REVISED COURSE STRUCTURE

(NEP-2020)

M.Sc.

(Environmental Sciences)

(w.e.f. from the session 2021-22)

DEPARTMENT OF ENVIRONMENTAL STUDIES

SCHOOL OF INTERDISCIPLINARY AND APPLIED SCIENCES

CENTRAL UNIVERSITY OF HARYANA

MAHENDERGARH (HARYANA) - 123031

June 2021

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1. Background

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of the Central University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in 32nd meeting of the Academic Council of the University held on April 23, 2021. The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focused on 'creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills' for the 'development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasising upon– integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points initially in undergraduate programmes; alignment of Vocational courses with the International Standard Classification of Occupations maintained by the International Labor Organization; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical , vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. In

case of UG programmes in Engineering and Vocational Studies, it was decided that the departments shall incorporate pertinent NEP recommendations while complying with AICTE, NBA, NSQF, International Standard Classification of Occupations, Sector Skill Council and other relevant agencies/sources. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department was discussed in series of discussion sessions conducted at Department, School and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of Masters Course, Learning Outcome Index, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and Appendices. The experts of various Boards of Studies and School Boards contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Accordingly, the curriculum may be reviewed annually.

About the Department

Department of Environmental Studies formerly known as the Department of Environmental Sciences under School of Earth, Environment & Space Studies was established from the academic year 2014-15 by offering two years Master's Degree programme in Environmental Science with an intake capacity of 30 students. Currently, the Department has been shifted to the School of Interdisciplinary and Applied Sciences. Now the intake capacity of the department has been increased to 38 students. Major aim of the department is to furnish the students with a comprehensive understanding of key environmental issues, and use of a wide range of environmental tools and methods so that they can play leading role in development and application of environmental policies and management. The Department plans to focus its research activities in diverse thrust areas during the coming years. Besides meeting its academic objectives, the Department aimed at providing leadership in the area of conservation of environment, rational utilization of natural resources and creation of public awareness. The academic programme of the

Department has been extensively reviewed, revised and updated, keeping in mind the need for sharper focusing, the available expertise at any given time, and committed to changes desired in curriculum of individual courses or specific programmes. The department has trained and experienced faculty having diverse background of Environmental Sciences. The department is also involved in extension activities in the adopted villages of CUH for the development of the community/society/nation by imparting environmental education with the involvement of students.

Programs Offered

Currently the Department is offering M.Sc. programme in Environmental Science and shortly going to start M.Phil./Ph.D. programme in same subject.

Objectives of the Department:

- To provide quality education and training in Environmental Sciences
- To pursue and facilitate research and development activities
- To establish working linkages with industry and undertake collaborative projects which offer long-term interaction opportunities with academia and industry
- To foster environmental awareness and promote the principles and practices of sustainable development.

Thrust Areas of Research

- Wastewater Treatment
- Carbon Sequestration
- Water Resources Management
- Paleoclimate studies
- Phytoremediation and Bioremediation
- Biofuels
- Solid Waste Management
- Environmental Pollution Monitoring and Analysis

2. Programme Outcomes (PO)

- **Basic and applied knowledge:** Interdisciplinary knowledge to find solution for the complex environmental problems
- **Problem analysis:** Ability to analyze society related/ applied research problem, design and execute experiments to find relevant solutions

- **Advanced Usage of Technology**: Apply advanced instrumentation tools, online resources with an understanding of the troubleshooting and limitations.
- **Ethics:** Commitment towards professional ethics and responsibilities as a social endeavor to bring harmony with nature
- **Lifelong learning:** Scientific skills for industrial applications and entrepreneurship

3. Programme Specific Outcomes

On completing M.Sc. Programme, the students shall be able to realize following outcomes:

- **PSO-1:** Knowledge about the natural resources, their status, importance and need for conservation.
- **PSO-2:** Knowledge of biodiversity, forest and wildlife ecology for their conservation and management.
- **PSO-3:** Enhancement of creative and critical thinking, aesthetic sensibility, and analytical skills.
- **PSO-4:** Understanding of the chemical processes that governs the natural and disturbed environments.
- **PSO-5:** Waste management practices for the betterment of environment and well beings.
- **PSO-6:** Understanding of the emerging regional and global environmental issues and their mitigations.
- **PSO-7:** Understating the EIA and its methodologies for Industries and Regulators. .
- **PSO-8:** Fundamental knowledge of instrumental methods employed in analysis of environmental samples.
- **PSO-9:** Understandings of natural disasters and their management approaches
- **PSO-10:** Knowledge of environmental laws, acts, and standard for environmental compliance

