hands-on training on the environmental aspects of biotechnology and microbiology.
EVS 3092	Practical – VI: Eco-hydrology and Watershed Management	Students will get hands-on training on the eco-hydrology and watershed management.

EVS 3102	Project Seminar	Students would get an exposure in the selection of project works in the project seminar.The purpose is to produce skilled, up to date, competent and adequately accomplished researchers capable of taking research work independently
Fourth Semester		
EVS 4013	Environmental Impact Assessment	The students will acquire knowledge on Environmental Impact Assessment, the nexus between environment and development, methods of impacts analysis, Air, Water, Soil, Noise and Energy impact analysis etc. and this will make students more skillful to solve problems.
EVS 4023	Environmental Law and Management	The knowledge of the legal, administrative and constitutional provisions for environmental protection in India and their implementation and shortcomings is essential to the students pursuing Environmental Science. So, the course has been incorporated.
EVS 4033	Climate Change and Global Environment	It is an open/In-house course, so emphasis has been given to impart knowledge on climate change, weather, climate change and global warming, climate change vulnerability, adaptation etc. common for all. It will also give ideas of national and international response on climate change scenario.
EVS 4043	Seismology and Seismic Hazards in NE India (**Group A: Elective-III**)	N.E part of India is very much prone to seismic hazards. So, the students should know about the different aspects of seismology and seismic hazards its magnitudes and waves, recording, zonation and hazard analysis and their mitigation measures. The aim of the course is to generate skilled manpower to be deployed in the study of seismology and this management in N.E.India. Hence the course has been incorporated.
EVS 4053	Flood Hydrology and Flood Hazards in NE India (**Group A: Elective – IV**)	N.E region of India, especially Assam is very much prone to floods. It is a regular phenomenon in the state of Assam. So, different components of floods, its control methods, flood forecasting and analysis, flow modelling, rehabilitation and quick response etc. are the need of the time,. Hence the course has been incorporated in the programme and it will definitely help the students.
EVS 4063	Solid and Hazardous Waste Management (**Group B: Elective-III**)	Solid waste management has become a subject of everyday discussion all over the world. India is of no exception. Assam is also facing the same problem. Hence to make aware of the grave situation of solid waste and their scientific management, the course has been framed. It will give some knowledge about the gravity to the problems and their probable solutions.

EVS 4073	Green Chemistry (**Group B: Elective – IV)**	To meet the demands of modern civilization, we need varieties of chemical products and chemical industries that lead to formation of hazardous substances injurious to the environment. Green chemistry aims to protect the environment and is known as Environmentally benign chemistry. It designs the chemical processes and products that reduce the use and formation of hazardous substances. So, this course is incorporated.
EVS 4083	Project	The purpose is to produce skilled, up to date, competent and adequately accomplished researchers capable of taking research work independently. It will also develop scientific communication skill useful for publishing research findings.

DETAILED SYLLABUS

FIRST SEMESTER

(15 weeks, 90 working days)
Average contact hours per week = 28 hours

EVS 1013: Man, Environment and Environmental Issues

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Introduction	Concept, scope and interdisciplinary nature of Environmental Science; Environmental factors; The Global environment and its segments; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere; Mass and energy transfer across the interfaces of various geospheres; environmental ethics	7
Unit-II: Weather and Climate	Weather and climate, environmental significance, measurement of weather parameters, variations in weather parameters, data analysis and interpretation, Extreme weather conditions; Climatic controls, Major climatic zones of the world; Climate, vegetation and human culture; Climatic extremes - environmental implications, Global climate change and its impact on environment.	7
Unit-III: Landscapes and Environment	Different kinds of landscapes, General relationship between landscape, biomes and climate. Climate, flora and fauna of different kinds of landscapes – Mountain, valley and desert environment.	5
Unit-IV: Man and Environment	Man-environment relationship, Resource utilization and human impact on environment, Concept of sustainable development Population growth - biological growth curves and carrying capacity, Human population growth and environmental constrains, Effects of environment on human culture and livelihood; Human impact on ecosystems; the Gaia hypothesis	6
Unit-V: Natural Resources	Different kinds of resources - Air, Water, Soil, Minerals, Forests and Energy resources; Concept of reserve and resources; Equitable uses of resources, Problems with the exploitation of resources, environmental constrains Vegetation/forest classification -Champion & Seth's classification of Indian vegetation. Major vegetation types of Indian - structure, composition and function; Floral diversity and botanical regions of	6

	India.	
Unit-VI: Major Environmental Issues and Environmental movements	Green House effect and Global warming, Ozone layer depletion, Acid rain, Deforestation and loss of bio-diversity Climate change and adaptability - Climatic variability and climate change Concept of Eco Feminism, Role of eminent environmentalist in in Environmental movements of India, Chipko movement, Apikko movement, Narmada Bachao Andolan, Tehri Dam conflict; Save Ganga movement; Mega Dams in NE India and its Consequences	7
Unit-VII: Environmental Risk and Hazards	Risk and hazards; Chemical hazards, Physical hazards, Biological hazards, Basics of hazard management and mitigation	7

Recommended Books

1. Daniel D. Chiras (2010): Environmental Science, eight editions, Jones & Bartlett,
2. G. M. Masters (2004): Introduction to Environmental Science and Engineering (2nd Ed.), Pearson Education Pvt. Ltd.
3. S. C. Santra (2011): Environmental Science, New Central Book Agency
4. Michael Allaby(2000): Basics of Environmental Science (2nd Ed.), Taylor & Francis
5. A. R. W. Jackson and J. M. Jackson (1998): Environmental Science – The natural environment and human impact, Longman
6. Jr. G. T. Miller (1997): Environmental Science (6thed), Wadsworth Pub. Co.

EVS 1023: Environmental Biology

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Introduction	Concept of Environmental Biology, Ecosphere and Biosphere; Ecological factors and variables Ecosystems – concept, types, structural and functional aspects; Energy flow in ecosystems, food chain, food web, trophic levels, Ecological pyramids – pyramids of numbers, pyramids of biomass, pyramids of energy Hydrologic cycle, Evolution of Biosphere, origin and speciation of life	7
Unit-II: Biomes and Habitat	Classification of biomes – Tundra, Taiga, Grassland, Desert, Evergreen and deciduous forests, Tropical rain forests and their characteristics, Classification of Aquatic Habitats – Fresh water and marine (Wetlands, Rivers, Inter-tidal Estuaries; Mangroves)- their characteristics.	7
Unit-III: Community Ecology	Definition and concept of community, community diversity, structure, dominance, stratification and periodicity; Community interdependence, Ecotone, Edge effect and Ecological Niche Ecological succession – characteristics, types of succession, concept of	6

	climax, significance of succession	
Unit-IV: Air Microflora	Microflora of atmosphere – different sampling techniques, identification of aeroallergens; Airborne diseases and allergies; Microbes and pollution abetment	7
Unit-V: Environmental Biophysics	Introduction, Bioenergetics – Principle of thermodynamics, First and Second law of thermodynamics, entropy and enthalpy changes; ATP Bioenergetics - ATP formation and breakdown in living system; Photobiology – UV, Visible and IR radiations, their biomedical uses; Photosynthesis; Bioluminescence	6
Unit-VI: Environmental Biochemistry	Proteins – Biological important proteins, biological functions of proteins; Nucleic acids – DNA, RNA, and their types, biological functions of nucleic acids	6
Unit-VII: Human Ecology	Principles and scope of Human Ecology; Ecology and Human settlement, Relationship of human-being with other organisms – Positive interactions; Negative interactions	6

Recommended Books

1. Eugene Odum(2004): Fundamentals of Ecology
2. S. C. Santra (2011): Environmental Science, New Central Book Agency
3. A. C. Dutta (2000): A Class-book of Botany; Oxford University Press, Calcutta
4. S. S. Purohit (2006): Microbiology Fundamentals and Applications (7^{th}ed), Agrobios
5. Hans Peter Schmauder (ed) (1997) : Methods in Biotechnology, Tailor & Francis

EVS 1033: Environmental Chemistry

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Environmental Chemistry Basics	Concept and scope of Environmental Chemistry; acid-base reactions, pH and pOH, ionic product of water, common ion effect, buffer solutions, solubility and solubility product, hydrolysis, chemical equilibrium, oxidation and reduction, chemical speciation, Chemistry of Environmental Trace Elements: Pb, As, Hg and Cd; concept of green chemistry Simple reaction mechanisms; Order and molecularity of chemical reactions; First, second and zero order reactions; Catalysis; Adsorption	7
Unit-II: Atmospheric Chemistry	Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain; oxygen and ozone chemistry; Catalytic decomposition process of ozone, Concept of atmospheric aerosol chemistry	6
Unit-III: Water Chemistry	Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters – physical, chemical and biological; Distribution of chemical species in water;	6

	Gases, organic matter and humic matter in water.	
Unit-IV: Soil Chemistry	Chemical & mineralogical composition of soil; Physical properties of soil – texture, bulk density, permeability; Chemical properties – cation exchange capacity, pH, macro- and micro-nutrients, major soil chemical reactions	6
Unit-V: Bio-geo-chemistry	Earth as a biogeochemical system, biogeochemical cycles – C, N, O, P, S cycles, basic thermodynamics; stable isotope studies of biogeochemical phenomenon; biogeochemical reactions in the atmosphere; Biogeochemistry of Wetlands and Lakes	7
Unit-VI: Chemistry of Cleaning Agents & Fuels	Soap, detergents and bleaching agents; Chemistry of colloids. Gasoline and additives, antiknock compounds, lubricants and greases, biogas	6
Unit-VII: Organic compounds	Hydrocarbons, PAH, PCBs, phenols, chlorofluorocarbons, pesticides, chemical fertilizers	7

Recommended Books

1. S. E. Manahan (2005) : Environmental Chemistry (8thed), CRC Press
2. B.K. Sharma (2007): Environmental Chemistry, Goel Publishing House, Meerut, India
3. James E. Girard (2013): Principles of Environmental Chemistry, Jones &Bartlett
4. V. Subramanian (2011): A Textbook of Environmental Chemistry, I.K. Intl. Pub. House Pvt. Ltd
5. J. W. Moore and E. A. Moore (2012): Environmental Chemistry, Academic Press
6. G. W. Vantoon& S. J. Duffy (2017): Environmental Chemistry - A global perspective, Oxford Univ. Press

