Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **First**
d. Course Name: **Introduction to Environmental Science**
e. Existing Base Syllabus: **Class XII Science**
f. Course level: **100-199**
g. Syllabus:

Unit	Contents
Unit I: Introduction	Concept, scope and interdisciplinary nature of Environmental Science; The Global environment and its segments; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere; Weather and climate, environmental significance; Major climatic zones of the world and India Environmental Ethics, constitutional provisions for environmental protection in India
Unit II: Environmental Earth-science-I	Concept and Scope of Earth Sciences; Rock types – igneous, metamorphic and sedimentary, Landforms: Types and development; Soil and its formation; Plate-tectonics, Concept of folds and faults; Mass-wasting; Erosion, Transportation and deposition of earth's materials by running water, wind and glaciers; Erosion –types, causes and consequences; Gully formation; Glaciers, Mass balance, Recession of Himalayan glacier
Unit III: Ecology and Environmental Biology-I	Ecosystems – concept, types, structural and functional aspects; Dynamic nature of ecosystems: Energy flow in ecosystems, Models of Energy flow, Productivity of an ecosystem, food chains, food web, trophic levels, Ecological pyramids – pyramids of numbers, pyramids of biomass, pyramids of energy; Ecological Succession Biodiversity: Concept, definitions and values; Bio diversity hot spots; Origin of India's flora & fauna Biogeochemical cycle; Microbes in air, water and soil environment; Environment and Health
Unit IV: Environmental Chemistry	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, oxidation and reduction, Chemical Kinetics, Thermodynamics, Chemical properties of composition of water, soil and atmosphere and their environmental significance; concept of green chemistry

Unit-V: Global Environmental Issues and movements	Green House effect and Global warming, Ozone layer depletion; Acid rain, Deforestation and loss of bio-diversity Climate change and climate change adaptation Environmental movements (national and international)- Chipko, Apikko, Narmada Bachao Andolan, Tehri Dam conflict;Save Ganga movement; Mega Dams in NE India and its Consequences; International conferences and agreement on environment, Concept of sustainable development, MDGs & SDGs

h. Reading list:

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 Miller (1997): Environmental Science (6thed), Wadsworth Pub. Co.
7 Eugene Odum (2004): Fundamentals of Ecology
8 S. E. Manahan (2005): Environmental Chemistry (8th), CRC Press
9 B.K. Sharma (2007): Environmental Chemistry, Goel Publishing House, Meerut, India
10 James E. Girard (2013): Principles of Environmental Chemistry, Jones &Bartlett
11 Keller (2012): Introduction to Environmental Geology, 5th Edition; Pearson
12 K. S. Valdiya (1987): Environmental Geology; Tata McGraw-Hill
13 Krishnamurthy (2004): An advanced textbook on Biodiversity: Principles and Practice, Oxford & IHB Publishing Co.
14 12. K. V. Krishnamurthy (2017): Textbook of Biodiversity, CRC Press LLC

i. Graduate Attributes

I. Course Objective: The course objective is to develop an understanding of the basic concepts of environmental sciences so that the learner can scientifically and objectively evaluate the environmental phenomenon, issues and problems both at local and global level. This will also enable the learner to reflect critically on their own roles and responsibilities as citizens, consumers and environmental actors within a complex interconnected world.

II. Learning Outcome: Understanding the concepts and methods of environmental sciences and their application in environmental problem solving.

- Appreciate the Earth science issues and the links between human and natural systems.
- Understanding the various types of ecosystem and their structure and composition. It will enable them to appreciate the structure and functioning of the overall biosphere
- Understand the basic chemical concepts that are required to further explain the composition and properties of natural water, soil and air and be able to appreciate

the various pathways of chemical elements and compounds that cause pollution of these environmental compartments.

- Appreciate the various global environmental issues including climate change and the various national and global movements associated with environmental conservation.

j. Theory Credit: **3**
k. Practical Credit:**1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes:**15**
o. Particulars of Course Designer :

- Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Second**
d. Course Name: **Foundation in Environmental Science**
e. Existing Base Syllabus: **Class XII Science**
f. Course level: **100-199**
g. Syllabus:

Unit	**Contents**
Unit I: Environmental Earth-science-II	Measurement of weather parameters, variations in weather parameters, data analysis and interpretation, Extreme weather conditions; Climatic controls, Climatic extremes - environmental implications Atmospheric Processes: Global distribution of solar energy, Heat balance of the earth- atmosphere system, Earth as a heat engine; Fundamentals of Meteorology Atmospheric thermodynamics – equation of state of dry and moist air, specific heats and application of laws of thermodynamics, thermodynamic process; Climate classification and climate of different land-use Determining factors of climate, Effects of topography,
Unit II: Ecology and Environmental Biology-II	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. Definition and concept of community, Characteristics of community, Composition, origin and Development of a community, Community structure, dominance, stratification; Community interdependence, Ecotone, Edge effect and Ecological Niche, Ecological habitat. Introduction and principles of ecotoxicology, Types of toxic substances; Environmental Diseases-Water, Soil & Air related
Unit III: Environmental Chemistry II	Chemistry of Environmental Trace Elements (e.g F, Pb, As, Hg, Cd etc.), chemical speciation & Fractionation; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, oxygen and ozone chemistry; Catalytic decomposition; process of ozone,

	Water and Air quality monitoring parameters – physical, chemical and biological; Physico-chemical properties of soil – texture, bulk density, permeability; cation exchange capacity, pH, macro- and micro-nutrients
Unit IV: Environmental Statistics and data analysis	Environmental Variables, Environmental data collection and presentations; Parameter and statistics; Basic Statistics - frequency distribution, Measures of Central Tendency and Dispersion, Moments, Skewness and Kurtosis, Population, sample and census, Different techniques of sampling – simple random sampling, stratified random sampling, systematic sampling; Relative advantages and disadvantages of different techniques; Scatter diagram and simple correlation, Concept of Regression.
Unit-V: Energy and Environment	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; Global energy balance; Fossil fuels; Bio-energy; Solar and Wind Energy; Nuclear energy, Geothermal and Hydrothermal energy

h. Reading list:

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 Miller (1997): Environmental Science (6thed), Wadsworth Pub. Co.
7 Eugene Odum (2004): Fundamentals of Ecology
8 S. E. Manahan (2005): Environmental Chemistry (8th), CRC Press
9 B.K. Sharma (2007): Environmental Chemistry, Goel Publishing House, Meerut, India
10 James E. Girard (2013): Principles of Environmental Chemistry, Jones &Bartlett
11 Keller (2012): Introduction to Environmental Geology, 5th Edition; Pearson
12 K. S. Valdiya (1987): Environmental Geology; Tata McGraw-Hill

i. Graduate Attributes

I. Course Objective: The course objective is to develop an understanding of the basic concepts of environmental sciences so that the learner can scientifically and objectively evaluate the environmental phenomenon, issues and problems both at local and global level. This will also enable the learner to reflect critically on their own roles and responsibilities as citizens, consumers and environmental actors within a complex interconnected world.

II. Learning Outcome: This course will enable the students to

- Understand the basic concepts related to meteorology including differentiating between weather and climate and describing the atmospheric processes
- Understanding the various types of ecosystem and their structure and composition. It will enable them to appreciate the structure and functioning of the overall biosphere
- Understand the chemical composition and properties of natural water, soil and air and be able to appreciate the various pathways of chemical elements and compounds that cause pollution of these environmental compartments.
- The students will get a brief overview of the pollution monitoring methods
- Understand the basic concepts of application of statistical theories and methods in environmental analyses
- Appreciate the various forms and sources of energy used across the world and the environmental implications of their extraction and

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes:**15**
o. Particulars of Course Designer :
    - Prof.(retd) H.P.Sarma, Department of Environmental Science, GU, hpsarma1957@gmail.com, 9864045328
    - Prof(retd) Dulal C Goswami, Department of Environmental Science, GU, dulal.goswami4@gmail.com, 9435199258

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Third**
d. Course Name: **Intermediate Environmental Science**
e. Existing Base Syllabus: **Core Papers 1 and 2 of Environmental Science**
f. Course level: **200-299**
g. Syllabus:

Unit	**Contents**
Unit I: Environmental Earth-science-III	General circulation and wind systems; Cyclones and anticyclones; Air masses - source, modification and classification; Fronts and weather systems; Monsoons, El-Nino, La-Nina, ENSO; Scales in meteorology. variation of air temperature, humidity and wind; Climate of India and NE India; Earth's Geodynamic Processes: Concept of foliation, lineation, drag folds, cleavage and joints and faults; Major Subduction and Spreading zones in the world; Formation of tectonic earthquakes; Environmental changes due to Earthquakes, Volcanoes and Tsunami. Hydrologic cycle and hydrologic budget; Inventory of Earth's water; Drainage basin; Watershed management – Concept, objectives, planning and measures
Unit II: Ecology and Environmental Biology-III	Population growth - growth curves, life curves, age structure, function and equilibrium; Population regulation; Factors of population regulation Concept of limiting factors, Laws of limiting factors; Combined concept of limiting factors; Species Interactions (positive and negative); Earth's carrying capacity; Bio geochemical cycles: Oxygen cycle, Carbon cycle Carbon source and Sink, carbon flux, Ocean-Atmosphere exchange, Nitrogen cycle, Sulphur cycle, phosphorous cycle Vector borne diseases - Different kinds of Vectors, Habitat of vectors, Environmental parameters affecting growth and development of vectors; Study of Diseases: Asbestosis, Silicosis Arsenicosis, Fluorosis, Asthma, Allergy, Malaria, Japanese Encephalitis, Filariasis, Itai-Itai

Unit III: Environmental Chemistry III	Noise Pollution: Basic properties of sound waves – 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 Thermal pollution: causes, sources, effects and control measures. Oil pollution: Causes, sources, effects and control Radiation Pollution: Radioactive decay; Biological impact and health hazards associated with radiation, Units of radioactivity and radiation dose; Protection against ionizing isotopes Radioactive waste disposal.
Unit IV: Environmental Geo-informatics	Basic concept of Environmental Geoinformatics: Remote sensing – history & development, definition, concept and principles; Elements involved in remote sensing, electromagnetic spectrum, energy sources, energy interactions with earth surface features & atmosphere, atmospheric windows Remote Sensing Platforms and Sensors: Multispectral and Hyperspectral sensors, Satellite orbits, IRS satellites Introduction to GIS – definition, concept and history of developments in the field of GIS, GIS Components, GIS data types: Spatial (Raster and Vector) & Non-spatial, Definition and concepts, Types of maps, Map scale, Map and Globe, Co- ordinate systems, Map projections, Geo-referencing Application of GIS in Environmental Monitoring
Unit-V: Natural Hazards and Disaster Management	Definition - Hazard, vulnerability and risk; Resilience and Disaster, Types of Hazards-Natural and man-made hazards; Flood, Seismic hazards, Landslide, Erosion causes and consequences with special reference to NE India. Disaster cycle and Management. Strategies for mitigation – warning system, forecasting, Emergency Preparedness, Education and Training Activities, Planning for Rescue and Relief works

h. Reading list:

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 Miller (1997): Environmental Science (6thed), Wadsworth Pub. Co.
7 Eugene Odum (2004): Fundamentals of Ecology

8 S. E. Manahan (2005): Environmental Chemistry (8th), CRC Press
9 B.K. Sharma (2007): Environmental Chemistry, Goel Publishing House, Meerut, India
10 James E. Girard (2013): Principles of Environmental Chemistry, Jones &Bartlett
11 Keller (2012): Introduction to Environmental Geology, 5th Edition; Pearson
12 K. S. Valdiya (1987): Environmental Geology; Tata McGraw-Hill

i. Graduate Attributes

I. Course Objective: The course objective is to develop an understanding of the basic concepts of environmental sciences so that the learner can scientifically and objectively evaluate the environmental phenomenon, issues and problems both at local and global level. This will also enable the learner to reflect critically on their own roles and responsibilities as citizens, consumers and environmental actors within a complex interconnected world.