4. Postgraduate Attributes

On completion of the post graduate programme in Environmental Studies, students are expected to equip with the skills of creative, critical and rational thinking associated with Environmental Studies and its use for human society. The following attributes are expected from the students of M.Sc. Environmental Studies:

- Disciplinary Knowledge
- Creative and Critical Thinking
- Reflective Thinking

- Problem Solving
- Analytical Reasoning
- Communication Skills
- Research Skills
- Life Skills
- Multicultural Competence
- Moral and Ethical Values
- Life-long Learning
- Global Competency

5. Structure of Programme (M.Sc. Environmental Science)

Total Credits: 100

SEMESTER – I						**Credits: 25**
Sr. No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1.	**SIAS EVS 01 01 01 C 4004**	**Fundamentals of Ecology**	**4**	**0**	**0**	**4**
3.	**SIAS EVS 01 01 02 C 4004**	**Biodiversity Conservation**	**4**	**0**	**0**	**4**
2.	**SIAS EVS 01 01 03 C 4004**	**Natural Resource Conservation & Management**	**4**	**0**	**0**	**4**
4.	**SIAS EVS 01 01 04 C 2002**	**Environmental Statistics**	**2**	**0**	**0**	**2**
5.	**SIAS EVS 01 01 05 C 0202**	**Seminar**	**0**	**2**	**0**	**2**
6.	**SIAS EVS 01 01 06 C 0055**	**Practical I (Ecology & Biodiversity)**	**0**	**0**	**10**	**5**
7.	**GE**	**To be taken from other department**	**4**	**0**	**0**	**4**
	GEC ***(offered to students of other department only)/ MOOC***					
8.	**SIAS EVS 01 01 01 GE 4004**	**Foundation Course in Ecology and Environment**	**4**	**0**	**0**	**4**
9.	**SIAS EVS 01 01 02 GE 4004**	**Regional and Global Environmental Issues**	**4**	**0**	**0**	**4**

SEMESTER – II						**Credits: 25**
1	**SIAS EVS 01 02 07 C 4004**	**Environmental Chemistry**	**4**	**0**	**0**	**4**
2	**SIAS EVS 01 02 08 C 4004**	**Environmental Pollution and Control**	**4**	**0**	**0**	**4**
3	**SIAS EVS 01 02 09 C 4004**	**Environmental Management and Impact Assessment**	**4**	**0**	**0**	**4**
4	**SIAS EVS 01 02 10 C 4004**	**Instrumental Techniques for Environmental Analysis**	**4**	**0**	**0**	**4**
5	**SIAS EVS 01 02 11 C 0055**	**Practical-II (Environmental Management)**	**0**	**0**	**10**	**5**

6	*Choose any one of the following two DCEC courses:*					
	SIAS EVS 01 02 01 DCEC 4004	Solid and Hazardous Waste Management	4	0	0	4
	SIAS EVS 01 02 02 DCEC 4004	Forest and Wildlife Ecology	4	0	0	4
	SIAS EVS 01 02 03 DCEC 4004	Environmental Biotechnology	4	0	0	4
	GEC *(offered to students of other department only)/ MOOC*					
7	SIAS EVS 01 02 03 GE 4004	Environmental Pollution and Health	4	0	0	4
8	SIAS EVS 01 02 04 GE 4004	Biodiversity Conservation and Wildlife Management	4	0	0	4

SEMESTER – III						Credits: 26
1	SIAS EVS 01 03 12 C 4004	Physical Environment	4	0	0	4
2	SIAS EVS 01 03 13 C 4004	Environmental Policy and Law	4	0	0	4
3	SIAS EVS 01 03 14 C 4004	Environmental Health and Toxicology	4	0	0	4
4.	SIAS EVS 01 03 15 C 0055	Practical III *(Environmental Monitoring & Analysis)*	0	0	10	5
5.	SIAS EVS 01 03 16 C 0001	Summer Training (Report and Presentation)	0	0	0	1
6.	GE	To be taken from other department	4	0	0	4
7.	*Choose any one of the following two DCEC courses*:					
	SIAS EVS 01 03 04 DCEC 4004	Water Quality Management	4	0	0	4
	SIAS EVS 01 03 05 DCEC 4004	Natural Disaster Management	4	0	0	4
	SIAS EVS 01 03 06 DCEC 4004	Environmental Microbiology	4	0	0	4
	GEC *(offered to students of other department only)/ MOOC*					

8.	**SIAS EVS 01 03 05 GE 4004**	**Sustainable Development and Resource Management**	**4**	**0**	**0**	**4**
9.	**SIAS EVS 01 03 06 GE 4004**	**Agriculture and Environment**	**4**	**0**	**0**	**4**