EVS 1043: Environmental Soil Science

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Introduction	Soil as Medium for plant growth, Regulator of water supplies, Recycler of raw materials, Habitat for soil organisms; Soil Profile and its layers (Horizons); Constituents of soils, Soil water, Soil air; Soil quality, Degradation and resilience of soil	6
Unit-II: Soil formation and classification	Weathering of rocks - physical, chemical and biological; Factors influencing soil formation, Parent & residual parent materials Concept of individual soils, Comprehensive classification - categories and nomenclature of soil, Soil orders	6
Unit-III: Chemical properties of Soil	Acidity of soil - acidification of soil, sources of hydrogen and hydroxide ions, classification of soil acidity, variability in soil pH, effects of soil acidity on plants reduction of soil acidity; Acidification of ecosystems, Environmental effects, Alkalinity of soil - sources, measurement of salinity and alkalinity, Salt-affected soils, Reclamation of saline soils Soil Colloids – types, genesis, sources of charges; Colloidal control of	7

	soil reaction	
Unit-IV: Physical properties of Soil	Particle size distribution, Soil structure, Soil density and porosity, Soil consistence, Thermal properties of soils - absorption and loss of solar energy, Soil temperature, Processes affected by soil temperature, Soil temperature control	6
Unit-V: Air and Water in Soil	Nature of soil aeration, Soil aeration in field, Factors affecting soil aeration, Ecological effects of soil aeration, Aeration in relation to soil and plant management; Capillary fundamentals and soil water, Soil water energy concepts, Soil moisture content and water potential, Flow of water in soil, Factors affecting amount of plant-available soil water, Mechanisms of water supplied to plants.	7
Unit-VI: Land degradation and soil conservation	Degradation of land, Causes of land degradation – overexploitation, pollution, erosion, Nature of erosion, erosion by water, erosion by wind, Environmental problems due to erosion, Soil conservation	6
Unit-VII: Impact of Human activity on soil Quality	Soil health - concept, effects of intensified agriculture, sustaining biological productivity, improving Low-Yielding agricultural systems Soil pollution - Toxic chemicals, pesticides; Behavior of chemicals in soil, Effects of pesticides on soil organisms, Pesticide leaching, Potential hazards of chemicals in sewage sludge, Remediation of contaminated soils	7

Recommended Books

1. Kim H. Tan (2009): Environmental Soil Science (Third Edition); CRC Press
2. Alan Wild (1996): Soils and the environment; Cambridge University Press
3. Donald Sparks (2002): Environmental Soil Chemistry, 2nd Edition; Academic Press
4. Gary M. Pierzynski, George F. Vance, J. Thomas Sims (2005): Soils and Environmental Quality; CRC Press
5. Nyle C. Brady and Ray R. Weil (2016): Nature and properties of soil, Pearson.

EVS 1053: Environmental Earth Science

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect
Unit-I: Introduction	Concept of origin and evolution of the earth, Plate tectonics, Sea floor spreading and Continental drift; Seismic zones and volcanic belts. Rock types – igneous, metamorphic and sedimentary; Rock cycle; Soil - formation, composition, and classification; Soil profile, Mineral deposits – formation and classification; Different types of mining; Environmental problems associated with extraction of mineral deposits	6
Unit-II: Earth's Surface Processes	Mass-wasting; Erosion, Transportation and deposition of earth's materials by running water, wind and glaciers; Development of landforms; Soil erosion – causes and consequences; Gully formation, Bank-side erosion; Control and management of erosion	6

Unit-III: Atmospheric Processes	Global distribution of solar energy, Heat balance of the earth-atmosphere system, Earth as a heat engine; General circulation and wind systems; Cyclones and anticyclones; Air masses - source, modification and classification; Fronts and weather systems; Monsoons, *El-Nino*, *La-Nina*, ENSO	7
Unit-IV: Fundamentals of Meteorology	Atmospheric thermodynamics – equation of state of dry and moist air, specific heats and application of laws of thermodynamics, thermodynamic process; Temperature lapse rate and inversion; Hydrostatic balance and atmospheric stability; Scales in meteorology. Planetary boundary layer – variation of air temperature, humidity and wind; Diffusion and Turbulence, Mixing height	6
Unit- V: Climate classification and climate of different land-use	Determining factors of climate, Effects of topography, Classification of climate - Koppen classification, Thornthwaite's classification; Climate of India, Indian climate change scenario (Temperature and Precipitation trends, Extreme rainfall events, Heat wave and cold wave), Monsoon behavior. Urban climatology, Agro-climatic classification, weather forecasting, Role of weather on pest and disease outbreak	8
Unit-VI: Earth's Geodynamic Processes	Concept of stress and strain; Mechanics and classification of folds and faults; Recognition and genesis of minor structural elements - foliation, lineation, drag folds, cleavage and joints; Formation of tectonic earthquakes; Environmental changes due to Earthquakes, Volcanoes and *Tsunami*.	7
Unit-VII: Glaciers	Physical and chemical aspects, Mass balance, Recession of Himalayan glaciers, Glaciers as index of climate change.	5

Recommended Books

1. Keller (*2012)*: Introduction to Environmental Geology, 5th Edition; *Pearson*
2. K. S. Valdiya (1987):Environmental Geology; Tata McGraw-Hill
3. J. M. Wallace and P. V. Hobbs (1977): Atmospheric Science – An introductory survey; Academic Press
4. H. R. Byers(1974):General Meteorology; McGraw-Hill
5. S. Pal Arya (1988): Introduction to Micrometeorology; Academic Press
6. T. R. Oke (1978): Boundary layer climates; Methuen & Co. Ltd
7. J. Bahadur (2004): Himalayan Snow and Glaciers – Associated Environmental problems, Progress and Prospect, Concept Pub

EVS 1063: Analytical Methods for Environmental Monitoring

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect
Unit-I: Sampling and Sample preparation	Sampling of Air, Water and Soil; Sampling equipments; Preparation of sample for trace metal analysis in water air and soil: Dissolution techniques and microwave digestion	7
Unit-II: Methods for water and soil analysis	Physiochemical parameters – Definition and determination of Conductivity, pH, DO, BOD,COD; Measuring instruments used for determination of Physiochemical parameters	6
Unit-III: Analysis of Metal Ions	Colorimetry and Spectrophotometry – theory and instrumentation; Theory, instrumentation and application of Atomic Absorption Spectrometry, Flame Emission Spectrometry and Inductively Coupled Plasma Mass Emission Spectrometry	7
Unit-IV: Separation Techniques	Principle and process of solvent extraction, Extraction reagents and Practical applications; Chromatography – principle and application of thin layer and ion exchange chromatography	6
Unit-V: Nephelometry and Turbidimetry	General discussion, Instruments for nephelometry and turbidimetry and their applications	6
Unit-VI: GC and HPLC	Principle, instrumentation and applications of Gas Chromatography and High Performance Liquid Chromatography	6
Unit-VII: IC,GC-MS, ASV and NAA	Principle and application of Ion-chromatography, GC-MS, Anode Stripping Voltametry and Neutron activation analysis	7

Recommended Books

1. Rafi Ahmad, Frank Taylor, Michael Cartwright (2001): Analytical Methods for Environmental Monitoring, Prentice Hall
2. Roger N. Reeve (2002): Introduction to Environmental Analysis, John Willy & Sons
3. Mahmood Barbooti (2015): Environmental Applications of Instrumental Chemical Analysis, CRC press
4. A. E. Greenberg, A. D. Eaton; APHA, AWWA,WEF: Standard Methods for Examination of water and waste water
5. C. N. Sawyer, P. L. McCarty and G. F. Parkin: Chemistry for Environmental Engineering and Science :
6. H. H. Rupa and H. Krist; Laboratory Manual for the Examination of Water, Waste water and soil; V C H Publication

EVS 1072: Practical – I: Environmental Biology & Geosciences 2 credits Total marks: 40

(a) Experiment related to Environmental Biology

1. Estimation of Grassland and Forest animal population (seen) by quadrate method
2. Vegetation studies by line and belt transact method and their analysis

3. Study of wetland flora and fauna and the status study or Visit to aquatic ecosystem and collection of water and plankton samples for quality and productivity studies
4. Study of Pond productivity by quadrate and plankton study

(b) Experiment related to Geosciences (any six)

1. Familiarization with meteorological instruments and their uses and experiment related to presentation and interpretation relating to upper air and surface weather conditions including coding and decoding of meteorological parameters
2. Use of survey instruments - theodolite, dumpy level, plane table and digital laser tacheometer.
3. Studies of thin sections of selective igneous, metamorphic and igneous rocks
4. Classification of soils using soil taxonomy
5. Determination of lime requirement of an acidic soil by buffer method
6. Determination of gypsum requirement of an alkali soil
7. Determination oforganic matter content and calcium carbonate content in soil
8. Humus study by visible spectrophotometric studies and the (E4/E6) values at two pH values

EVS 1082: Practical –II: Environmental Chemistry and Instrumental Analysis

2 credits Total marks: 40

1. Experiments related to physicochemical properties of water (pH, EC, Free CO_2, Bicarbonate, Alkalinity, Salinity, TDS etc.)
2. Estimation of turbidity in water and soil using spectrophotometer
3. Estimation of halides in water samples (Cl^-)
4. Estimation of alkali metals in water/soil samples by flame-photometry
5. Analysis of soil for Organic Carbon, total and available plant nutrients
6. Identification and quantification of minerals in soil fractions

EVS 1092: Field Study (1 week duration) 2 credits Total marks: 20

SECOND SEMESTER

(15 weeks, 90 working days)
Average contact hours per week = 28 hours

EVS 2013: Environmental Statistics and Data Analysis

45 classes 3 credits Total marks: 50

Unit	Contents	Lect.
Unit-I: Introduction	Environmental Variables, Environmental data collection and presentations; Basic Statistics - frequency distribution, Measures of Central Tendency and Dispersion, Moments, Skewness and Kurtosis, Outliers and Robustness Population, sample and census, Different techniques of sampling – simple random sampling, stratified random sampling, systematic sampling; Relative advantages and disadvantages of different techniques	7