II. Learning Outcome: This course will enable the students to

- Understand the concepts related to meteorology including the atmospheric processes related to monsoon, climatic classifications and with special reference to NE India
- Understand the basic concepts of hydrological cycle and concepts related to watershed management
- Understanding the various ecological concepts related to population studies, biogeochemistry and environmental health issues
- Understand the concepts of noise, radiation and thermal pollution in the context of industrial growth and their monitoring methods
- Understand the basic concepts of geoinformatics and its application in environmental sciences
- Appreciate the various forms natural hazards occurring across the world and their environmental implications with special reference to NE India and the grasp the basic concepts in disaster management.

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes:**15**
o. Particulars of Course Designer :

- Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945
- Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234
- Prof(retd) Dulal C Goswami, Department of Environmental Science, GU, dulal.goswami4@gmail.com, 9435199258
- Prof (retd) S. Kalita, Department of Environmental Science, GU, skalita53@gmail.com, 9435148264

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fourth**
d. Course Name: **Forestry and Forest Management**
e. Existing Base Syllabus: **Class XII in Science**
f. Course level: **200-299**
g. Syllabus:

Unit	Contents
Unit I: Forest Ecology and Ethnobotany	Definition, basic concept and importance of forest ecology; Forest communities: Vegetation analysis, biomass, net primary productivity, litter fall, forest floor mass and nutrient cycling; physiology in stress environments (drought, water logging salinity and alkalinity); Definition and concept of Ethnobotany; Role of Ethnobotany in Indian Systems of Medicine; Ayurveda and Unani; Factors affecting action and toxicity of drug plants and their chemical constituents.
Unit II: Silviculture and Silvicultural systems	Definition, Concept & Importance of Silviculture; Types of Silvicultural systems; Silviculture of some economically important trees of India such as Teak, Eucalyptus and Tarmarid
Unit III: Forest Mensuration and Utilization	Forest Mensuration-Definition, Objectives of Measurement, Measurement of trees (Diameter or Girth, Height, Form & Volume)Units of Measurement and Instruments used Environmentally sound forest harvesting practices; logging and extraction techniques and principles, transportation system, storage and sale; Need and importance of wood seasoning and preservation; General principles of seasoning; Utilization of plantation wood; problems and possibilities
Unit-IV: Forest Management	Definition and scope, management of private forest vis-a-vis public forests, objects of management; Legislations related to forest management in India: Forest policies and Laws; Sustainable Forest management strategies
Unit V: Participatory Forest Management	Agroforestry: scope and necessity; Agro forestry systems under different agro-ecological zones; selection of species and role of multipurpose trees and NTFPs Social/Urban Forestry: objectives, scope and necessity; peoples participation. JFM - principles, objectives, methodology, scope, benefits and role of NGOs

	Tribology: Definition and concept; Tribal scene in India; cultural tradition, customs, ethos and participation in forestry programmes.

h. Reading list:
   1 Parthiban et al., (2016): Forestry- A Subjective Guide for IFS Aspirants
   2 Parthiban et al., (2015): Objective Forestry: For all competitive Examinations
   3 Prabhu and Manikandan (2021): Indian Forestry A Breakthrough Approach To Forest Service, 8th Edition
   4 Objective Silviculture And Agroforestry by Behera Suryakanta and Nalini Kumar Panda

i. Graduate Attributes
   I. Course Objective:
      - To teach students the science and skill of producing, maintaining, using, preserving, and restoring forests and related resources for human and environmental benefit.
      - The curriculum aims to teach students specialized topics such as Quantitative Techniques, Forest Mensuration, Management Information System, and Supply Chain Management, among others.

   II. Learning Outcome: This course will enable the students to
      - The course will demonstrate knowledge of forest ecology and silviculture principles to understand how forests and forested watersheds respond to natural disturbances or management activities. The students will also have a gist of the traditional/tribal methods of forest management.

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes:**15**
o. Particulars of Course Designer :
   - Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945
   - Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234
   - Prof. Partha Pratim Baruah; Dept. of Botany, Gauhati University; ppbaruah@gauhati.ac.in; 7896748848
   - Prof. Jogen Chandra Kalita; Dept. of Zoology, Gauhati University; jogenck@gauhati.ac.in; 9435083544

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fourth**
d. Course Name: **Energy and Environment**
e. Existing Base Syllabus: **Class XII in Science**
f. Course level: **200-299**
g. Syllabus:

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.
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
Unit-III: Bio-energy	Biomass composition and types; Conversion processes – pyrolysis, 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.
Unit-V: Nuclear energy, Geothermal and Hydrothermal energy	Fission and fusion, Nuclear fuels, – Mining and processing of Uranium – concentration, refining, enrichment, Nuclear reactors and radioactive waste; Environmental implications Harnessing of geothermal energy – problems and prospect; Geothermal energy prospect in India Hydrothermal energy; Tidal and wave energy, Problems and prospects.

h. Reading list:

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.

i. Graduate Attributes

I. Course Objective:

- Students will be able to explain the purpose of electrical energy, identify different forms of energy, and define, explain, and list forms of kinetic and potential energy. Facilitate economic integration and cooperation and promote sustainable development.
- Reduce energy and carbon intensities.
- Minimize the impact of the energy sector on the environment from source to use.
- Ensure that energy production, conversion and use is cost competitive.

