ANNEXURE A

UNDERGRADUATE PROGRAMME IN ENVIRONMENT SCIENCE AND IMPACT ASSESSMENT (ESIA)

(Implemented Academic Year 2025-2026)

COURSE STRUCTURE

SEMESTER	DISCIPLINE SPECIFIC CORE COURSES (4 credits/course)	MINOR/ VOCATIONAL (4 credits/course)	SKILL ENHANCEMENT COURSES (3 credits/course)
I	UG-ESIA-101: Ecology, Ecosystem and Biodiversity		UG-ESIA-SEC1: Ecology and Society
II	UG-ESIA-102: Environment Issues, Perspectives and Policies		
III	UG-ESIA-201: Conservation Biology		UG-ESIA-SEC3: Anthropogenic Impact on Food Resources
	UG-ESIA-202: Physics and Chemistry of Environment		
IV	UG-ESIA-203: Climate change and Sustainability	UG-ESIA-VOC1: Biostatistics	
	UG-ESIA-204: Geographical Information System and Remote Sensing		
	UG-ESIA-205: Mineral Resources and Management		
	UG-ESIA-206: Environmental Evaluation		

ANNEXURE C

PROGRAMME SPECIFIC OUTCOMES IN ENVIRONMENT SCIENCE AND IMPACT ASSESSMENT

After successful completion of a three years Bachelor's degree in Environment Science and Impact Assessment, the student will be able to:

PSO 1: Scientific understanding of environmental systems and its impacts	Develop a comprehensive knowledge of environmental systems, including climate change, water resources, and mineral resources, integrating principles from biology, chemistry, and physics. Apply this knowledge to assess anthropogenic impacts and develop solutions for sustainable management.
PSO 2: Skill development for drafting Environment Impact Assessment plans and provide solutions.	Gain hands-on experience in environmental evaluation techniques, geospatial analysis, and statistical tools for data interpretation. Apply these skills in impact assessment, policy analysis, and sustainable resource management to support national and global environmental policies.
PSO 3: Innovation, Research, and Technology in Sustainability	Use scientific methods, and interdisciplinary approaches to design and implement sustainable solutions for environmental challenges. Research in Ecosystem restoration, conservation strategies, and climate resilience through innovative and sustainable practices.
PSO 4: Ethical, Social, and Professional Responsibility in Environmental Decision-Making	Develop a strong ethical foundation to understand environmental challenges, considering social, economic, and legal aspects. Cultivate leadership and collaborative skills to engage with diverse stakeholders.

SEMESTER I

ESIA-101: ENVIRONMENT, ECOLOGY, AND BIODIVERSITY

COURSE TITLE : ECOLOGY, ENVIRONMENT, AND BIODIVERSITY (THEORY CORE-1)
COURSE CODE : UG-ESIA-101
SEMESTER : I
CREDITS : 03
MARKS : 75
TOTAL HOURS : 45

Course Objective:
The course introduces the concept of environment and provides the fundamentals about ecosystems, their types, distribution, components, functioning, services and their role in biodiversity. Current scenario of Biodiversity in the Indian and world context will be understood. Most importantly the student will be able to understand and measure biotic and abiotic components of the ecosystem and then learn the relationship between them.

Course Learning Outcomes:
On the successful completion of the course, students will be able to:
CLO1 Understand and interpret the structure, variables, processes and functions operating in Environment and ecosystems.
CLO2 Understand the connectivity among all the components of ecosystems and their services.
CLO3 Understand How to identify and group different plants and animal species and the importance of biodiversity and methods to measure it.
CLO4 Gain basic knowledge on the assessment of Biotic and abiotic components
CLO5 Will gain basic knowledge in distribution of species in different ecosystem and threats to species, extinction and indicator species

Module 1: Environment (15 hours)
Concept of environment and types: Physical environment; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere; biotic environment; biotic and abiotic interactions; Habitat and Niche: Concept of habitat and niche, niche, width and overlap, resource partitioning; natural resources and alternatives.
Biogeographic provinces of the world and agro-climatic zones of India. Concept of sustainable Development.

Module 2: Ecology and Ecosystem (15 hours)
Definitions: Ecology, landscape, habitat, ecozones, biosphere, ecosystems; Autecology, synecology; Types of ecosystem: forest, grassland, lentic, Lotic, estuarine, marine, desert, wetlands; ecosystem: Structure and function; abiotic and biotic components of ecosystem; Ecosystem function; ecosystem metabolism; primary production and models of energy flow; Secondary production and trophic efficiency ecosystem

connections: food chain, food web; detritus pathway of energy flow and decomposition processes; Ecosystem: stability, resistance and resilience.
Biogeochemical cycles and nutrient cycling: Carbon cycle; nitrogen cycle; phosphorus cycle; sulfur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; decomposition and nutrient release; Ecological succession: Primary and secondary successions; Ecological pyramids: pyramids of number, biomass and energy, ecological niche.

Module 3: Biodiversity (15 hours)
Definition; the past (diversity and extinction) and present; major groups of biological organisms; evolution of biodiversity and drivers of biodiversity; Patterns in biodiversity: Spatial and temporal patterns at genetic, species and taxonomic diversity, Approaches to biodiversity studies. Loss of biodiversity and biodiversity targets 2030.
Measuring Biodiversity: Species richness and Biodiversity Indices; Methods of Measuring Biodiversity; Alpha, Beta and Gamma-diversity; Genetic, Species and Ecosystem Diversity; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, protocooperation, predation, competition, parasitism, mimicry, herbivory;
Hotspots of Biodiversity and their distribution; Drivers of biodiversity change;Biodiversity of India Bio-geographical regions of India; Forest types and major ecosystems of India. Endemism. Concepts of keystone, umbrella and flagship species. Strategies for biodiversity conservation: in situ, ex situ and in vitro conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India.