Unit-II: Probability Distributions	Basic probability rules, expectation, conditional probability; Probability distributions – Binomial, Poisson, Normal and Log-normal distributions; Fitting of probability distributions to environmental data.	7
Unit-III: Bi-variate and Multivariate data analysis	Bi-variate and Multivariate data, Scatter diagram and simple correlation, Multiple and partial correlations, Regression analysis, Fitting of mathematical curves. Factor analysis, Principal component analysis,	7
Unit-IV: Sampling distribution and Test of Significance	Parameter and statistics; Sampling distribution, Standard error and its uses; Concept of t- distribution, F-distributions, Chi Square distribution without derivation and their applications; Null hypothesis and uses of t- test, F-test, X^2-tests; Test of significance of large samples	7
Unit-V: Analysis of Variance	Different types of models used in AOV; Basic assumptions and its violation; One and two way classified data; Application of AOV to environmental data	6
Unit-VI: Theory of Attributes	Definition and classification of Attributes, Contingency Table, Independence of attributes, Yule's coefficient of association and its properties	5
Unit-VII: Time series analysis	Components of time series, Models, measurement of trend, seasonal movements, cyclical movements	6

Recommended Books

1. Wayne R. Ott (1994): Environmental Statistics and Data Analysis, Lewis Publishers
2. Vic Barnett (2005): Environmental Statistics: Methods and Applications, John Wiley & Sons Ltd.
3. S. C. Gupta and V. K. Kapoor (2007): Fundamentals of Mathematical Statistics; S. Chand & Co.
4. Aslam Mahmood (1998): Statistical Methods in Geographical Studies; Rajesh Publications, New Delhi
5. J.Medhi (1992): Statistical Methods : An Introductory Text : New Age International Ltd. Publishers

EVS 2023: Environmental Remote Sensing and GIS Applications

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Introduction	Concepts and physics of remote sensing, effects of atmosphere, Principle of scanner and CCD array, Spectral reflectance of earth's surface features; spectral characteristics of surface features (rocks, soils, vegetations, water); Applications of Remote Sensing in environmental monitoring.	7
Unit-II: Thermal remote sensing	Basic principles, Radiation laws, Sensing radiant energy, Thermal sensors, characteristics of image and their uses.	6
Unit-III: Microwave remote sensing	Basic definitions and principles, RADAR, SLAR, SAR; General characteristics, spectral resolution and interpretation.	7

Unit-IV: Areal Photography and Digital Image Processing	Fundamentals of photogrammetry, areal cameras, planning of areal photography, principle of stereo-photography, parallax and measurement of height & slope, Elements of image interpretation, convergence and evidence, interpretation keys; Interpretation of photographs and images for environmental analysis Principles, Image rectification, Image enhancement and mosaicing. Image classification; Ground truth data and training set manipulation, Classification accuracy assessment.	7
Unit-V: Geographical Information System (GIS*)*	Basic principles, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography	6
Unit-VI: Land Surveying Techniques	Elementary ideas regarding land surveying and leveling; Principle and uses of Plane Table, Dumpy level, Theodolite and Total station; Global Positioning System (GPS) - Basic principles, Applications to environmental studies	6
Unit-VII: Integration of Remote Sensing data with GIS technology	Methods of Spatial Data Input- Keyboard entry, Digitizing, Electronic data transfer; Entering Non-Spatial Data; Errors in GIS Database; GIS data management system (DBMS)	6

Recommended Books

1. J. R. Jensen (2007): Remote Sensing of the Environment – An earth resource perspective; Pearson Education
2. Martin (2003): Geographic Information Systems; Routledge
3. Heywood (2010): An Introduction to GIS; Pearson
4. Yadav (1997): Remote S sensing in Land Evaluation; Rajesh Pub
5. Essentials of GPS (2004): N. K. Agarwal; Spatial Networks Pvt. Ltd., Hyderabad

EVS 2033: Environmental Pollution – Monitoring and Control Technologies

45 classes 3 credits Total marks: 50

Unit	Contents	Lect
Unit-I: Introduction	Definition and sources of pollution; Different types of pollution and their global, regional and local aspects	3
Unit-II: Air Pollution	Types and sources of air pollutants; Reactions of pollutants (smog, O_3, PAN, Acid rain); Atmospheric diffusion and stack performance; Transport of pollutants, Dispersion models; Effects of air pollutants on flora and fauna*;* Sinks of atmospheric gases: Firework pollution – composition/ingredients, monitoring strategies, Effect of air pollution on human health. Air pollution control technologies - Particulates filters, Scrubbers and electrostatic precipitators; Vehicular Pollution and its control	8
Unit-III: Water Pollution	Sources of water and their contamination; Types of pollutants, Sources of pollutants – domestic wastes, organic debris, agricultural wastes, pesticides; Industrial effluents - pulp and paper mills, oil exploration and refinery,	7

	petrochemicals, iron and steel industries; Eutrophication – causes and effects and control measures. Effect of water pollution on human health.	
Unit-IV: Soil pollution	Causes of soil pollution; Types of pesticides; Effects of pesticides on soil components and soil organisms; residual toxicity and pollution. Different kinds of synthetic fertilizer (N, P, K) - their toxicity and interactions with different components of soil.	7
Unit-V: Radiation Pollution	Radiation Pollution :Radioactive decay; Interaction of radiation with matter; Biological impact and health hazards associated with radiation, Units of radioactivity and radiation dose; Protection against ionizing isotopes and their applications in waste water and air pollution analysis and treatment; Radioactive waste disposal.	7
Unit-VI: Noise Pollution	Noise Pollution :Basic properties of sound waves – plane and spherical waves, sound pressure, loudness and intensity levels, decibel; Sources of Noise Pollution –Measurement and analysis of sound, Effects of Noise pollution on Human health; Measures to control noise pollution - Absorbing materials, barrier materials, damping materials, acoustical enclosures, Reactive silencers and filters; Active noise control methods.	7
Unit-VII: Thermal and Oil pollution	Thermal pollution: Definition and sources, Chemical and biological effects of thermal pollution, Effect on marine life, bacteria and water quality and other aquatic biota; Thermal pollution from power plants and their control. Oil pollution and marine ecology, sources of oil pollution, factors effecting fate of oil after spillage, spreading, evaporation, emulsification, dispersion, remote sensing in water quality monitoring.	6

Recommended Books

1. Marquita K. Hill (2004): Understanding Environmental Pollution: A Primer; Cambridge University Press
2. P AarneVesilindJ. Jeffrey PeirceRuth F. Weiner (1990): Environmental Pollution and Control, 8th Edition; Butterworth-Heinemann
3. H. Koren (1980): Handbook of Environmental Health and Safety – principle and practices (Vol. I & II); Lewis Publishers
4. C.S. Rao (2018):Environmental Pollution Control Engineering; 3rd Edition; New Age International
5. Environmental Chemistry : B.K. Sharma, and H. Kaur

EVS 2043: Ecosystem Dynamics, Biodiversity and Conservation Biology

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect
Unit-I: Human impact and Ecosystems sustainability	Dynamic nature of ecosystems, Ecosystem services, Exploitation of ecosystem services, Human impact on forest ecosystem, grassland and aquatic ecosystems and their environmental consequences; Degradation and Sustainability of ecosystems, Management of ecosystems – forest, grassland and aquatic.	6

Unit-II: Population growth and regulation	Population growth - growth curves, life curves, age structure, function and equilibrium; Population regulation – biotic potential and environmental resistances; Factors of population regulation – density dependent and density independent; Concept of limiting factors, Laws of limiting factors – laws of minimum and tolerance; Combined concept of limiting factors; Earth's carrying capacity; Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predatism; Competition – intra-specific and inter-specific,	7
Unit-III: Human population growth and environmental issues	Human population growth – global and regional; Changes in life expectancy; Problems of population growth, Controlling of human population growth Human food requirements, Food production - Green Revolution and its environmental significance (Food chain losses; effects of pesticides on non-target organisms, effects on predator, pollution)	7
Unit-IV: Biodiversity & Biogeography	Concept, definitions and values of biodiversity, Various components of Biodiversity value (Total Economic Value, etc), Genetic, species and ecosystem diversity; Values of bio-resources - social, ethical and aesthetic; Bio diversity hot spots, Bio-geographical concepts, dispersal and faunal exchange, barriers, mode of dispersal, origins and radiation; Applied biogeography - biogeographical process, endemism, refugium; bio-geographical realms and provinces, Phyto-geographical regions of world, Phyto-geographical regions of India; Origin of India's flora & fauna and routes of faunal exchange & migration.	7
Unit-V: Threats to Biodiversity	Biodiversity at global, regional and local levels. Monitoring & measurement of biodiversity; useful indices. Threats like overexploitation, fragmentation, habitat loss, poaching of wildlife, man-wildlife conflicts, natural calamities, effect of degeneration of biodiversity on future of evolution.	6
Unit-VI: Conservation of Wild Flora and Fauna	Endangered and endemic species; Threatened species; Categories of IUCN, Threatened species of plants and animals in Northeast India, Red data books; Strategies for conservation, Global agreements and national concerns, RAMSAR sites, CBD, Quarantine regulations, National forest policy, Biodiversity act., Wild-life protection act of India; Conservation of national parks and sanctuaries; Plant conservation issues and strategies	6
Unit-VII:: *In-Situ* and *Ex-situ* Conservation	Concept and practice; Importance of Conservation; Keystone species, Umbrella species and Flagship species; *in-situ* and *ex-situ* conservation, Protected areas –its classification and characteristics (wildlife sanctuaries, National Parks, Biosphere reserves, Zoo etc); Conservation of plant diversity in seed banks, gene banks or germplasm reserves, cryopreservation; Projects related to conservation of different wild life species (Project Tiger, Project Rhino etc), Marine protected areas	6