II. Learning Outcome: This course will enable the students to

- Energy is essential to life and all living organisms. The sun, directly or indirectly, is the source of all the energy available on Earth. Our energy choices and decisions impact Earth's natural systems in ways we may not be aware of, so it is essential that we choose our energy sources carefully.

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes:**15**
o. Particulars of Course Designer :

- Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234
- Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945
- Prof (retd) S. Kalita, Department of Environmental Science, GU, skalita53@gmail.com, 9435148264
- Prof. Ajay Kalamdahd, Department of Civil Engineering. IIT Guwahati. kajay@iitg.ac.in , 9678621395

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fourth**
d. Course Name: **Environmental Sampling and Survey Techniques**
e. Existing Base Syllabus: **Core 1, Core 2 and Core 3 papers of Environmental Science**
f. Course level: **200-299**
g. Syllabus:

Unit	Content
Unit I: Introduction	Basics of sampling: Concept of sample survey and census, advantages of sample survey over census, errors in sample survey
Unit II: Sampling Methods	Sampling Methods and Environmental Sampling: General guideline, Sampling types, standard methods, sampling equipments, determination of sample size, environmental sampling of soil and water, sampling of air pollution parameters, biological sampling
Unit III: Understanding Survey	Understanding Sample Survey- definition, map scales, linear measurements, classifications, and various stages in a sample survey
Unit IV: Survey Instruments	Modern Surveying Instruments: Instruments used in modern Survey for the environment parameters, Types of curves- transition curve, vertical curve, map projections, classification of projections.
Unit V: Geoinformatics and survey	Remote Sensing Techniques: Introduction, basic principles in brief, Sensors, GIS and uses, GPS, Data model, photogrammetric surveying

h. Reading list:

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

i. Graduate Attributes

I. Course Objective:

- The paper attempts to teach the students about different methods and techniques of statistics which are relevant to environmental data analysis.

II. Learning Outcome:

- The students would learn how to handle and analyze environmental data sets for drawing statistical inference and decision making through this paper.

j. Theory Credit: **3**

k. Practical Credit: **1**

l. No. of Required Classes: **60**

m. No. of Contact Classes: **45**

n. No. of Non-Contact Classes:**15**

o. Particulars of Course Designer :

- Prof (retd) S. Kalita, Department of Environmental Science, GU, skalita53@gmail.com, 9435148264
- Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fourth**
d. Course Name: **Environmental Pollution: Monitoring and Control Technologies**
e. Existing Base Syllabus: **Class XII Chemistry**
f. Course level: **200-299**
g. Syllabus:

Unit	Contents
Unit-I: Introduction	Definition and sources of pollution; Different types of pollution and their global, regional and local aspects
Unit-II: Air Pollution	Types and sources of air pollutants; 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
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, petrochemicals, iron and steel industries; Eutrophication – causes and effects and control measures. Effect of water pollution on human health.
Unit-IV: Noise Pollution	Noise Pollution: Basic properties of sound waves – 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.
Unit-V: Thermal, Marine Pollution and Radioactive	Thermal pollution: Definition and sources, Chemical and biological effects of thermal pollution, 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. Radiation Pollution: Radioactive decay; Biological impact and health hazards associated with radiation, Units of radioactivity and radiation dose; Protection against ionizing isotopes Radioactive waste disposal.

h. Reading list:

1 **C.S. Rao (2018)** Environmental Pollution Control Engineering; 3rd Edition; New Age International
2 **H. Koren (1980)** Handbook of Environmental Health and Safety – principle and practices (Vol. I & II); Lewis Publishers

3 **Manahan, Stanley. E. (1997)** Environmental Science and Technology, Lewis Publication.
4 **Marquita K. Hill (2004)** Understanding Environmental Pollution: A Primer; Cambridge University Press
5 **P Aarne Vesilind J. Jeffrey, Peirce Ruth, F. Weiner (1990**) Environmental Pollution and Control, 8th Edition; Butterworth-Heinemann
6 **Maiti, S.K.,** Handbook of methods in Environmental Studies, Vol. I & II, ABD Publ.
7 **APHA (1984)** Standard Methods for examination of water and wastewater. American Public Health Association, 12th Ed.
8 **Trivedy, R.K., & Goel, P.K.,** Chemical & Biological Methods for Water Pollution Studies, Environmental Publ.

i. Graduate Attributes

I. Course Objective:

- This course is aimed at developing student knowledge & skills on environmental pollution control and management. The course is focused on the assessment & management of impacts of different types of pollution on human society and critical appraisal of environmental engineering approaches to manage risks and mitigate pollution.

II. Learning Outcome: On completion of the course the student is expected to be able to:

- Appreciate underlying processes that causes environmental pollution and the methods used to assess & manage risks of pollution on human society
- Critically evaluate environmental engineering-based systems of pollution monitoring, control & management
- Understand the various national and international systems and standards of environmental management including various pollution control legislation & policies

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes:**15**
o. Particulars of Course Designer :

- Prof.(retd) H.P.Sarma, Department of Environmental Science, GU, hpsarma1957@gmail.com, 9864045328
- Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fifth**
d. Course Name: **Analytical Methods for Environmental Monitoring**
e. Existing Base Syllabus: **Core 1, Core 2 and Core 3 papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Unit	Contents
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
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
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
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
Unit-V: HPLC, GCGC-MS, and IC	Principle, instrumentation and applicationsof Gas Chromatography and High-Performance Liquid Chromatography, Principle and applicationof Ion-chromatography, GC-MS

h. Reading list:

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

i. Graduate Attributes

I. Course Objective:
   - The course is designed to develop sampling and analytical skills of the students which are required in environmental monitoring
   - The students will be exposed to various standard protocols used in environmental monitoring
   - Understand the biomonitoring of the environment
   - Learn the sampling techniques and sample preservation
   - Determine the analytical techniques that are required to collect samples for a variety of contaminants/pollutants.