COURSE TITLE : ECOLOGY, ENVIRONMENT, AND BIODIVERSITY (PRACTICAL CORE-1)
COURSE CODE : UG-ESIA-101
SEMESTER : I
CREDITS : 01
MARKS : 25
TOTAL HOURS : 30

1. Introduction to Environment lab and Instruments in Ecology
2. Study of Members: kingdom Plantae
3. Study of Members: kingdom Animalia
4. Measurement of Basic abiotic factors: Temperature; Sunlight; Relative Humidity; Soil Moisture content; Wind speed; Atmospheric Pressure; Type of Soil/substrate
5. Study of grassland vegetation by List Count Quadrat Method to determine the Frequency, Density; Abundance.
6. Estimation of number of animals in population
7. Visit to a sacred grove/Forest/Grassland/Marine ecosystem to assess its biodiversity
8. Study of wetland (source region visit) and its vegetation and seasonal bird diversity

REFERENCES

- Primack, R.B., (2002) Essentials of Conservation Biology (3rd edition). Sinauer Associates, Sunderland, USA.

- Loreau, M. and Inchausti, P., (2002) Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK
- Singh, J.S., Singh, S.P. and Gupta, S.R., (2006) Ecology, Environment and Resource Conservation. Anamaya Publications.
- Gaston, K J. and Spicer, J.I., (1998) Biodiversity: An Introduction. Blackwell Science, London, UK.
- Odum, E.P., (1971) Fundamentals of Ecology. W.B. Sounders.

OPEN SOURCE

https://indiabiodiversity.org/page/4246006
https://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/EnviStats/Chap7-Biodiversity_envst22.pdf
http://nbaindia.org/

SEMESTER II

ESIA-102: Environment Issues, Perspectives and Policies

COURSE TITLE : ENVIRONMENT ISSUES, PERSPECTIVES AND POLICIES (THEORY-CORE 2)
COURSE CODE : UG-ESIA-102
SEMESTER : II
CREDITS : 03
DURATION : 45 HOURS
MAXIMUM MARKS : 75

Course Objectives:
The course focuses on environmental pollution and different types of environmental issues. It deals with their causes and impact on the environment. Students will learn about the different types of wastes generated which affects the environment. Most importantly, students will be able to understand the different types of environmental policies and laws.

Course Learning Outcomes:
On the successful completion of the course, students will be able to:
CLO1 Understand pollution and its harmful effects on the environment.
CLO2 Acquire knowledge about various environmental issues, causes and effects of different types of wastes.
CLO3 Acquire knowledge about environmental policies and laws.
CLO4 Apply the basic knowledge of environmental issues and policies through field work.

Module 1: Environmental Pollution (15 hours)
Pollution: Introduction; pollutants and their statutory limits, types of pollution, air, water, and soil pollution; their causes and impact on the environment; measures to control the pollution; Acid rain: causes and its harmful effect (example of Taj Mahal), causes and prevention of Corrosion (example of rusting of iron), impact of toxic chemicals in environment. Pollution case studies with key lessons; role of an individual in prevention of pollution.

Module 2: Environmental Issues (15 hours)
Introduction, causes and impact on the environment due to global warming, climate change, ozone layer depletion, greenhouse effect, deforestation, and overpopulation; preventive measures; case studies with key lessons.
Types, causes and effects of wastes: Solid waste, plastic waste, hazardous waste, e-waste, biomedical waste and batteries waste; waste management; control measures of urban and industrial wastes.
Urban problems related to energy; from unsustainable to sustainable development. Environmental ethics: issues and possible solutions.

Module 3: Environmental Policies and Laws (15 hours)

History of Global and National policies; Stockholm conference, constitutional provision of environmental law; significance, amendments, and applications of the Wildlife (protection) Act, 1972; the water pollution act, 1974; Toxic Substances Control Act, 1976; Soil pollution Act, 1980; Forest Conservation Act, 1980; Air pollution Act, 1981; the Environment (protection) Act, 1986; National Forest Policy, 1988; Oil Pollution Act, 1990; Biological Diversity Act, 2002; the National Green Tribunal Act, 2010 and Compensatory Afforestation Fund Act, 2016, SWM rules, EIA Notification and requirements.

Various sections under the Code of Civil Procedure 1908 ('CPC'), the Indian Penal Code 1860 ('IPC') and the Code of Criminal Procedure 1973 ('CrPC') for the prevention and control of pollution with case studies (any two). Issues involved in enforcement of environmental legislation; public awareness.

COURSE TITLE : ENVIRONMENT ISSUES, PERSPECTIVES AND POLICIES (PRACTICAL-CORE 2)
COURSE CODE : UG-ESIA-102
SEMESTER : II
CREDITS : 01
DURATION : 30 HOURS
MAXIMUM MARKS : 25

1) Field visits to the local polluted area (Urban/Rural/Industrial/Agricultural) and prepare a report.
2) Field survey on environmental issues.
3) Identification of primary and secondary impacts of nearby ongoing developmental activity.
4) Study of physical and chemical parameters of soil and water.
5) Understanding compliance mechanisms and reports.
6) Understanding the procedure for environmental clearance for any sector.
7) Suggestions and Recommendations for a better plan of surrounding environments.