Recommended Books

1. W. S. C. Gurney and R. M. Nisbet (1998): Ecological Dynamics, Oxford University Press
2. F. Jopp, H. Reuter, B. Breckling (2011): Modelling Complex Ecological Dynamics - An Introduction into Ecological Modelling, Springer

3. Krishnamurthy (2004): An advanced textbook on Biodiversity: Principles and Practice, Oxford & IHB Publishing Co.
4. K. V. Krishnamurthy (2017): Textbook of Biodiversity, CRC Press LLC
5. Fred Van Dyke (2008): Conservation Biology: Foundations, Concepts, Applications. Springer
6. Navjot S. Sodhi, Paul R. Ehrlich (2010): Conservation Biology for All. Oxford Univ. Press
7. Martha J. Groom, Gary K. Meffe and C. Ronald Carroll (2012): Principles of Conservation Biology, Sinauer

EVS 2053: Environmental Health and Eco-toxicology

45 classes **3 credits** **Total marks: 50**

Unit-I: Overview of Environmental Health and Diseases	Concept and scope; Global and regional perspectives; Basic requirements for healthy environment; Environmental quality, human exposure and health impact – impact of environmental factors on human health. Environmental Diseases – Asbastosis, Silicosis, Asthma, Fluorosis and Arsenocosis	6
Unit-II: Industrial Pollution and Chemical Safety	Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents	6
Unit-III: Occupational Safety and Health	The relationship of occupational hygiene/ safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and heavy metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health.	6
Unit-IV: Eco-toxicology and Toxicants	Introduction to ecotoxicology, Principles of toxicology, Types of toxic substances - degradable and non-degradable; Influence of different factors on the effects of toxicity, Exposure types, Exposure pattern, Dose, Interaction within chemicals Toxicants in the Environment, their sources and entry roots; Transport of toxicants by air and water; Environmental Fate Models, Transport through food chain - bio-accumulation and bio-magnification	7
Unit-V: Man and Environmental Toxins	Routes of toxicants to human body – entry through inhalation, skin absorption, indigestion and injection; Absorption and Translocation of Toxic agents, Fate of the Toxic agent after Absorption, Accumulation of the toxic agent in Biological systems, Response to toxin exposures –Dose response Curve; Lethal and sub-lethal doses; Dose-Response relationships between chemical and biological reactions. Analysis of NOEL, LD 50, LC 50 and MLD; Biotransformation of Toxic Agents-Stage I and Stage II Reactions, Detoxification in human body - detoxification mechanisms, organs of	7

	detoxification	
Unit-VI: Environment and Vector borne Diseases	Different kinds of Vectors, Habitat of vectors, Environmental parameters affecting growth and development of vectors, Control technique of vectors population; Vector borne diseases - Malaria, Kalaazar; Dengue, Japanese Encephalitis, Epidemiological issues	5
Unit-VII: Environmental Health Hazard and Risk Assessment	Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management, Bioconcentration Factor, Numericals related to Chronic Daily Intake, Exposure Risk and Margin of Safety, Therapeutic Margin, Selective toxicity	5

Recommended Books

1. D. W Moeller and D. W Moeller (2009): Environmental Health, (3rd Edition), Harvard University Press
2. Friis (2018): Essentials of Environmental Health, Jones & Bartlett Learning
3. H. Koren and M. S. Bisesi (2002): Handbook of Environmental Health, 4thEdn. (Vol. I & II), Taylor & Francis
4. I. C. Shaw and J. Chadwick (1998): Principles of Environmental Toxicology; Taylor& Francis ltd
5. Ming-Ho Yu, H. Tsunoda and M. Tsunoda (2016): Environmental Toxicology: Biological and Health Effects of Pollutants (3rdedn), CRC Press
6. L. G. Cockerham, B. S. Shane (1993): Basic Environmental Toxicology. CRC Press
7. Monroe T. Morgan and D. B. Barnett (2003): Environmental Health; Thomson/Wadsworth

EVS 2063: Energy and Environment

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Introduction	Human energy requirement, Energy use pattern in different parts of the world and its impact on the environment; Energy use pattern in India; Sources of energy and their classification; Energy forms and transformation Sun as source of energy: Source of sun's energy, Solar spectrum, solar radiation – absorption, reflection, scattering and diffusion in the atmosphere, Albedo, Global energy balance	7
Unit-II: Fossil Fuels	Fossil fuels – classification, composition, physicochemical characteristics; Energy content of coal, petroleum and natural gas;Formation, reserves, exploration/ mining and uses of Coal, Oil and Natural gas; Environmental problems associated with exploration/mining, processing, transportation and uses	7
Unit-III:	Biomass composition and types; Conversion processes – pyrolysis,	7

Bio-energy	charcoal production, compression, gasification and liquefaction; Energy plantation; Biogas – production and uses, anaerobic digestion; Environmental constrains; Energy from solid Wastes - Sources, types, energy production	
Unit-IV: Solar and Wind Energy	Solar Energy - Harnessing of solar energy, Solar collectors and concentrators, Solar thermal energy, Solar electricity generation, Solar heaters, dryers, and cookers; Photovoltaics Wind Energy - Wind power, Harnessing of wind energy, Power generation – wind mills, concentrators, wind characteristics and siting, environmental considerations; Wind energy potential in India with special reference to Northeast India	7
Unit-V: Nuclear energy	Fission and fusion, Nuclear fuels, – Mining and processing of Uranium – concentration, refining, enrichment, fuel fabrication and fuel cycle; Nuclear reactors and radioactive waste; Environmental implications	7
Unit-VI: Hydroelectricity	Principles of generation of hydroelectric power, hazard related to hydropower generation and distribution, environmental impact	5
Unit-VII: Geothermal and Hydrothermal energy	Sources – crust, high temperature aquifers, low temperature aquifers, reserves; Harnessing of geothermal energy – problems and prospect; Geothermal energy prospect in India Hydrothermal energy; Tidal and wave energy, Problems and prospects	5

Recommended Books

1 R. Toossi (2009): Energy and the Environment: Sources, Technologies, and Impacts; VarVe Publishers

2 M. André and Z. Samaras (Ed) (2016): Energy and Environment, ISTE, Limited

3 V. C. Nelson (2011): Introduction to Renewable Energy, CRC Press

4 R. Ehrlich (2013): Renewable Energy: A First Course; CRC Press

5 D. Mukherjee (2004): Fundamentals of Renewable Energy Systems, New Age

6 S. K. Agarwal (2003): Nuclear Energy – Principles, practice and prospects; APH Publishing Corporation

7 V S. Mahajan (2005): National Energy – policy, crisis and growth; Ashis Publishing House

EVS 2072: Practical – III: Remote sensing &GIS

2 credits Total marks: 40

1. Numerical problems on the aerial photographs: Determination of photo scale; determination of number of Strips and total number of aerial, photographs; Preparation of photo index.
2. Stereo test; Orientation of stereopair under mirror stereoscope; Use of parallax bar and the determination of heights and slopes; Preparation of base map.
3. Interpretation of Satellite Imageries: Referencing and lay out of satellite images; Identification of objects/features on multi-band imageries and FCC; Interpretation of physical and cultural features from IRS imagery;
4. Experiments related to image processing

5. Pattern Recognition and Image Classification: Unsupervised classification; Training sets and supervised classification
6. Data Base Creation: Spatial data input and Geo-referencing; Spatial data base creation; Creation of non-spatial data sets into DBF format; Linking of Spatial data with non-Spatial data sets and map composition.
7. Spatial Analysis: GIS analysis: Proximity, Thematic mapping and Over lay; 3D Modelling: DEM, Slope and Aspect Overlay, buffer and proximity analysis; Output and report generation;
8. Global Positioning System: Demonstration on GPS; Selection of datum, units and scale; GPS measurement: Collection of GCPs; Mobile mapping; Transfer of GPS data into GIS software.

EVS 2082: Practical – IV: Pollution, Ecosystem & Toxicology

2 credits Total marks: 40

(a) Experiments based on Environmental pollution

1. Measurement of noise in silent, industrial, residential and commercial zones.
2. Determination of (i) SPM in ambient air by high volume sampler and their analysis
3. Determination of DO, BOD and COD
4. Analysis of SO_2, NO_X, by wet chemistry method
5. Estimations of fluorides and iron in ground water
6. Extraction of heavy metals from biological materials

(b) Experiments based on Ecosystem dynamics

1. Forest ecosystem studies: vegetation mapping, estimation of primary production
2. Aquatic ecosystem: surveying and mapping, determination of some physico-chemical characteristics, studies related to aquatic microphytes, estimation of primary production and respiration of phytoplankton population, studies related to aquatic macrophytes
3. Grassland studies: estimation of frequency, density, bio-mass, coverage and important value index (IVI)

(c) Experiment related to Eco-toxicology (any four expt.)