II. Learning Outcome:
   - Understand the basic terminologies related to environmental contaminations, monitoring, pollutants and ecosystems.
   - Apply environmental sampling techniques in practice for water, soil, sediment and air
   - Classify and categorize sources and types of pollution

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :
   - Prof.(retd) H.P.Sarma, Department of Environmental Science, GU, hpsarma1957@gmail.com, 9864045328
   - Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fifth**
d. Course Name: **Ecosystem Dynamics, Global Change & Ecological Restoration**
e. Existing Base Syllabus: **Core papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Unit	Contents
Unit-I: Ecosystem Dynamics-I	System-like properties of Ecosystem; Application of concept of Systems and System Models in population and ecosystem studies; System Stability and Change - Cause and Effect; Interactions among the living and non-living entities of ecosystem; complexity of interactions; Ecological energetics: Laws of Thermodynamics and their ecological significance; Flow of matter and energy through an ecosystem; hierarchy and integrative levels of organization; feedback loops and regulatory processes; Linear and Non-linear development of ecosystems
Unit II: Ecosystem Dynamics-II	Ecosystem Functions and Services; Ecosystem's resilience to change; Ecological Threshold; Productivity of ecosystems Role of humans in ecosystems; Human needs and biodiversity; Trade-offs between conservation and development goals; Concept of Social-ecological system(SES); Social-ecological systems framework and sustainability
Unit-III: Population Dynamics	Populations within ecosystems; Attributes of Populations; Interactions; Population regulation; Role of different species – role of ecosystem engineers, keystone species, and indicator species; Habitat Partitioning; Concept of Niche; role of species in shaping their ecosystems; Adaptation of species to their environments; Concept of population stability and change; Impact of the addition or loss of a species on an ecosystem; Models in population ecology: Structured and Unstructured models of population growth; Meta-population dynamics; Population Viability analysis; Competition and Predation models; Harvest models; Life history and Life history traits.
Unit-IV: Ecosystem and Global Change	Temporal Dynamics - Inter-annual versus long-term fluctuations in ecosystem processes; disturbance cycles and the successional process; Landscape Heterogeneity and Ecosystem Dynamics - Spatial variation in ecosystem patterns and processes; concepts of state-factors and interactive controls; patch dynamics on the landscape; movement of plants and animals; human land-use change;

	Consequences of human-alterations of global biogeochemical cycling
Unit-V: Ecological Restoration	Defining Ecological Restoration; Principles of ecosystem restoration – Guiding Principles and Ecological Principles; Reference ecosystems; Terrestrial - Wildlife Habitat Restoration, Species Reintroduction; Invasive species management; Aquatic Ecosystem Restoration – Streams and Wetlands; Fire and Forest Restoration; Revegetation; Bio-cultural approaches to Conservation and Restoration; Traditional Knowledge and Community Engagement in restoration; Methods and principles in Restoration planning.

h. Reading list:

1 **Folke, Carl, Thomas Hahn, Per Olsson, and Jon Norberg (2005)** ADAPTIVE GOVERNANCE OF SOCIAL-ECOLOGICAL SYSTEMS. Annual Review of Environment and Resources 30 (1): 441-473.

2 **Ostrom, Elinor. (2009)** A General Framework for Analyzing Sustainability of SocialEcological Systems. Science 325 (5939): 419-422.

3 **Epstein, Graham, et al.** "Missing ecology: integrating ecological perspectives with the social ecological system framework. International Journal of the Commons 7.2 (2013): 432-453

4 **Partelow, Stefan (2018)** A Review of the Social-Ecological Systems Framework: Applications, Methods, Modifications, and Challenges. Ecology and Society 23(4)

5 **Folke, C. (2016)**. Resilience (Republished). Ecology and Society 21(4):44. https://doi.org/10.5751/ES-09088-210444

6 **Schlesinger, W.H., E.S. Bernhardt (2013)**. Biogeochemistry: An Analysis of Global Change, Academic Press (Elsevier), San Diego, 3rd Edition, 688 pp

7 **D.A. Falk, M.A. Palmer and J.B. Zedler (2016)** Foundations of Restoration Ecology. SECOND EDITION. Island Press. N

i. Graduate Attributes

I. Course Objective:

- The course builds further on the students' knowledge and experiences from earlier courses in ecology and aims at conveying an independent and evidence-based working method for a future professional career and in research, with sustainable development as the overarching aim. The course focuses on how current ecological theory describes the interplay among organisms and their environment and how this knowledge can be applied to analyzing and solving ecological problems such as conservation of ecological communities, sustainable harvesting of populations and regulation of ecosystem processes. The main emphasis is on the dynamics of consumer-resource interactions and spatial processes and their influence on ecological, as well as evolutionary, processes at the population, community and ecosystem levels.

II. Learning Outcome: On completion of the course, the student should be able to -

- explain important ecological processes, principles and concepts, as well as evaluate and critically report on theories and scientific results in population, community and ecosystem ecology

- broadly explain structure and function of ecosystems and interactions between them from a systems perspective, and justify the use of systems approach as a basis for nature conservation, environmental protection and management
- construct and analyze population and ecosystem models with graphical and numerical methods
- explain and distinguish between different forms of anthropogenic influence on ecosystems
- independently plan, justify and carry out sampling and analysis for monitoring and evaluate the results
- Develop skill sets and perspectives that are necessary for application of 'resilience thinking' to contemporary resource management.