REFERENCES:

Mandatory Reading:

- Bharucha E. (2013): Text Book of Environmental Studies. University Press (India) Private Limited, Hyderabad (A.P.) India.
- Kaushik, A., Kaushik, C. P. (2004): Perspectives in Environmental Studies. 2nd Edition. New age international limited publishers, New Delhi.

Supplementary Reading:

- Asthana, D. K., Asthana M. (2009): A Text book of Environmental Studies. S Chand and Company Limited, New Delhi.

WEB REFERENCES:

- https://www.shivajicollege.ac.in/Study/Environmental%20Pollution.pdf
- https://www.unescap.org/sites/default/files/CH08.PDF

- https://tmv.ac.in/ematerial/geography/SEM-4_CC10T%20ENVIRONMENTAL%20POLICY%20AND%20PROGRAMMES%20IN%20INDIA.pdf
- https://www.slideshare.net/SurajPoudel11/a-report-on-a-visit-to-a-local-polluted-site

	UG-ESIA-404: Green Chemistry		
VIII	UG-ESIA-405: Environmental Restoration and Remediation		
	UG-ESIA-406: Land Oceans and Atmospheric Interactions		
	UG-ESIA-407: Advanced Remote Sensing and GIS		
	UG-ESIA-408: Forestry and Conservation		

SEMESTER III

Course Title **: CONSERVATION BIOLOGY (CORE: THEORY)**
Course Code **: UG-ESIA-201**
Semester **: III**
Credits **: 03**
Marks **: 75**
Hours **: 45**

Course Prerequisites: Nil.

Course objectives: The course will provide an in-depth understanding of the principles and practices of Conservation Biology. It focuses on Biodiversity, impact of human activities on biodiversity, scientific, ethical, policy aspects and traditional conservation strategies of conservation biology.

Course Learning Outcomes:

Upon successful completion of the course, student will be able to:
CLO1 demonstrate an understanding of biodiversity and its significance
CLO2 analyse the causes and consequences of biodiversity loss
CLO3 evaluate various conservation strategies and their effectiveness into environment impact assessments
CLO4 develop skills for designing and implementing conservation projects

Module I: Introduction to Conservation Biology (15 hours)
Concept of nature conservation; Biodiversity at global, national, and local levels; flagship species, umbrella species, keystone species, IUCN red list of threatened species, endemic species, scheduled species and their distribution; diversity of mega-diverse countries

Ecosystem Diversity: definition and types of ecosystems; threats: habitat destruction, fragmentation, climate change, pollution

Species Diversity: concept of species diversity, importance of species diversity for ecosystem stability; threats*:* over exploitation, invasive species

Genetic Diversity: definition and importance of genetic diversity, methods for assessing

genetic variation, role of genetic diversity in species adaptability and resilience; threats: loss of genetic variation due to small population sizes, inbreeding and genetic drift.

Module II: Strategies for biological conservation (15 hours)

Conservation approaches: *In-situ* and *ex-situ* conservation; threat assessment and management, conservation at population and species levels

In-situ conservation: establishing, designing, and managing protected areas: national parks, wildlife sanctuaries, biospheres, sacred groove, marine protected areas, Ramsar Sites; conservation in non-protected areas.

Ex-situ conservation: captive breeding, microbial conservation, plant propagation - tissue culture, re-establishment and relocation, conservation of plant diversity in seed banks, germplasm reserves.

Traditional methods of conservation, case studies of national conservation efforts.

Module III: Conservation and Sustainability (15 hours)

Sustainable development: sustainable development at local, national, and international levels. Individual initiatives and community-based conservation initiatives.

Restoration: restoration of damaged ecosystems, endangered species restoration, applied population biology, manipulation of wild populations, establishing new populations, control of predators, herbivores, and competitors.

Legislation and Policies: National and International conservation organisations and Institutions: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN), World Wildlife Fund (WWF), Non-Governmental Organizations (NGOs), Convention on Biological Diversity (CBD), Convention on International Trade in Endangered Species of Wild Flora and Fauna, Protected Area Networks (PAN); role of local government organisations. Environmental policies, environmental laws, and legislations.

Course Title **: CONSERVATION BIOLOGY (CORE: PRACTICAL)**
Course Code **: UG-ESIA-201**
Semester **: III**
Credits **: 01**
Marks **: 25**
Hours **: 30**

List of experiments

1. Species survey to differentiate protected and unprotected areas using field guides, keys, and digital tools for species identification from a similar geographic area. *(04 hours)*
2. Analyse species richness and evenness using quadrat sampling/transect methods by biodiversity indices (Shannon-Wiener Index) *(04 hours)*
3. Identification of keystone species. *(02 hours)*

4. Identification of IUCN status for Biodiversity. *(02 hours)*
5. Design a restoration plan for a degraded area, including site assessment, selection of native species for replanting, and a monitoring plan. *(02 hours)*
6. Visit to any one protected area within the state. *(04 hours)*
7. Develop a seedling from synthetic seed. *(02 hours)*
8. Develop and implement a community outreach or education campaign on a local conservation issue. *(02 hours)*
9. Practical Assessments. *(06 hours)*

REFERENCES

Mandatory Reading:

1. Primark, R.B. (2014). *Essentials of Conservation Biology.* Sinauer Associates.
2. Groom, M.J., Meffe, G.K., & Carroll, C.R. (2006). *Principles of Conservation Biology.* Sinauer Associates.
3. Sutherland, W.J. (1998). *Conservation Science and action*. Blackwell Science.