1. Extraction and separation of organic compounds from biological materials Ammonium sulphate method (Nichols method), TCA method, Acid digestion method, Wet washing for metals, Steam distillation for volatiles
2. Experiments related to data reduction, data representation, cumulative and noncumulative dose response curves, transformation of data
3. Construction of a dose-response curve for the effect of a toxic substance (pesticide/insecticide) on the germination of seeds
4. Estimation of hazard quotient
5. Determination of Cancer Risk (CR) Assessment in a given population
6. Short term acute toxicity testing using fish species

EVS 2092: Practical – IV: Summer Internship/Field Work

(Minimum 10 days) 2 credits Total marks: 20

THIRD SEMESTER

(15 weeks, 90 working days)

Average contact hours per week = 28 hours

EVS 3013: Environmental Biotechnology and Microbiology

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Environmental Biotechnology	Introduction, concept and scope of environmental Biotechnology; concept of Genetic manipulation, restriction endonuclease, introduction of cloned gene into new host using plasmid and phase vector system; Polymerase Chain Reaction (PCR); Recombinant DNA technology	6
Unit-II: Environmental Microbiology	Fundamentals of Microbiology, Classification of Microorganisms, Microbes in Terrestrial, aquatic & natural environment, Extreme environments; Types of Interaction: Microbes-microbes, Interaction between micro-organisms and plants, Plant- microbes, microbe-animal interaction, Role of micro-organism in elemental cycles- the carbon cycle, nitrogen cycle, sulfur cycle and phosphorus cycle	7
Unit III: Application of Environmental Biotechnology	Application of Environmental Biotechnology in pollution abatement –microbial degradation of pesticides; Sewage treatment using microbial system; - Bio-filtration, Bio-tickling filtration; Microbes in oil pollution control.	6
Unit-IV: Bioremediation and Phytoremediation	Bioremediation – Introduction to Bioremediation; advantages and applications; types of Bioremediation: Natural (attenuation) ; Ex-situ and In-situ; Bio-augmentation and bio-stimulation; Bio-scrubbers ; Bio-venting; Bio-reactions; Role of microbes in biodegradation	6
Unit V: Microbes in Wastewater Treatment	Microbiology of waste water treatment- activated sludge processes; trickling filters; waste stabilization ponds; sludge processing; Anaerobic digestion of waste water and Bio-solids; Hydrolytic bacteria, Fermentative, acidogenic bacteria, Methanogens; Factors controlling anaerobic digestions	7
Unit VI: Eco-friendly technologies-	Fermentation technology; Enzyme technology; Vermiculture; Tissue culture; Biofuel Technology and biogas technology.	6
Unit-VII: Agriculture and Food microbiology	Agricultural and food microbiology; Microbes in agriculture; Mycorrhiza, Nitrogen fixing microbes; microbes in rhizosphere and Endosphere, Plant pathogens; Bio fertilizers; Bio pesticides. Food microbiology- Microbes in food, food production and food spoilage- fish and meat, food poisoning. Preservation of food, Genetically modified crops (GMO) with special reference to Bt cotton, Bt brinjal	7

Recommended Books

1. Microbiology by R.P Singh
2. Environmental microbiology by Maier, Pepper and Gerba
3. Microbiology-Fundamentals and application by S. S Purohit
4. Environmental and applied microbiology by K. C Agarwal
5. Hand book of environmental microbiology by S. C Bhatia
6. Hand book of Environmental Biotechnology by S. C Bhatia (Vol I, II, III)
7. Advances in Environmental Biotechnology by A. K Srivastav
8. Bio technology by Keshav Tehran

EVS 3023: Eco-hydrology and Watershed Management

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Introduction	Hydrologic cycle and hydrologic budget, Inventory of Earth's water, Global Water Balance; Drainage basin – characteristics, Surface and subsurface environment; Stream classification and ordering	5
Unit-II: Precipitation	Mechanism, forms and types of precipitation; measurement of precipitation - rain gauge, radar, satellite; analysis; presentation and interpretation of precipitation data – areal distribution, temporal variation, estimation of areal average; Precipitation characteristics in India – seasonality, areal distribution and trend; precipitation characteristics of Northeast India	6
Unit-III: Water Abstractions	Different process of water abstraction in a basin**;** Evaporation and evapo-transpiration - Mechanism, Factors affecting evaporation and transpiration, Measurement of evaporation and evapo-transpiration; estimation of evapo-transpiration; Infiltration and percolation - Infiltration capacity of soil, Factors influencing infiltration capacity, methods of determining infiltration capacity	7
Unit-IV: Runoff and Stream flow	Factors affecting runoff – climatic & physiographic; stream flow measurement – stage and discharge, measuring instruments; Stage-discharge relationship - rating curves and their determination; Stream flow hydrograph – elements, analysis, flow separation; Unit hydrograph – concept, assumption, construction, limitations and uses	7
Unit-V: Ground water	Definition – soil moisture, Water table, Aquifers; Geology of aquifers; Ground water flow; Abstraction of ground water; Environmental influences on ground water - fluctuations due to evapo-transpiration, fluctuations due to meteorological phenomena, urbanization: Ground water recharging and rain water harvesting	6

Unit-VI: Hydrological forecasting and Watershed management	Frequency analysis; Cyclical nature of hydrological phenomena Watershed management-Concept, objectives, planning and measures; Land use planning for watershed management; Water harvesting and recycling; flood control and watershed management; Socioeconomic aspects of watershed management	7
Unit-VII: Wetland and Forest hydrology	Wetlands – definition and classification, Hydrologic regimes – reduction of flash flood, storage of water, role in ground water recharge; Role of forests in ground water recharge, soil conservation and flood moderation	7

Recommended Books

1. Elementary hydrology: V. P. Singh,
2. Hydrology – Principles, analysis and design: H. M. Raghunath,
3. Elements of water resource engineering: K. N. Duggal and J. P. Soni,
4. Applied Hydrology: Chow
5. Integrated watershed management: Rajora
6. River Basin Morphology: Devi
7. Applied Hydrology-Murtreja
8. Engineering Hydrology: K. Subramanya
9. Elementary Engineering Hydrology: M. J. Deodhar
10. Engineering Hydrology-C.S.P. Ojha, R. Berndtsson and P. Bhuyan
11. Integrated Watershed Management: E. Beheim, G.S.Rajwar, M.J.Haigh and J. Krecek

EVS 3036: Natural Resource Management and Sustainable Development *(Open/In-house)*

90 classes **6 credits** **Total marks: 100**

Unit	Contents	Lect
Unit-I: Introduction	Introduction to natural resources-Air, Water, Soil, Mineral resources, Forests and Energy resources; Classification of natural resources; Concept of reserve and resources; Factors influencing resource availability; Resource distribution-in India and NE India.	12
Unit-II: Water resource and its management	Brief about water resource management-Surface and Groundwater (Global, National and Regional perspectives); Water scarcity and the related problems; Water conflicts-case studies; Different water management techniques-modern and traditional; Indigenous Water management techniques in NE India (Dong, Zabo, Bamboo drip irrigation); Interlinking of Rivers and their consequences	15
Unit-III: Mineral resource and its management	Use and exploitation of mineral resources; Environmental effects of extracting and using mineral resources-case studies; Resource conflicts-resource extraction, access and control system; Approaches in resource management-ecological approach, economic approach and ethnological approach; Integrated resource management strategies; Mineral resources of NE India and the associated environmental issues and management strategies.	12
Unit-IV: Forest resource	Forest types and their characteristics; Status and distribution of forests-National and regional scenario; Timber extraction, mining,	13

and its management	dams and their effects on forest and indigenous people; Traditional and modern forest management strategies; Joint forest management	
Unit-V: Sustainable Development	Concept and growth of the idea; Agenda 21; Millennium Development Goals (MDG) &Sustainable Development Goals (SDG); Indicators of sustainability; Models of sustainable development; Basic aspect of sustainability; Practices towards sustainable development; Sustainable development scenario-Global and national	13
Unit-VI: Life Cycle Assessment	Evolution of Life Cycle Analysis (LCA); Technical framework for LCA; Life cycle design; Life cycle inventory and methodology-case studies; Gadgil-Joshi Model;	12
Unit-VII: Sustainable livelihood and national resource management	Concept and scope of livelihood; livelihood framework analysis; Indigenous communities and traditional livelihood; Impacts of natural resource crisis on the livelihood of the people	13

Recommended Books

1. Sustainable natural resource management in North east India: K.C.Das, P.J.Das and S.Ojha
2. Dying Wisdom- A.Agarwal and S.Narain
3. Environmental management and Sustainable Agriculture: M.A.Khan
4. Environmental Conservation-promises and actions: A.Ghosh
5. River Water sharing-Transboundary conflict and cooperation in India: N.S.Mohan; S.Routray and N.Sashukumar
6. Integrated management of water resources with reference to biodiversity and livelihood: S.N.Dwivedi, P.Tamot and A.M.Yasin
7. Environmental Economics: N. Hanley, J.F.Shogram and B.White
8. Mining Geology: Arogyaswamy

EVS 3043: Environmental Hazards and their Mitigation (Elective-I)

45 classes **3 credits** **Total marks: 50**

Unit	**Contents**	**Lect**
Unit-I: Environmental hazards& their mitigation	Definition - Hazard, vulnerability and risk; Natural and man-made hazards, Strategies for mitigation – warning system, forecasting, Emergency Preparedness, Education and Training Activities, planning for Rescue and Relief works Identification of hazard prone belts, Hazard zonation and Risk assessment, Developing warning system, Risk assessment and reduction in vulnerable areas.	6
Unit-II: Seismic Hazards	Origin and severity of earthquakes, effects of earthquakes, risk evaluation, seismic hazards and its zonation in India, Coping with seismic hazards; Tsunami – their origin, nature and impact on coastal areas; Tidal waves;	7
Unit-III:	Definition - Floods, Floodplains and Flood-Prone Areas;	7

Flood hazard and its management	Causes, nature and frequency of flooding; urbanization and flooding; Flood Hazard Assessment - environmental effects of flooding, Flood prone areas of India and associated hazards, flood mitigation and management, Floods in NE India; Flood hazard management in NE – Structural and Non-structural Measures	
Unit-IV: Meteorological Hazards	Desertification and Drought – Causes of desertification; Evaluation of desertification hazard – potential and zoning: Drought -causes, types, distribution and management Cyclones: Cyclones – their nature and genesis; Nor'westers; Weather associated with cyclones;	6
Unit – V Landslide Hazards	Slope instability and Landslide hazard: Causes - destabilizing forces; mass movement types; human use and landslides; landslide hazard zonation, strength of materials and instability of slopes, subsidence and swelling of ground, landslides in NE India	7
Unit-VI: Man-made Hazards	Hazards due to dams and reservoirs, hazards due to nuclear power plant; Industrial hazards, Occupational hazards; Mitigation measures for man-made hazards	5
Unit-VII: Climate Change and Environmental hazards	Observed climate variability and change- Evidences of warming and change in atmosphere/ ocean circulations; Climate extremes,-thunderstorms, Tornadoes, Heat waves, Rise of global temperature, Rise of sea level, Melting of glaciers	7