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :

- Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234
- Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945
- Prof. Partha Pratim Baruah; Dept. of Botany, Gauhati University; ppbaruah@gauhati.ac.in; 7896748848
- Prof. Jogen Chandra Kalita; Dept. of Zoology, Gauhati University; jogenck@gauhati.ac.in; 9435083544

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fifth**
d. Course Name: **Eco-hydrology and Watershed Management**
e. Existing Base Syllabus: **Class XII Science and Core papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Unit	Contents
Unit I: Introduction	Hydrologic cycle and hydrologic budget; Inventory of Earth's water; Global Water Balance Drainage basin – characteristics; Stream classification; Stream ordering: Horton & Strahler method Watershed management – Concept, objectives, planning and measures
Unit II: Precipitation	Mechanism, forms and types of precipitation; Measurement of precipitation - rain gauge, radar, satellite; Estimation of areal average precipitation; Precipitation characteristics in India –with special reference to Northeast India;
Unit III: Water Abstraction	Different process of water abstraction in a basin**;** Evaporation and evapotranspiration - Mechanism, Measurement & Factors affecting evaporation and transpiration; Infiltration and percolation - Infiltration capacity of soil, Factors influencing infiltration capacity; Methods of determining infiltration capacity
Unit IV: Runoff and Stream flow	Factors affecting runoff – climatic & physiographic; Stream flow measurement – stage and discharge; Stage-discharge relationship - rating curves and their determination; Stream flow hydrograph – elements, analysis, flow separation Unit hydrograph – concept, assumption, construction, limitations and uses
Unit-V: Ground water and Wetland Hydrology	Definition – soil moisture, Water table, Aquifers; Geology of aquifers; Environmental influences on ground water - fluctuations due to evapotranspiration, fluctuations due to meteorological phenomena, urbanization; Ground water recharging and rain water harvesting Wetlands – definition, classification & environmental significance

h. Reading list:

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

i. Graduate Attributes

I. Course Objective:

- 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.

II. Learning Outcome:

- Provide a background in the theory of hydrological processes and their measurement
- Apply science and engineering fundamentals to solve current problems and to anticipate, mitigate and prevent future problems in the area of water resources management
- The students would develop an ability to manipulate hydrological data and undertake widely-used data analysis
- The students can define the key components of a functioning groundwater, can determine the main aquifer properties – permeability, transmissivity and storage by identifying geological formations capable of storing and transporting groundwater
- The students would be able to apply different methods and importance of rain water harvesting

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :

- Prof(retd) Dulal C Goswami, Department of Environmental Science, GU, dulal.goswami4@gmail.com, 9435199258
- Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Fifth**
d. Course Name: **Environmental Health and Ecotoxicology**
e. Existing Base Syllabus: **Core papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Unit-I: Overview of Environmental Health and Diseases	Health and Diseases, Environmental factors and health, Public exposure to industrial pollution, Occupational Health Hazards, 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. Environmental Diseases – Asbestosis, Silicosis, Asthma, Fluorosis and Arsenicosis
Unit-II: 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
Unit-III: Man and Environmental Toxins	Routes of toxicants to human body – entrythrough 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 detoxification
Unit-IV: Environment and Vector borne	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

Diseases	Encephalitis,Covid 19.
Unit-V: Environmental Health Hazard and Risk Assessment	Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management, Bioconcentration Factor, Numerical related to Chronic Daily Intake, Exposure Risk and Margin of Safety, Therapeutic Margin, Selective toxicity

h. Reading list:

1 D. W Moeller and D. W Moeller (2009): Environmental Health, (3rd Edition), HarvardUniversity 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: Biologicaland 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

i. Graduate Attributes

I. Course Objective:

- The main objective of the course is to give the students knowledge and skills that allow an overall assessment of the fate of foreign chemicals in the environment and of their effects on biological system. Moreover, the conceptual framework introduced during the course in toxicology will be further developed and use in practical applications.

II. Learning Outcome: On completion of the course, the student should be able to:

- describe sources and fates of chemicals in the environment
- present and explain mechanisms for adverse effects of chemicals
- estimate the risk for adverse effects of a chemical on different biological systems based on knowledge about the toxicity, degradability, and bioavailability of the chemical
- able to conduct Risk assessment study for different toxicants in the environment

j. Theory Credit: **3**

k. Practical Credit: **1**

l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :

- Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234
- Prof(retd) Dulal C Goswami, Department of Environmental Science, GU, dulal.goswami4@gmail.com, 9435199258
- Prof (retd) S. Kalita, Department of Environmental Science, GU, skalita53@gmail.com, 9435148264

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Sixth**
d. Course Name: **Environmental Hazards and their Mitigation**
e. Existing Base Syllabus: **Core papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Unit	Contents
Unit I: Introduction	Definition - Hazard, vulnerability and risk; Types of Hazards-Natural and man-made hazards; Strategies for mitigation – warning system, forecasting, Emergency Preparedness, Education and Training Activities, Planning for Rescue and Relief works
Unit II: Geophysical Hazards: Seismic Hazards & Landslide 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 Slope instability and Landslide hazard; Causes – destabilizing forces; Mass movement types; Atterberg limits; Subsidence and swelling of ground; Landslides in NE India
Unit III: Flood hazard and its management	Definition - Floods, Floodplains and Flood-Prone Areas; Causes, nature and frequency of flooding; Environmental effects of flooding; Flood mitigation and management Floods in NE India; Flood hazard management in NE – Structural and Non-structural Measures
Unit IV: Meteorological Hazards	Desertification & Drought–Causes, Types, Distribution and Management Cyclones – their nature and genesis; Nor'westers; Weather associated with cyclones
Unit-V: 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

h. Reading list:

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
5 Response Planning: G. Morgan
6 Elementary seismology: C. F. Richter
7 Geodynamics of Northeastern India and the adjoining region: D. R. Nandy
8 Introduction to Seismology: P. M. Shearer
9 Principles of Seismology: A. Udias
10 Fundamentals of Geophysics: W. Lowrie
11 Environmental geo-hazards (Vol. I & II): K. K. Sharma, S. K. Bandooni and V. S. Negi
12 Environmental Hazards: S. N. Prasad

i. Graduate Attributes

I. Course Objective:

- Indian subcontinent, especially the N.E region is highly exposed to natural 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.