Supplementary Reading:

1. Hunter, M. L. Jr., Gibbs, J. P., & Popescu, V. D. (Eds.). (2019). *Fundamentals of conservation biology* (4th ed.). Wiley-Blackwell.
2. Bawa, K. S., & Dayanandan, P. (Eds.). (2011). *Conservation biology: A primer for South Asia*. Oxford University Press.
3. Van Dyke, F., & Lamb, R. L. (2011). *Conservation biology: Foundations, concepts, applications*. Wiley-Blackwell.

Web References:

- https://www.cbd.int/brc
- https://www.unep.org/explore-topics/oceans-seas/what-we-do/working-regional-seas/partners/world-wide-fund-nature-wwf
- https://www.unep.org/
- ndiacode.nic.in/bitstream/123456789/1726/1/a1972-53.pdf
- https://www.indiacode.nic.in/bitstream/123456789/19381/1/the_forest_%28conservation%29_act%2C_1980.pdf

Course Title **: PHYSICS AND CHEMISTRY OF ENVIRONMENT (CORE: THEORY)**
Course Code **: UG-ESIA-202**
Semester **: III**
Credits **: 03**
Marks **: 75**
Hours **: 45**

Course prerequisites: Nil

Course objectives: The main objective of this course is to build conceptual understanding of the basic principles of physical and chemical environmental processes of air, water and soil. This course also helps to develop practical skills through various laboratory experiments to demonstrate the physics and chemistry associated with particle movement, chemical processes and pollutant chemistry.

Course Learning Outcomes:
Upon successful completion of the course, student will be able to:
CLO1 explain the fundamentals of environmental physics and chemistry.
CLO2 describe the properties of air and water and relate their nature to the environment.
CLO3 explain soil physio-chemical properties and recognise common heavy metal and surfactant pollutants in the environment.
CLO4 demonstrate and apply the knowledge of fundamental Physics and Chemistry of the environment through laboratory experiments.

Module I: Fundamentals of Environmental Physics and Chemistry (15 hours)
Fundamentals of environmental Physics: Basic concepts of light and matter; introduction to the concept of absorption; transmission of light, Beer-Lambert law, scattering of light; basic concepts of pressure, force, work, and energy; concept of heat transfer, conduction, and convection; concepts of temperature, lapse rate (dry and moist adiabatic); Laws of thermodynamics; concept of heat and work; diffusion and dispersion

Fundamentals of Environmental Chemistry: Solution concentration (Normality, Molarity, Molality, ppm, Equivalent weight, Molecular weight); types of chemical reactions; acids, bases and salts, solubility products; solutes and solvents; redox reactions, concepts of pH and pE.

Module II: Air and Water chemistry (15 hours)
Chemistry of Air: Introduction, properties of air, composition of air, chemistry of air constituents: sulphur dioxide, carbon dioxide, carbon monoxide, ozone, photochemical smog, water vapour in the atmosphere; acid rain; particles in the atmosphere: lead and heavy metals. Ozone chemistry - depletion and recovery of stratospheric ozone - monitoring, effects and control measures.

Chemistry of Water: Introduction, occurrence, physical and chemical properties of water: colour, odour, turbidity, total salt content, Total Suspended Solids (TSS) in water; Hydrogen bonding; Analysis of water: pH, Dissolved Oxygen (DO), total hardness, calcium and magnesium. Changes in water properties on addition of solute. Water interaction with gases and earth minerals; solubility of metals, complex formation and chelation.

Module III: Soil Chemistry and Chemistry of common pollutants (15 hours)
Soil Chemistry: Introduction, soil formation, structure and composition of soil, water and air in soil; soil reactions and essential elements: macro and micronutrients in soil, adverse effects of toxic elements in soil; brief account of soil biota. Soil weathering and erosion; properties of soil: colour, texture, temperature, pH, porosity, bulk density, water holding capacity, soil salinity; types of soil and their distribution, organic carbon, Carbon-Nitrogen ratio, soil fertility and productivity.

Chemistry of some Heavy Metals: Chemistry of Lead, Mercury, Cadmium and Arsenic, its physical and chemical properties. Environmental Impact and toxicity.

Chemistry of Surfactants and Detergents: Classification, characteristics and composition. Environmental Impact and toxicity.

Course Title **: PHYSICS AND CHEMISTRY OF ENVIRONMENT (CORE: PRACTICAL)**
Course Code **: UG-ESIA-202**
Semester **: III**
Credits **: 01**
Marks **: 25**
Hours **: 30**

List of experiments
1. Study the relationship between the volume of a gas and its pressure: Boyle's law. *(2 hours)*
2. Study of humidity using humidity sensors. *(2 hours)*
3. Study diffraction of Light using Lycopodium powder. *(2 hours)*
4. Study reflection and refraction of light by tracing the path of a ray of light. *(2 hours)*
5. To verify Beer-Lambert's law for $KMnO_4$ colorimetrically. *(2 hours)*
6. Measurement of the specific latent heat of fusion of ice. *(2 hours)*
7. To determine the moisture content and bulk density in soil samples. *(2 hours)*
8. To determine the soil fertility: Nitrogen, Phosphorous, Potassium. *(4 hours)*
9. Spectrophotometric determination of Chromium (III). *(2 hours)*
10. Determination of ambient air quality- particulate matter using Ambient air quality monitor (portable). *(2 hours)*
11. Determination of wind speed, wind direction using Anemometer. *(2 hours)*
12. Practical Assessments. *(6 hours)*

REFERENCES
Mandatory Reading:

1. Bharucha, E. (2013). *Text Book of Environmental Studies.* University Press (India) Private Limited, Hyderabad (A.P.) India.
2. Girard, J. (2013). *Principles of Environmental Chemistry* (3rd Edition). Jones & Bartlett.