Recommended Books

1. Floods – A geographical perspective: R. Ward
2. Natural Hazards – Local, National, Global: G. F. White
3. Handbook of Applied Hydrology: V.T. Chow
4. Satellite Remote Sensing Technology for Natural Hazards Preparedness and Emergency Response Planning: G. Morgan
5. Elementary seismology: C. F. Richter
6. Geodynamics ofNortheastern India and the adjoining region: D. R. Nandy
7. Introduction to Seismology: P. M. Shearer
8. Principles of Seismology: A. Udias
9. Fundamentals of Geophysics: W. Lowrie
10. Environmental geo-hazards (Vol. I & II): K. K. Sharma, S. K. Bandooni and V. S. Negi
11. Environmental Hazards: S. N. Prasad

EVS 3053: Disaster Risk Reduction &Management (Elective -II)

45 classes **3 credits** **Total marks: 50**

Unit	**Content**	**Lect**
Unit-I: Understanding Disasters	Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks); Disasters: Classification, Causes & Impacts; Differential impacts- in terms of caste, class, gender, age, location, disability. Global trends in disasters: urban disasters, pandemics,	7

	complex emergencies; Climate change and occurrence of disasters	
Unit II: Methods & Approaches to Disaster Risk reduction:	Disaster cycle - its analysis, Phases; Community based Disaster Risk Reduction (DRR); Structural/non-structural measures, roles and responsibilities of-community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), states, Centre, and other stake-holders.	6
Unit –III: Application of Science & Technology in Disaster Management	Geo-informatics in Disaster Management (RS, GIS, GPS); Disaster Communication System (Early Warning and Its Dissemination); Disaster Safe Designs and Constructions; Role of science& technology Institutions for Disaster Management in India	6
Unit –IV : Environment and Disaster	Environment, ecosystem and disasters; Industrial hazards and safety measures; Post disaster impact on environment; Impact of developmental projects on disaster risk; Aspects of environmental management for disaster risk reduction; Environmental Impact Assessment (EIA).	6
Unit V: Emerging approaches in Disaster Management	Three stages: Pre-disaster Stage (preparedness), Emergency Stage, Post Disaster stage - Rehabilitation	6
Unit VI: Inter-relationship between Disasters and Development	Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.; Relevance of indigenous knowledge, appropriate technology and local resources.	7
Unit VII: Disaster Risk Management in India	Hazard and Vulnerability profile of India; Institutional arrangements (Mitigation, Response and preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation) NAMA guidelines for Disaster Management.	7

Recommended Books

1. Disaster mitigation-experiences and reflections: P. Sahni, A. Dhameja and U. Medury
2. Environmental changes and natural disaster: R. K. Yadav and R. Singh
3. Extreme events-a physical recronstruction and risk assessment: J. Nott
4. Disaster management strategies: V. Deolankar
5. Disaster management and economic development: G. P. Kapoor
6. Handbook of environmental disaster and management: T. S. Nath
7. Disaster management: V. K. Sharma
8. Management of man-made disaster: S. L. Goel

EVS 3063: Industrial Pollution Control and Waste Management (Elective-I)

45 classes **3 credits** **Total marks: 50**

Unit	Content	Lect
Unit I: Introduction	Types and characteristics of industrial wastes; Principles of industrial waste treatment; Pollution of biosphere; hydrosphere, atmosphere & geosphere due to industrial wastes and emissions	6
Unit II: Treatment and Disposal of Industrial Wastes	Treatment of wastes containing organic and inorganic impurities; Classification of effluent treatment methods – mechanical, physico-chemical, biological, thermal methods; Specific treatment methods- equalization and neutralization tank, removal of oil and grease; Case studies-Coal mining and Acid Mine Drainage (AMD),Paper & pulp industries.	7
Unit III: Industrial Wastewater Treatment Technologies	Industrial wastewater treatment processes: selection procedure for physical, chemical and biological methods of industrial wastewater treatment; Concept of CETPs; Concept of zero discharge-Case studies- Oil Refinery, Paper & Pulp industry	7
Unit IV: Air Pollution Control Technologies	Gravity settling chambers, Cyclone Separator, Wet Scrubbers, Fabric filters, Electrostatic precipitators: design and operation; Control devices for gaseous pollutants; Case study- Cement Industry, Coal mining industry Vehicular Pollution Control; Combustion Cycle, Fuel/air ratio and Catalytic convertor; selective catalytic and selective non-catalytic reduction Indoor air pollution and its control	7
Unit V: Noise Pollution Control Technologies	Control of noise at source and protection of exposed person; Sound absorbent, Anti-noise device; Industrial noise control -acoustic quieting	6
Unit VI: Industrial Pollution: Case Studies from NE India	Cement Industry, Paper and Pulp Industry, Oil Explorations and Refineries, Tea Industry, Uranium Mining, Coal Mining, Limestone mining, Stone quarrying.	6
Unit VII: Waste Management and Reclamation	Concept of 3Rs- Reduce, Recycle, Reuse; Waste minimization by reuse and recovery. Waste minimization by recovery and external sale of products, case studies-Landmark episodes, Preventive and Control measures.	6

Recommended Books

1. Industrial pollution and management: A. Kumar
2. Physico-chemical examination of water, sewage and industrial effluents: N. Manivasakam
3. Environmental Chemistry: B. K. Sharma

4. Environmental Chemistry: S. E. Manahan
5. Pollution management in industries: R. K. Trivedi
6. Environmental management in petroleum industry: Wahi, Agnihotri and Sharma
7. Heavy metals and environment: M. Athar and S. B. Vohora
8. Environmental engineering: G. N. Pandey and G. C. Carney

EVS 3073: Municipal Water Supply and Wastewater Treatment (Elective -II)
45 classes 3 credits Total marks: 50

Unit	Content	Lect
Unit I: Introduction	Water supply scheme: Importance & necessity of water supply scheme; Types of water demands; Self-purification of waste in streams; zones of purification; eutrophication; disposal standards and philosophy of Minimal National Standards (MINAS); Status of water supply and sanitation sector	5
Unit II: Municipal water supply and sanitation	Components of water supply schemes; water treatment flow-sheet; estimation of sewage quantity and characteristics; discharge variation; sewage treatment plant flow-sheet; components of water distribution and sewerage systems	5
Unit III: Water treatment Systems	Aeration and types of aerators; purpose and mechanism of flocculation; coagulation, sedimentation, filtration; Chemical and non-chemical methods of disinfection; Chick's law; tertiary treatment methods	8
Unit IV: Wastewater fundamentals	Wastewater characteristics; Physical characteristics; inorganic constituents; organic constituents; non-metallic constituents; metallic constituents; Biological characteristics; wastewater sources.	7
Unit V: Municipal Wastewater (Sewage) treatment	Physical treatment methods: screen chamber; grit separators; primary and secondary settling tanks. Biological treatment: Biology of sewage treatment; types of biological treatment processes; process description and design principals; removal of nitrogen and phosphorus. Sludge stabilization and dewatering systems; Low cost sewage treatment technologies- septic tanks; reed bed; oxidation ponds and lagoons	8
Unit VI: Waste water disinfection processes	Characteristics of ideal disinfectant; Disinfection method; Mechanism of disinfectants; Factors influencing action of disinfectants; Disinfection with-Chlorine dioxide, ozone and UV-radiation; De-chlorination.	7
Unit VII: Waste water reclamation and reuse	Terms used in water use application; Water reclamation criteria; Issues in water reuse; Public health and environmental issues; Water reclamation technologies	5

Recommended Books

1. Wastewater Engineering-Treatment and Reuse: Metcalf and Eddy
2. Water and Wastewater: K. Gopal
3. Urban Storm water management: Novopny
4. Wastewater microbiology: D. H. Bergey
5. Wastewater treatment: M. N. Rao and A. K. Dutta
6. Chemistry of the Environment: Beiley, Clark, Ferris, Strong and Krause
7. Urban water management: M. S. Rathore and V. R. Reddy
8. Sewage disposal and air pollution engineering: S. K. Garg

EVS 3082: Practical V (Environmental Biotechnology & Microbiology) (Any 6) (2 Credits)

1. Microscopy: Light microscopy – principles, parts and functions (demonstration)
2. Preparation of microbial media
3. Basic Sterilization techniques
4. Experiments related to aero-microbiology
5. Preparation of Agar media
6. Sampling of microbes in water, air and soil: Microscopic examination of pure and mixed microbial cultures and serial dilution and spread plating of mixed microbial cultures
7. Streak plating, microscopy and gram staining techniques
8. Microscopic measurements: micrometer, haemocytometer
9. Handling of liquid cultures and monitoring microbial growth phases via spectrophotometry
10. Microscopic study of phytoplanktons and zooplanktons
11. Tissue culture: preparatory steps for tissue culture, callus culture and cell suspension
12. Determination of portability of water using MPN methods; presumptive and confirmatory tests for coliforms

EVS-3092- Practical VI (Eco-hydrology & Watershed Management) (2 Credits)

1. Drainage Basin Morphometry.
2. Estimation of annual average precipitation/volume of precipitation by using *isohyetal method*
3. Estimation of annual average precipitation/volume of precipitation by using *Thiessen method*
4. Water balance study
5. Measurement and analysis of meteorological data
6. Estimation of design discharge (10yrs, 50yrs and 100yrs) of a river by using *Log Pearson Type III method*
7. Determination of Return period for flood frequency analysis using *Gumbel's distribution method*
8. Measurement and estimation of flow using *area-velocity method*
9. Estimation of evaporation and evapo-transpiration
10. Hyetograph and hydrograph analysis
11. Construction of unit hydrograph
12. Flow separation from discharge hydrograph of given sample data

FOURTH SEMESTER

(15 weeks, 90 working days)