II. Learning Outcome:

- The course addresses the full range of hazardous events from extreme geological, hydrological, atmospheric and biological events, such as earthquakes, floods, storms and epidemics, to technological failures and malfunctions, such as industrial explosions, fires and toxic material releases. This course would highlight issues of human exposure, vulnerability, awareness, response and risk. The role of hazards in affecting development, and issues of efficiency, social justice and sustainability would also be explored in the course.

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :

- Dr. Minakshi Bora, Assistant Prof. Dept. of Environmental Science, GU, minakshi18@gauhati.ac.in, 9101127945
- Prof (retd) S. Kalita; Dept. of Environmental Science, GU; skalita53@gmail.com; 9435148264
- Prof. Bhagawat Pran Duarah; Dept. of Geological Sciences, Gauhati University; bpduarah@gauhati.ac.in; 9864324036

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Sixth**
d. Course Name: **Environmental Meteorology**
e. Existing Base Syllabus: **Core papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Unit	Content
Unit I: Introduction	Definition and scope of meteorology, Meteorological Parameters - Units, Data interpretation and analysis, Atmospheric variables – pressure, temperature, density and humidity, Solar radiation and Heat balance of the Earth-Atmosphere System
Unit II Atmosphere	Atmospheric layers and their characteristics, Atmospheric gases and particles, SPM
Unit III: Atmospheric Thermodynamics	– Gas Laws, 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; Planetary boundary layer – variation of air temperature, Humidity and wind; Diffusion and Turbulence, Mixing height
Unit IV: Atmospheric processes	– Wind circulation and different types of winds, Cyclone and Anticyclones – associated weather phenomenon; Cloud formation and its mechanism; Precipitation types, Spatial distribution of precipitation – effect of topographic barriers, Evaporation and Evapo-transpiration; Air masses- formation and their sources, ENSO, El Nino, La Nina
Unit V: Weather and Climate:	Concept of weather and Climate, weather elements, Measurements of weather parameters, Instruments for measurements of weather parameters, climatic extremes - Environmental implications, IPCC, UNFCCC, Climate change and NE India, Global impacts of climate change, Climate; agriculture and industry

h. Reading list:

1. The atmosphere (2nd edition): Richard A. Anthese, Hans A. Panofsky, John J. chair, Albert Rango.
2. Climatology (2nd edition) : an atmospheric Science: John E Oliver, John J. Hidore
3. General climatology (2003): Howard J. Critchfield
4. Fundamentals Of Meteorology 2021 Edition: Spiridonov V., Springer
5. Meteorology: An Introduction to Weather, Climate, and the Environment: C. Donald Ahrens, Robert Henson

i. Graduate Attributes
   I. Course Objective:
      - This paper attempts to teach various meteorological phenomenon's related to our environment
   II. Learning Outcome:
      - Meteorology is a very essential subject to understand the day to day weather events. This paper will let the students know about the wind circulation of earth atmosphere system and related weather phenomenon and climatic events which are very essential now a day's owing to the effects of global warming and climate change

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :
   - Prof(retd) Dulal C Goswami, Department of Environmental Science, GU, dulal.goswami4@gmail.com, 9435199258
   - Prof (retd) S. Kalita; Dept. of Environmental Science, GU; skalita53@gmail.com; 9435148264

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Sixth**
d. Course Name: **Environmental Law and Management**
e. Existing Base Syllabus: **Core papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Units	Contents
Unit I: Important national policies	National environmental policy, 2006; National Forest policy, 1894, 1952 and 1988; National water policy 2002 and other policies e.g., National biotechnology policy, National agricultural policy etc.
Unit II: Environmental legislation	Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; Wetland (Conservation and Management) Rules, 2017; Legal control of Public liability insurance-Act 1991
Unit III: International laws and policy	Role of UN authorities in protection of Global Environment, Nairobi Declaration, Vienna Convention, Basal convention, Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol, 1987; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention; Copenhagen Summit, 2009
Unit-IV: Legal control of Waste	Environmental management: Concept and scope; Environment management Systems (EMS) and approaches; Management of Solid waste (Municipal, Bio medical, Hazardous, E waste): Municipal Solid Wastes (Management & Handling) Rules, 2000; Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules, 2022; Bio-Medical Waste Management (Second Amendment) Rules, 2019; E-Waste (Management) Rules, 2022; Plastic Waste Management (Second Amendment) Rules, 2022. Swachh Bharat Abhiyan guidelines (Gramin & Urban)
Unit V: Environmental Audit & Case studies	Environmental Audit; Coverage – GOI Notification on Environmental Audit – Benefits to Industry; Report to industry, public and the governments, International and Indian Environmental Audit Scenario, Green Economy, Green funding, Environmental management system (EMS): Carbon Trading/ Emission/Trading, Carbon Tax, Tax shift- green taxes, Environmental Certification, Green technology, Eco-labeling; International trade and environment; Trade Related Intellectual Properties (TRIPs), Intellectual Property Rights (IPRs); Carbon Footprint (Personal/Business), Carbon Market, National Green Tribunal: Aditya N Prasad vs. Union of India & Others; Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988; environmental education case: M.C. Mehta vs. Union of India, WP 860/1991

h. Reading list:

1 Anonymous (1997) The Indian Forest Act, 1927 along with forest conservation act, 1980. Natraj Publisher's Dehradun.
2 Divan, S. and Rosencranz, A. (2002) Environmental Law and Policy in India (2nd edn.). Oxford.
3 Eccleston, C. H. (2011): Environmental Impact Assessment. Taylor & Francis.
4 Sustainable development (Vol. I & II): N. L. Gupta and K. K. Gurjar (ed); Rawat Publications
5 Environmental management: G. N. Pandey; Vikash Publishing House
6 Environmental management: H. M. Saxena; Rawat Publications
7 Environmental Law and Policy in India: S. Divan & A. Rosencranz; Oxford University Press
8 Environmental Management – Physio-ecological facets (Vol. I & II): Rai, Mohapatra & Goel (ed); Rawat Publications
9 Environmental Management in India Vol. I & II): R. K. Sapru; Ashish Publishing House

i. Graduate Attributes

I. Course Objective:

i. To explain the role of law, policy and institutions in the conservation and management of natural resources as well as pollution control
ii. To introduce the laws and policies both at the national and international level relating to environment
iii. To equip the students with the skills needed for interpreting laws, policies and judicial decisions

II. Learning Outcome:

i. Be familiar with the laws, policies and institutions in the field of environment.
ii. Acquire the skills needed for interpreting laws, policies and judicial decisions in a holistic perspective.
iii. Also acquire the ability to evaluate the role of law and policy in conservation and management of natural resources and prevention of pollution.

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :

- Dr. Pallavi Sharma, Assistant Professor, Department of Environmental Science, GU, pallavi.sharma@gauhati.ac.in, 9859182234
- Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945
- Prof(retd) Dulal C Goswami, Department of Environmental Science, GU, dulal.goswami4@gmail.com, 9435199258
- Prof (retd) S. Kalita, Department of Environmental Science, GU, skalita53@gmail.com, 9435148264

Environmental Science

a. Four Year Undergraduate Programme
b. Subject: **Environmental Science**
c. Semester: **Sixth**
d. Course Name: **Advances in Environmental Geoinformatics**
e. Existing Base Syllabus: **Core papers of Environmental Science**
f. Course level: **300-399**
g. Syllabus:

Unit	Contents
Unit I: Aerial Photography	Fundamentals of photogrammetry; Aerial cameras; Planning of aerial photography; Concept of vertical, tilted and oblique photography; Stereoscopy and Principle of stereo-photography; Stereoscopic Parallax and measurement of height & slope; Application of Aerial Photography in Environmental studies with special reference to Unmanned Aerial Vehicles (UAVs)
Unit II: Global Positioning System	Basic principle of GPS; Information provided by GPS; GPS segments; NAVSTAR system; Indian indigenous GPS; Differential GPS; Indian indigenous GPS system: NavIC; Applications of GPS in Environmental studies
Unit III: Map Projection	Cartography: Definition and concepts, Types of maps, Map scale, Map and Globe; Map Projection concepts; Necessity of Map Projection; Defining different spheroids for accurate mapping; Datums; Global Reference System; Projected Coordinate systems; Properties of map projections, Projection Types; Choosing a map projection; New series of SOI, Image rectification and Georeferencing
Unit IV: GIS based environmental modelling	Basic concept and principle of environmental modeling; GIS based hydrological/watershed model, air pollution dispersion model, urban planning, natural resource mapping, forest degradation studies, GIS based noise mapping; use of remote sensing and GIS in wildlife conservational modeling and planning.
Unit III: Spatial Data Analysis	Logical operations, general arithmetic operations, general statistical operations, geometric operations, query and report generation from attribute data, geometric data search and retrieval, complex operations of attribute data, classification reclassification, integrated geometry and attributes, overlay, buffer zones, raster data overlay, integrated data analysis

h. Reading list:

1 B. Bhatta (2013): Research Methods in Remote Sensing
2 B. Bhatta (2020): Remote Sensing and GIS; 3rd edition
3 J. R. Jensen (2007): Remote Sensing of the Environment – An earth resource perspective; Pearson Education
4 Martin (2003): Geographic Information Systems; Routledge
5 Heywood (2010): An Introduction to GIS; Pearson
6 Yadav (1997): Remote S sensing in Land Evaluation; Rajesh Pub
7 N. K. Agarwal (2004): Essentials of GPS; Spatial Networks Pvt. Ltd., Hyderabad

i. Graduate Attributes

I. Course Objective: The course is designed to fulfill the following objectives

- To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing
- To acquire skills in storing, managing digital data for planning and development
- It aims at providing basic photogrammetry concept, procedures and processing task.

II. Learning Outcome:

- The students on the completion of this course would be able to understand the basics of terrestrial and satellite digital photogrammetry.
- They will be able to identify and communicate concepts of data model and modeling which is vital in any environmental analysis.
- Acquire skills in handling instruments, tools, techniques and modeling while using Remote Sensing Technology

j. Theory Credit: **3**
k. Practical Credit: **1**
l. No. of Required Classes: **60**
m. No. of Contact Classes: **45**
n. No. of Non-Contact Classes: **15**
o. Particulars of Course Designer :

- Dr. Minakshi Bora, Assistant professor, Department of Environmental Science, GU, minakshi18@gmail.com, 9101127945
- Prof. Dhrubajyoti Saharia, Department of Geography, Gauahti University, dhruvajyoti@gauhati.ac.in, 9864137971
- Prof Sarat Phukan, Department of Geological Science, Gauahti University, saratphukan@gauhati.ac.in, 7002041539