3. Harnung, S. E; & Johnson, M. S. (2012). *Chemistry and the Environment*. Cambridge University Press.
4. Asthana, D. K.; & Asthana, M. (2009). *A Textbook of Environmental Studies*. S Chand and Company Limited, New Delhi.
5. Pani, B. (2007). *Textbook of Environmental Chemistry*. IK International Publishing House.
6. Connell, D. W. (2005). *Basic Concepts of Environmental Chemistry* (2nd Edition). CRC Press.
7. Kaushik, A., Kaushik, C. P. (2004). *Perspectives in Environmental Studies* (2nd Edition). New age international limited publishers, New Delhi.
8. Boeker, E. & Grondelle, R. (2011). *Environmental Physics: Sustainable Energy and Climate Change*. Wiley.
9. Connell, D.W. (2005). *Basic Concepts of Environmental Chemistry* (2nd Edition). CRC Press.
10. Forinash, K. (2010). *Foundation of Environmental Physics*. Island Press.

Supplementary Reading:

1. Boeker, E.; Grondelle, R. (2011). *Environmental Physics: Sustainable Energy and Climate Change*. Wiley.
2. Manahan, S. E. (2010). *Environmental Chemistry*. CRC press.
3. De, A. K. (2003). *Environmental Chemistry*. Wiley Eastern Ltd. House, New Delhi.
4. Katyal, T.; Satake, M. (2002). *Environmental Pollution*, Anmol Publications Pvt. Ltd. New Delhi.

Web References:

1. https://tmv.ac.in/ematerial/botany/ap/SEM%20IV,%20C9T(UNIT%204),%20LIGHT%20TEMPERATURE%20AND%20RAINFALL,%20ARGHYA%20PAL.pdf
2. https://ntrs.nasa.gov/api/citations/19960008864/downloads/19960008864.pdf
3. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000275/M025523/ET/1513072771Paper5module26_e-text.pdf
4. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/environmental_chemistry/14.soil_composition,_micro_and_macronutrients/et/4781_et_et.pdf

LIST OF COURSES AT SEMESTER III AND IV

SEMESTER	DISCIPLINE SPECIFIC CORE COURSE 4 credits/course	VOCATIONAL COURSE 4 credits/course	SKILL ENHANCEMENT COURSE 3 credits/course
IV	UG-ESIA-203: Climate Change and Sustainability	UG-ESIA-VOC1: Biostatistics	
	UG-ESIA-204: Geographical Information System and Remote Sensing		
	UG-ESIA-205: Mineral Resources and Management		
	UG-ESIA-206: Environmental Evaluation		

SYLLABUS SEMESTER IV

Course Title : CLIMATE CHANGE AND SUSTAINABILITY (THEORY CORE)
Course Code : UG-ESIA-203
Semester : IV
Credits : 03
Marks : 75
Hours : 45

Course Prerequisites: Nil

Course Objectives: The course provides in-depth, specialized content to explore climate change from different perspectives—health, finance, ecosystems, and communication—each vital to understanding the broader implications and solutions around climate change, sustainability and its mitigation.

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:
CLO1 Explain the current issues and processes related to climate change.
CLO2 Analyse the various global and Indian climate policies and treaties.
CLO3 Study the various solutions and mitigation measures to tackle climate change.
CLO4 Develop practical and field skills to identify and assess various indicators and factors that contributes to Climate change.

Module 1- Climate Change and Impacts (15 hours)

Introduction; Climate change: definition, difference between weather and climate, cause of Climate Change- natural (Solar radiations, Volcanic activity, Ocean Currents) and anthropogenic factors.

Impacts of Climate change– Greenhouse gases (CO2, Methane, Chlorofloro carbons, Nitrogen Oxide, (greenhouse effect), Acid rain, Global temperature rise (melting ice caps, rising sea levels), Ocean acidification, Terrestrial ecosystems. Biodiversity and ecosystems under threat (Forest Fires).

Economic impacts (agriculture, fisheries); Social impacts (climate refugees, food insecurity)

Impacts of climate change on Health- Heatwaves, respiratory diseases, Mental health impacts of climate-related events (displacement, disasters). Impact on Weather and Natural disasters

Module 2- Climate Policy, Global Action and Public Health (15 hours)
International climate agreements (Paris Agreement, Kyoto Protocol). Role of governments, NGOs, international organizations and treaties. Climate justice and equity, Individual and collective actions for climate change.

The impact of climate change on global and regional health. Climate policy: global scenario, and Indian scenario; Lifestyle for Environment (LiFE), Swachh Bharat Abhiyan.

Public health strategies for climate adaptation. Green business initiatives.