Average contact hours per week = 28 hours

EVS 4013: Environmental Impact Assessment

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Introduction	Concept of environment and environmental Impact, Nexus between development and environment, origin and development of EIA, Measurement of impact – physical, social - economical, natural; Concept of significant effect; Short term versus long term effect; relationship of EIA to sustainable development; EIA Notification 1994 and 2006, Environmental Clearance (EC), Authorities involved in granting EC at State and Central Government Levels.	7
Unit II: Framework of EIA	Description of environmental setting; Environmental impact factors and area consideration, Prediction and assessment of impact on air, water, noise and biological environment; Prediction and assessment of impact on the cultural and socio-economic environment; Methods of impact analysis; Public participation in environmental decision making, Integration and Optimization criteria for Multipurpose Development Projects	7
Unit-III: Impact Assessment Methodologies	Evaluation of proposed actions and determination of impact importance, EIA methodologies; Comparison of alternatives and decision making; Compensatory actions - green belts; Preparation and writing of EIA/EIS; Review of procedures, practices and guidelines for EIA in India; Examples of total impact evaluation. Role of GIS in EIA - Base line study; risk assessment, risk management, mitigation measures, comparison of alternatives.	7
Unit-IV: Air and Water quality impact analysis	Typical considerations and factors; Pollution sources, atmosphere interactions; Air pollution effects; Air quality Modelling; Legal aspects; Assessment methodology; Mitigation procedures; Case studies – Highway and Power Plants. Water quality criteria and standards, Environmental setting; Water quality impact by project type; Water quality Modelling	6
Unit-V: Noise and Energy Impact Analysis	Nature of sound, Environmental noise problem, sound power and sound intensity; Decibels and levels, sound propagation and attenuation; Effect of noise on people; Noise scale and rating methods, estimating transportation noise impact, examples of impact assessment. Importance of energy impact analysis; Energy inventory, supply demand scenario; Energy conservation; Energy alternatives.	6
Unit-VI: Vegetation and Wild Life Impact Analysis	Biological concepts and terms; Assessment topics, mitigation measures, alternatives, assessment methodologies; Example of biotic assessment	6
Unit-VII:	Types of socioeconomic impact, basic steps in SIA, Analysis of public	6

Socioeconomic Impact Analysis	services and facilities impacts; Fiscal impact analysis; Analysis of social impacts; Impacts of economic profile of the community.	

Recommended Books

1. Environmental Impact Analysis Handbook: J. G. Rau and D. C. Wooten; McGraw-Hill Book Co.
2. Environmental Impact Assessment, L. W. Canter, Mc Graw Hill Publication,
3. Methods of Environmental Impact Assessment: P. Morris & R. Therivel; UCL Press
4. Environmental Impact Assessment (2003): A. K. Srivastav; A P H Publishing Corporation
5. Introduction to Environmental Impact Assessment: Glasson; Research Press
6. Environmental Impact Assessment, Prof P.R Trevedi
7. Environmental Impact Assessment, Berthwal

EVS 4023: Environmental Law and Management

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit-I: Environmental laws in India	Legal, administrative and constitutional provisions for environmental protection in India; Statutory protection of the Human Environment - Factories Act, Motor Vehicle Act, Hazardous Waste legislation for pollution abatement; Acts related to Pollution - The Water Act- 1974; The Air Act -1981; The Environment Protection Act, 1986; Wildlife Protection Act, 1972, The Forest Conservation Act, 1980, Coastal Regulation Act, National Green Tribunal.	7
Unit-II: International Environmental Laws	Evolution and development of International Environmental laws with reference to Stockholm Conference, Nairobi Declaration, Rio Conference, Rio+5 and the Rio+10, etc. Global environmental issues and International laws: to control Global warming, Ozone depletion, Acid rains, hazardous waste; Role of UN authorities in protection of Global Environment, Montreal Protocol ,Vienna Convention, Ramsar Convention	7
Unit-III: Environmental Management	Concept and scope, Environment management Systems (EMS) and approaches, Standards - international and national; Ecomark; Green funding and taxes, Trade and environmental management; Corporate Social Responsibility (CSR)	6
Unit-IV: Environmental Audit	Definition of Environmental audit, Objectives, Advantages, Audit Methodologies, Five Steps Audit Approach, Environmental Audit Scenario in India, International scenario of EA	6
Unit-V: Environmental standards	The ISO 14000 and ISO 14001 standards, Management product design for the environment (ISO 14062); Eco-labelling, ecological and carbon footprints (ISO 14064-	7

	65)–Case study	
Unit VI: Urban Environmental Management	Urban Environment, Urban Sprawl, Pollution and waste management associated with urban growth, Sustainable Urban Development: water supply, waste disposal, urban agriculture, transport, energy, Urban-rural linkages	6
Unit-VII: Management of Solid Wastes	Different types of solid wastes, Methods of disposal and management of Municipal solid wastes; Bio-medical wastes and Hazardous wastes; Recycling of wastes and waste minimization techniques, Solid waste Management scenario in NE India. Solid Waste management Scenario-global and National	6

Recommended Books:

1. Eccleston, C. H. (2011): Environmental Impact Assessment. Taylor & Francis
2. Sustainable development (Vol. I & II): N. L. Gupta and K. K. Gurjar (ed); Rawat Publications
3. Environmental management: G. N. Pandey; Vikash Publishing House
4. Environmental management: H. M. Saxena; Rawat Publications
5. Environmental Law and Policy in India: S. Divan & A. Rosencranz; Oxford University Press
6. Environmental Management – Physio-ecological facets (Vol. I & II): Rai, Mohapatra&Goel (ed); Rawat Publications
7. Environmental Management in India Vol. I & II): R. K. Sapru; Ashish Publishing House
8. Urbanization and its Environmental Impact: B S Irya and S A. Abassi
9. Environmental Legislations in India: K R. Gupta

EVS 4033: Climate Change and Global Environment *(Open/In-house)*

90 classes **6 credits** **Total marks: 100**

Unit	**Contents**	**Lec**t.
Unit-I: Climate and Weather	Weather and climate change, Geological time scale, ice ages, human influences on climate change. Internal forcing mechanisms and external forcing mechanisms, The Milankovitch Cycle theory, Solar Variation	12
Unit-II: Greenhouse gases and Global warming	Radiative forcing and GHGs-Definition, concept and processes; Forcing –response relationship, Radiative forcing by tropospheric ozone, Radiative forcing of tropospheric Aerosols; Enhanced greenhouse gas effect; Global warming; Effects and causes of global warming	15
Unit-III: Physical evidences of climate change	Major events: Oceanic Anoxic Events, Holocene climatic optimum, Paleocene–Eocene Thermal Maximum, Tree ring analysis, Polar ice, Isotopes, Ice melting and Ice core analysis, glaciers and arctic sea loss Sea level changes and Shore line changes and temperature changes	14

Unit-IV: Human ecology of climate change	Anthropogenic activities responsible for climate change: Source activities: Burning of fossil fuel, Industrial activity, Urbanization, Agriculture, transportation, waste generation, Removals of Sinks; Rapid changes in Land use and Land cover; Climate change and food security	14
Unit –V: Climate Change Vulnerabilities	Vulnerabilities of different ecological and social systems; issues for developing countries; tipping points in the Earth System	10
Unit –VI: Climate Change Adaptation	Indicators of adaptation; Connections between adaptation and mitigation: trade-offs and mal-adaptation. Consequences of adaptation strategies. Case studies from NE India.	13
Unit-VII: International & National response to climate change	IPCC -UNEP,WMO, IPCC bureau, Task Groups, UNFCC-The convention, Sites and Platforms, Kyoto Protocol, Paris agreement, 2020 ambition, Talanoa, Documents and decisions; National and local government responses: NAPCC, SCAAP	12

Recommended Books:

1. Global Warming and Climate Changes (Vol I, II, III): GBhargav
2. Climate change and Environmental Science: S.C Bhatia
3. Climatology: A Awasthi
4. Physical climatology - Critchfield
5. Climate Change: An Asian Perspective: S Singh and M. Kumar
6. Global warming and Climate Change: S K Agarwal
7. Weather and Climate Modelling: SV Singh, S Basu and T N. Krishnamurti
8. Climate change and Environment: J Sundaresan et al
9. Climate Change and International Policies: N Gaan

EVS 4043: Seismology and Seismic hazards in NE India (Elective-III)

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit I Introduction to Seismology & Earthquake Hazards	History of Earthquakes; Causes of Earthquakes: Types of Plate Boundaries; Elastic Rebound theory; Continental Drift and Plate Tectonics; Major Subduction zones in the world; Major Spreading zones in the world Major Thrust Faults in the world; Major Strike Slip Faults in the world; Uncertain/Diffuse Boundaries in the World Types of Earthquake/Seismic Hazards; List of Major Historic Earthquakes in the World; Large and Damaging Earthquakes of India	7
Unit II:	Overview of Plate Tectonics; Types of faults; Activity	7

Earthquake sources, magnitude and waves	and fault Studies; Earthquake source mechanisms; Source models. Concept of Seismic magnitude and Intensity, earthquake size, different magnitude scales and relations. Theory of wave propagation; Seismic waves, body and surface waves	
Unit III: Earthquake Instrumentation and Recording	Earthquake recording instrumentations; concept of seismograph, Seismic station; Interpretation of Seismic Records –acceleration, velocity and displacement; Frequency and Time Domain parameters; Response Spectra and Spectral parameters; Epicenter and magnitude determination;	6
Unit IV: Seismic Zonation	Introduction to Seismic zones and codes, Global and National seismic hazard assessment mapping programs; Safety of Individual Site; Concept of Seismic Micro-zonation: Need for Micro-zonation, Types and Scale, Methodology	6
Unit V: Seismic Hazard Analysis	Introduction to seismic hazard analysis; methods; Deterministic and probabilistic; Attenuation models	5
Unit VI: Earthquake in NE India	Seismic environment of NE India; Major faults and seismo-tectonic zones; Eastern Himalayan Collison zone, Indo-Myanmar Subduction zone; Syntaxis zone, Shillong Plateau, Mikir Hills and Assam Valley Zone, Tripura-Mizoram Fold Belt; Status of seismicity in NE India – major earthquake- Shillong Earthquake 1897, Assam Earthquake 1950; Seismic Gaps; Earthquake Disaster Mitigation & Management in NE India	8
Unit VII: Application of Geo-informatics in seismic hazard studies	Geo-informatics in earthquake mitigation, RS and GIS application for post-quake rehabilitation, GIS database for previous earthquakes, geospatial information system for earthquake disaster management, mapping tectonic lineaments.	6

Recommended Books:

1. Natural Hazards – Local, National, Global (1974): G. F. White (ed), Oxford University Press
2. Satellite Remote Sensing Technology for Natural Hazards Preparedness and Emergency Response
3. Planning (1989): G. Morgan, World Bank, Environment Operation and Strategy Division, World Bank
4. Elementary seismology (1969): C. F. Richter; Eurasia Publishing House Pvt. Ltd.