Module 3- Climate Solutions and future direction (15 hours)
Energy solutions: past and present. Transportation, Building and habitation. Industry and waste management. Land use, agriculture and forestry. Adaptation and tropical forest sequestration.

The role of finance in climate change mitigation and adaptation. Carbon trading, carbon taxes, carbon credits and pricing. Emissions trading systems (ETS) Green bonds and sustainable investment. Financing mechanisms for renewable energy projects. Economic opportunities in green innovation and the green job market. Eco labelling,

Urban sustainability- Urban Planning and urban forests smart Cities. . Strategies for ecosystem restoration (reforestation, habitat restoration) Biodiversity conservation in the face of climate change. Nature-based solutions: the role of indigenous knowledge and local communities in conservation.

Climate change adaptation, mitigation strategies and models.

Course Title : CLIMATE CHANGE AND SUSTAINABILITY (PRACTICAL CORE)
Course Code : UG-ESIA-203
Semester : IV
Credits : 01
Marks : 25
Hours : 30

1. Carbon Audit and Report. *(6 hours)*
2. Assessment of carbon footprint using various methods. *(4 hours)*
3. Develop a case study on a successful ecosystem restoration project (e.g., wetlands, coral reefs) and assess its impact on biodiversity and

climate resilience. *(6 hours)*

4. Create a podcast episode or a video explaining a climate change issue (e.g., rising sea levels, climate refugees) and propose solutions. *(6 hours)*
5. Study Goa state climate action plan. *(8 hours)*

REFERENCES

Mandatory Reading:

- Stephen Schneider, Armin Rosencranz, Michael Mastrandrea, eds., 2010. *Climate change science and policy*. Island Press.
- Bert Metz, 2010. *Controlling climate change*, Cambridge University Press.
- Lester Brown, 2009. *Plan b 4.0: mobilizing to save civilization*. W.W. Norton.
- Kerry Emanuel, 2007. *What We Know About Climate Change*. Boston: Boston Review/MIT Press.
- Tim Flannery, 2006. *The Weather Makers*. New York: Atlantic Monthly Press

Supplementary Reading:

- Bill McKibben, 2010. *Earth.* NY: Times Books.
- David Blockstein and Leo Weigman 2010. *The Climate Solution Consensus.* NCSE/Island Press.
- Monty Hempel, 1996. *Environmental Governance: The Global Challenge*. Washington, DC: Island Press.
- Arnold J. Bloom, 2009. *Global climate change: convergence of disciplines*. Sinauer Associates.

Web References:

- https://www.un.org/sustainabledevelopment/climate-change/
- https://www.worldbank.org/en/news/speech/2014/01/15/climate-change-is-challenge-for-sustainable-development
- https://www.sciencedirect.com/science/article/abs/pii/S1469306203001013

Course Title : GEOGRAPHICAL INFORMATION SYSTEM (GIS) AND REMOTE SENSING (CORE)
Course Code : UG-ESIA-204
Semester : IV
Credits : 03
Marks : 75
Hours : 45

Course Prerequisites: Nil

Course Objectives:

The course focuses on the fundamentals concept Geographical Information System, GPS and Remote Sensing. The aim is to Gain basic experience in the hands-on application of use of GPS, GIS and remote sensing data through visual interpretation and digital image processing exercises.

Course Learning Outcomes:

On completion of the course, the students will be able to:

CLO1 Demonstrate proficiency and conceptual understanding in techniques to carry out GIS and Remote Sensing

CLO2 Explain different type of datasets and software's available for GIS and Remote sensing applications

CLO3 Demonstrate practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze, and interpret GIS & RS data and maps

CLO4 Develop proficiency in GIS based Software.

Module 1: Introduction to Geographical Information System (GIS) (15 hours)

History and development of GIS; Data: Types- Spatial, Attribute and metadata; GIS file formats: raster and vector; spatial relationships and linear networks; GIS Data Capture Methods: primary and secondary; GIS maps; Introduction to GIS software: ArcGIS QGIS, and EpiCollect.

Module 2: Introduction to Remote Sensing (15 hours)

Introduction to Remote Sensing: History and development; stages in Remote Sensing; Electromagnetic Spectrum and Electromagnetic Radiation; Interaction of Electromagnetic Radiation with atmosphere and earth surface; Platform, satellites Sensors, and Sensor resolution; Interpretation of Satellite Imageries: Elements of visual interpretation, digital image analysis and classification and change detection

Module 3: Introduction to Global Positioning System (15 hours)

Global Positioning System (GPS): development and navigational models, segments, sources of Error and signals and

Global Navigation Satellite System (GNSS) and Radio Navigation Satellite System (RNSS), Indian Regional Navigation System (IRNS), GPS Aided GEO Augmented Navigation (GAGAN), Navigation with Indian Constellation (NavIC).

Differential Global Positioning System (DGPS): system, functions and Applications.

Data acquisition, processing and transformation.