5. Geodynamics of Northeastern India and the adjoining region (2001): D. R. Nandy; acb Publications,Kolkata
6. Introduction to Seismology (1999): P. M. Shearer; Cambridge University Press
7. Principles of Seismology (1999): A. Udias; Cambridge University Press
8. Fundamentals of Geophysics: William Lowrie
9. Environmental Geoscience - Interaction Between Natural Systems and Man (1973): A. N. Strahler and A.H. Strahler; Santa Barbara, California: Hamilton Publishing
10. Environmental Geology (1987): K. S. Valdiya; Tata McGraw-Hill
11. Keith Smith and Petley David, 2008. Environmental Hazards:Assessing Risk and Reducing Disaster, Routledge
12. Showalter, Pamela S. and Lu, Yongmei, 2010. Geospatial Techniques in Urban Hazards and Disaster Analysis. Springer.
13. NDMA, 2004. Disaster Management in India, A Status Report, National Disaster Management Division, Ministry of Home Affairs, India
14. NRSC, 2009. Manual for National Geomorphological and Lineament Mapping on 1:50,000 scale.
15. Burbank D.W., and Anderson, R.S. 2001. Tectonic Geomorphology

EVS 4053: Flood Hydrology and Flood Hazards of NE India (Elective - IV)

45 classes **3 credits** **Total marks: 50**

Unit	Contents	Lect.
Unit I River Mechanics	River Equilibrium: Stability Of Channel –Regime Relations –River Bend Equilibrium –Hydraulic Geometry of Downstream -Bars and Meandering - River Dynamics –Degradation and Aggradations of River Bed –Confluences And Branches	6
Unit II Hydrologic System and Statistical Analysis	Hydrologic Cycle –System Concept –Hydrologic System Model –Classification of Hydrologic Models – Statistical, Stochastic And Deterministic Approaches – Statistical Characteristics of Hydrological Data –	7
Unit III Flood Estimation	Hydrologic Extremes –Flood–Types Of Flood –Effects Of Flood –Design Flood -SPF/MPF -Estimation Of Design Flood –Physical Indicators -Envelope Curves - Empirical Methods –Rational Method -Statistical Methods –Frequency Analysis –Unit Hydrograph Method	7
Unit IV River Training & Regulation	River Training Works and River Regulation Works – Objectives, Classification, Methods; Flood Plain Management –Waves and Tides in Estuaries -Interlinking of Rivers –River Stabilization	6
Unit V	Flood Control Methods – Classification, Structural and Non-Structural Measures; Design Flood and its	6

Flood Control Methods	estimation; Flood Control reservoirs; Flood Plain Management ; Flood Plain Zoning; Benefits of flood control; National Policy on Floods	
Unit VI Flood Forecasting& Warning	Fundamental considerations in flood forecasting and warning systems – definitions, meteorological considerations, hydrological considerations, dissemination of forecast and warnings, institutional aspects; Data Requirements; Overview of methods and models; Monitoring Network; Real time data transmission and management; Role of GIS in forecasting and warning systems	7
Unit VII Flood Modelling	Remote Sensing and GIS for Flood Modelling and Management; Flood Models, Flood Modelling: Flood Peak Estimation and Flood Routing Overview of Flood Models, Hydrologic Analysis: Flood Risk Analysis: Flood Frequency Analysis, Depth Duration And Risk Analysis	6

Recommended Books:

1. Floods – A geographical perspective (1978): Roy Ward; The Macmillan Press Ltd
2. Natural Hazards – Local, National, Global (1974): G. F. White (ed), Oxford University Press
3. Handbook of Applied Hydrology (1964): V.T. Chow, (New York: McGraw-Hill,
4. Satellite Remote Sensing Technology for Natural Hazards Preparedness and Emergency Response
5. Planning (1989): G. Morgan, World Bank, Environment Operation and Strategy Division, World Bank
6. Elementary hydrology (1994): V. P. Singh, Prentice-Hall of India
7. Hydrology – Principles, analysis and design (1996): H. M. Raghunath, New Age International Publisher
8. Elements of water resource engineering (1996): K. N. Duggal and J. P. Soni, New Age Intel. Pub.
9. Natural Hazards – Local, National, Global: G. F. White (ed), Oxford University Press
10. Handbook of Applied Hydrology (1964): V.T. Chow, (New York: McGraw-Hill,
11. Environmental Geoscience - Interaction Between Natural Systems and Man (1973): A. N. Strahler and A.H. Strahler; Santa Barbara, California: Hamilton Publishing
12. Environmental Geology (1987): K. S. Valdiya; Tata McGraw-Hill
13. Manual on Flood Forecasting and Warning- World Meteorological Organisation, WMO-1072; 2011 edition (web material)

EVS 4063: Solid and Hazardous Waste Management (Elective-III)

45 classes **3 credits** **Total marks: 50**

Units	Contents	Lect
Unit-I: Solid Waste Management	Waste Stream Assessment (WSA), Waste characterization: Physical and chemical, Factors affecting waste quantity and quality, Major legislations, Monitoring responsibilities, Sampling & characterization, Composition of MSW, Health and Environmental effects of Solid waste pollution.	7
Unit-II: Collection & Transport of Solid Waste	Collection of solid wastes, Types of solid wastes collection systems, Alternative Techniques for collection systems, Collection & Transformation of solid wastes, Transport means and methods, Transfer stations types & design.	6
Unit III: Source Reduction, Product Recovery and Recycling	Source Reduction Basics, Purpose, Significance of Recycling, Recycling Programme Elements : Source separation, Storage and collection of recyclables, Collection vehicles for recycling, Processing equipments for recycling Material recovery facilities (MRF's) , Commonly Recycled Materials and Processes : Paper and cardboard, Glass, Metals, Plastic	6
Unit IV: Disposal of SW	Sanitary landfill -planning, Site selection, Design and operation, Landfill Processes, landfill Gas emissions, Aerobic landfill stabilization, Biological oxidation, Composting, Vermicomposting, Pyrolysis, Incineration & Energy Recovery,	6
Unit-V: Hazardous waste Management	Definition & identification of Hazardous Wastes, Sources & Characteristics of hazardous wastes, Hazardous waste in municipal waste, Hazardous Waste Treatment technologies, Physical, chemical & thermal methods of stabilizations, Solidification, Chemical Fixation & encapsulation, Incineration of Hazardous waste landfills, Reclamation of Hazardous waste landfill sites.;	
Unit-VI: Biomedical Waste	Classification, segregation and colour coding-coding for storage containers; Disinfection/ sterilization, autoclaving, microwave treatment and incineration; Disposal methods;	6
Unit VII: Waste Reclamation	Physical, Chemical and Biological reclamation; Reclamation of hazardous waste landfill sites; Reclamation planning: Physical reclamation: re-contouring, terracing, slope preparation, segregation and burial of toxic substance, reclamation alternatives, reclamation equipment, scheduling and costs.	7

Recommended Books:

1. Handbook of Solid Waste Management: G Tchbanoglons and F. Kreith
2. Solid and hazardous Waste management: S C Bhatia
3. Environmental Science: S C Santra
4. Environmental Science: R T Wright
5. Hazardous Waste Management: S Malhotra
6. Environmental Science and Engineering: J G Henry and G W Heinke
7. Environmental Engineering: H S Peavy, D R Rowe and G Tchobanoglaons

EVS 4073: Green Chemistry (Elective- IV)

45 classes **3 credits** **Total marks: 50**

Unit	Content	Lect
Unit I: Basics of Green Chemistry	Green Chemistry – Definition – Principles & Concepts of Green Chemistry; Historical Context; Limitations; Public Policy	6
Unit II: Green Chemistry and Catalysis	Basics oforgano-metallic chemistry and Catalysis; Oxidations & Reductions; C-C bond formation; Phase Transfer Catalysis; Hydroformylation; Carbonylation; Metathesis; Heterogeneous Catalysis	7
Unit III: Environmentally Benign Solutions	Industrial use of green solvents; Ionic liquids, Fluorous solvents, Supercritical CO_2, VOC's	6
Unit IV: Sustainable Polymers	Polyactide, Uses of biofuels (Ethanol, Biodiesel, Fuel Cells); Plastics from Plant oils; Lignin based products; Synthesis and properties of 2-Methyltetrahydrofuran	6
Unit V: Green Chemistry Using Bio Catalytic Reactions	Introduction - Fermentation and Bio-transformations - Production of Bulk and fine chemicals by microbial fermentation-Antibiotics – Vitamins – Bio-catalytic synthesis of industrial chemicals- Future Tends.	6
Unit VI: Nanotechnology in Green Chemistry	Basic concepts of Nanoscience and Nanotechnology; Classification of Nanomaterials; Properties and Application of Nanomaterials.; Bio-inspired Green Nanomaterials –Risks and safe nanotechnology	7
Unit VII: Green Chemistry In Agriculture & Renewable Resources	Alternative feed stocks**,** Agrochemicals, Plantorigin Insecticides, Fungicides, Biocides; Renewable resources Biomass; Energy from Biomass; Other forms of renewable energy-Fuel Cells, Solar Power; Bio refinery chemicals from fatty acids; Polymer from Renewable Resources	7

Recommended Books:

1. New Trends in Green Chemistry: V K Ahuwalia and M Kidwa
2. Environmental Chemistry with Green Chemistry: Asim K Das
3. Green Chemistry: S Rastogi and L Jha
4. Chemistry for Green Environment: Rastogi and Jha

EVS 4083: Project **100 marks /6 credits**

Each student has to submit a dissertation based on his/her research project selected in the third semester through paper EVS 3102. The research shall be carried out under the guidance of faculty members as decided by the DAC. The dissertation shall be evaluated by both internal and external examiners as per university rules and this shall carry 75 marks. The students shall appear for a Viva-voce examination before a panel constituted as per university rules and this shall carry 25 marks. Thus the project work shall carry in total 100 marks equivalent to 6 credits.