Course Title : GEOGRAPHICAL INFORMATION SYSTEM AND REMOTE SENSING (PRACTICAL)
Course Code : UG-ESIA-204
Semester : IV
Credits : 01
Marks : 25
Hours : 30

1. Working with Global Positioning System (GPS) in an urban forest: capturing Ground Control Points (GCPs) *(2 hours)*
2. Introduction to QGIS software Graphical User Interface (GUI) *(2 hours)*
3. Georeferencing and Projection of the base map *(2 hours)*

4. Base map preparation of urban forest; Digitisation Vector data creation : point line and polygon; Adding vector attribute data Querying on Attribute Data *(4 hours)*
5. Vector Analysis: buffer, overlay, network analysis, Nearest neighbourhood analysis *(2 hours)*
6. Raster Analysis: image classification and thematic information extraction *(2 hours)*
7. Working with Developing Digital Elevation Model *(2 hours)*
8. Data processing and conversion – Vector to Raster, Raster to Vector *(2 hours)*
9. Map design and layout management *(2 hours)*
10.Identifying visual features marked on IRS IC LISS III imagery *(2 hours)*

Note: Students are expected to use IRS 1C/1D LISS III /IV imagery from Bhoonidhi Portal (https://bhoonidhi.nrsc.gov.in/bhoonidhi/home.html#services) , Landsat 8/9 images form USGS Earth Explorer (https://earthexplorer.usgs.gov). Vector data may be taken form DIVA GIS and GIS English portal.

REFERENCES:

- Joseph, George (2007) *Fundamentals of Remote Sensing* Universities Press India.
- Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2007). *Remote sensing and image interpretation*, 5th ed., Wiley. ISBN 0-471-15227-7.
- Chang, K. (2007). *Introduction to Geographic Information System, 4th Ed*. McGraw Hill.
- Campbell, J.B. (2002). *Introduction to Remote Sensing, 3rd ed.*, The Guilford Press. ISBN 1-57230-640-8.
- Curran Paul, J. (2000). *Principles of Remote Sensing*. UK: ELBS.
- Burrough, P.A. and McDonnell, R.A. (1998) *Principles of geographical information systems*. Oxford University Press, Oxford, 327 pp.

WEB REFERENCES

- https://www.nrsc.gov.in/
- https://www.iirs.gov.in/

OPEN SOURCES

- https://www.nateko.lu.se/sites/nateko.lu.se.sv/files/remote_sensing_and_gis_20111212.pdf
- https://ncert.nic.in/textbook/pdf/kegy307.pdf
- https://www.mpgmahavidyalaya.org/userfiles/07_chapter3.pdf
- https://vardhaman.org/wp-content/uploads/2021/03/Geographical-Information-Lab-1.pdf
- Bhoonidhi Portal https://bhoonidhi.nrsc.gov.in/bhoonidhi/home.html#services
- USGS Earth Explorer https://earthexplorer.usgs.gov

Course Title : MINERAL RESOURCES AND MANAGEMENT (THEORY CORE)
Course Code : UG-ESIA-205
Semester : IV
Credits : 03

Marks : 75
Hours : 45

Course Prerequisites: Nil

Course Objectives:
The course aims to equip students with the knowledge and skills to classify minerals, understand the relationship between rock types and ore formation, and explore India's metallogenic provinces and mineral resources. Its objectives include enabling students to explain the stages of mine development, assess the environmental and socio-economic impacts of mining, and critically analyse the national mineral scenario, policies, and sustainable mining practices. Additionally, the course aims to develop practical skills in identifying economic minerals, mapping ore deposits, and estimating resources through hands-on activities.

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

CLO1 Classify minerals and explain their relationship with rock types and ore-forming processes.
CLO2 Explain the stages of mine development and assess the environmental and socio-economic impacts of mining.
CLO3 Analyse the national mineral scenario, policies, and regulations for sustainable mining.
CLO4 Identify economic minerals, locate ore deposits on a map, and estimate resources using the cross-sectional method.

Module I: Minerals and Mineral Resources (15 hours)
Introduction to Minerals: Mineral, Physical Properties of minerals; distinction between rock-forming and ore minerals.
Minerals as abiotic components to biotic resources.
Types of rocks: Igneous/ sedimentary/Metamorphic and its relation to ore forming processes.
Metallogenic Provinces and Epochs.
Mineral resources of India: metallic and non-metallic minerals; fossil fuels.

Module II: Mineral exploration and Mining (15 hours)
Economic Geology: Concepts including mineralization, ore, gangue; reserves and resource classification.
Stages of Mine Development: Exploration and Categorisation of mineral resource;
Mining: Open cast and Underground; Mine planning, ore extraction, Processing and Mine Closure.
Environmental and socio-economic impacts of mining.

Module III: Regulatory framework for Mineral resource Management (15 hours)
National Mineral Scenario: Analysis of the current status, challenges, and future directions.
National Mineral Policy: overview
Mineral Conservation and Development Rules, 1988: provisions and practices for sustainable mining: ore segregation, blending, waste management.
Case Study: Mining Scenario in Goa.

Course Title : MINERAL RESOURCES AND MANAGEMENT (PRACTICAL CORE)
Course Code : UG-ESIA-205
Semester : IV
Credits : 01
Marks : 25
Hours : 30

1. Study of Economic minerals in hand specimens: Metallic and non-metallic (15 specimens) (*12 hours)*
2. Location of various ore deposits on the outline map of India. (*06 hours)*
3. Resource estimation using cross sectional method. (*12 hours)*

REFERENCES

Mandatory Reading:

- Pohl, L.W. (2011). *Economic Geology – Principles and Practice*. Wiley-Blackwell.
- Singh, P. (2008). *Engineering and General Geology* (7th ed.). SK Kataria and Sons.
- Marjoribanks, R. (1997). *Geological Methods in Mineral Exploration and Mining*. Springer-Science+Business Media.
- Babu, S. K., & Sinha, D. K. (1988). *Practical Manual of Exploration and Prospecting*. CBS Publishers and Distributors, New Delhi.
- Gokhale, G.V.G.K. (1983). *Ore Deposits of India*. CBS Publishers, New Delhi.
- Krishnaswamy, S. (1979). *Indian Mineral Resources*. Oxford and IBH.
- Arogyaswamy, R. N. P. (1973). *Courses in Mining Geology*. Oxford & IBH Publishing Co.
- Indian Bureau of Mines (IBM) Publications.

Web References:

https://mines.gov.in/webportal/home
https://bhukosh.gsi.gov.in/Bhukosh

Course Title : ENVIRONMENTAL EVALUATION (THEORY CORE)
Course Code : UG-ESIA-206
Semester : IV
Credits : 03
Marks : 75
Hours : 45

Course Prerequisites: Nil

Course Objectives: The course in Environmental evaluation is designed to build detailed knowledge, understanding and skills among students for conducting an environmental impact assessment (EIA), so that they are able to identify sustainable modes of environmental operation. The course starts with an overview of environmental impact assessment (EIA) the

different methodologies on which it draws the state of the art, current practices, constraints and future directions.

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:
CLO1 Explain the purpose, concept, evolution and examples of environmental evaluation.
CLO2 Study the different processes and approaches towards environmental evaluation.
CLO3 Study the framework and policies of Environmental Impact Assessment (EIA).
CLO4 Prepare an environmental evaluation report.

Module I - Introduction to environmental evaluation as a part of EIA
Defining environmental impact assessment (EIA); Purpose, concept and evolution of EIA. Sustainable Development challenges and need for Environment Evaluation. EIA procedure in India and Systematic Environmental Clearance (EC), Environmental Impact Statement (EIS), impact indicators. EIA Notification including Form 1, Schedule I, authorities/committees and stages.

Module II – Process and approach of environmental evaluation
Project screening including categorization. Project scoping including Terms of Reference (TOR), consideration of alternatives, establishing the study area and environmental baseline, impact identification, prediction and evaluation and impact mitigation. Public Consultation including purpose, procedure, participants, Appraisal process.
EIA methodologies - ad hoc, overlays, checklists, matrices, networks; strategies for selection of EIA methodologies, methodologies for prediction: judgmental approach, mathematical models, simulation, and physical models.

Module III- EIA report, methodologies and techniques
EIA Report – Purpose, executive summary, Project Description, Anticipated Environmental impacts, mitigation measures, Environmental Monitoring Programme.
Environment Management Plan (EMP); EMP - purpose, scope.
Biodiversity Impact Assessment (BIA): role, purpose and scope. Identification, prediction and evaluation of impacts on biodiversity.
Techniques of biodiversity impact assessment and monitoring, threat reduction methods. Case studies of EIA for Indian industries (oil, metallurgical, petrochemical, iron and steel, fertilizer, projects of roads / dams)

Course Title : ENVIRONMENTAL EVALUATION (PRACTICAL CORE)
Course Code : UG-ESIA-206
Semester : IV
Credits : 01
Marks : 25
Hours : 30

1. Campus Environmental Audit- Assess waste management, energy consumption and water usage in the campus and propose improvements. (*6 hours*)

2. Basic concepts of monitoring and evaluation, guidelines tool, (logic model, monitoring plan, evaluation plan), measures and indicators. *(4 hours)*
3. Screening and scoping of construction projects (Site visit) - categorising them based on regulatory frameworks and local guidelines followed by problem tree analysis, terms of reference and scoping checklist. (*6 hours*)
4. Case Study of an EIA Report- Analyse and critique an existing EIA document, compare different countries EIA regulations and effectiveness (SCIA- source to get an EIA report) . (*8 hours*)
5) Designing an Environmental impact assessment strategy for a given local site (site visit). *(6 hours)*

REFERENCES

Mandatory Reading:

- 1.Eccleston, Charles H., 2011. *Environmental Impact Assessment: A Guide to Best*
- *Professional Practices,* CRC Press.
- Baumgartner Ruedi, 2004. *The search for a sustainable livelihood system*. Sage Publications.
- Dale R. 2004. *Evaluating Development Programme and Project, 2nd Ed.*, Sage
- Publication.
- Canter L.W. 1996 *Environmental Impact Assessment, 2nd Ed*. New York, McGraw Hill.
- Bathwal R.R. 1988. *Environmental Impact Assessment*, New Age, International
- Biswas A.K, 1987). *Environmental Impact Assessment*, Tycooly International.
- Desh Bandhu, 1981. *Environment management*, Indian Environment Society.
- Environmental Impact Assessment, 1991. Selected reading, Wildlife Institute of India

Supplementary Reading:

- Kulkarni and Ramchandra, 2006. *Environment Management*, Capital Publishing Company,
- Lee N. and Kirkpatrick C. (Eds) (2000) *Integrated Appraisal and Sustainable Development in a Developing World*, Cheltenham, Edward Elgar.

Web References:

- https://www.boem.gov/environment/environmental-assessment/what-environmental-assessment-0
- https://www.sciencedirect.com/topics/social-sciences/environmental-evaluation
- https://moef.gov.in/environmental-impact-assessment-eia
- https://www.cseindia.org/understanding-eia-383
- https://www.cbd.int/impact/whatis.shtml

Course Title : BIOSTATISTICS (THEORY VOCATIONAL)
Course Code : UG-ESIA-VOC1
Semester : IV
Credits : 03
Marks : 75