SEMESTER – IV						**Credits: 24**
1.	**SIAS EVS 01 04 01 SEEC 002020**	**Dissertation (Research work, Seminar, Report and Viva voce)**	**0**	**0**	**40**	**20**
2.	**SIAS EVS 01 04 17 C 4004**	**Research Methodology and Writing Skills**	**4**	**0**	**0**	**4**

L: Lecture; T: Theory; P: Practical; S: Seminar; GEC- General Elective Course: DCEC: Discipline Centric Elective Course; C: Credits

SEEC: Skill Enhancement Elective Course (Compulsory and exclusively for M.Sc. (Environmental Science) students)

****Blue text courses will be taught in online mode.***

SEMESTER- I

FUNDAMENTALS OF ECOLOGY

(SIAS EVS 01 01 01 C 4004)

Course title: Fundamentals of Ecology

Course objective: To provide an understanding of the impacts of various environmental factors on the living being and vice-versa.

Learning outcomes:

• It will give knowledge of the environmental factors affecting animals and plants.
• A sense of the energy flow and nutrient cycling in the environment.
• A sense of the application of the population ecology.

Course content:

Unit-I: **Introduction to Ecology**

Definition, subdivision and scope, Basic concepts in ecology, Autecology and Synecology, Level of organization in Ecology, Environmental heterogenicity, Applied ecology, Environmental complexes, Interaction of ecological factors,

Unit-II: Ecological Factors

Light, temperature, precipitation (rainfall), humidity. Atmosphere: gases and wind, atmospheric gases, wind factor and fire factor, topographic and edaphic factors. Different environmental laws and limiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors). Biotic community, Interdependence in a community and community metabolism, Community ecology: structure, composition and development of community, species diversity in communities, Ecotones, Concept of edge effect, Ecological niche, Gause's Principle.

Unit-III: **Ecosystem**

Introduction, kinds of ecosystem, structure and functions, abiotic and biotic component, Ecological energetics, Energy flow models, Food chain and Food web, Concepts of productivity and standing crops, Ecological Pyramids-types, Ecological succession, Ecological indicators, Ecological efficiencies, Biogeochemical cycles in ecosystems.

Unit-IV: Population Ecology

Population characteristics; density, natality, mortality, biotic potential, survivorship curves, age distribution, growth curves and models, r & k selection. Population interaction, Prey-Predator Relationship, Ecological Model.

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4. Raven P H, Berg L R, Hassenzahl D M (2018) Environment. 10th Edition. John Wiley & Sons., USA
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9. Juniper T (2019) The Ecology Book: Big Ideas Simply Explained. DK

BIODIVERSITY CONSERVATION
(SIAS EVS 01 01 02 C 4004)

Course title: Biodiversity Conservation

Course objective: To aware the students about the biological diversity, its importance, status and need of worldwide efforts in its preservation.

Learning outcomes:

- It will be helpful for students to understand the species diversity and associated issues.
- They will be able to understand the threat at biodiversity, causal factors and mitigation measures.
- The students will get the knowledge about trends of biological diversity and conservation strategies and thereafter be able to create awareness for its preservation and development.

Course content:

Unit-I: Introduction

Concepts and components of biodiversity, types of diversity (Microbial, Plant, Soil, Agro-biodiversity), Importance of biodiversity: aesthetic, cultural and ecosystem services, biodiversity informatics, biodiversity values, biodiversity indices, biodiversity losses, Human population growth implications on biodiversity.

Unit-II: Strategies for Biodiversity Conservation

In-situ conservation: sanctuaries, biospheres reserves, national parks, preservation plots. Ex-situ conservation: captive breeding, botanical gardens, zoos, aquaria, homestead garden, herbarium; In-vitro conservation of plant tissue culture: Gene bank, pollen bank, spore bank, DNA bank. Wildlife corridors, Resource partitioning, Pressure of firewood collection, non-wood forest produce collection, livestock grazing and fire on protected area and habitat management. National and international programmes for biodiversity conservation.

Unit-III: Megadiversity Zones and Biodiversity Hotspots

Concepts, distribution and importance of megadiversity zones, Biogeographic regions Biodiversity hotspots, National and global red data lists, Categories of species and their management, Restoration of biodiversity, Acceleration of ecological succession, Reintroduction of biota. Methods for

inventorying and monitoring biodiversity trends, Habitat evaluation, IPRs and protection: Patent protection, TRIPs, Biopiracy and Bioprospecting.

Unit-IV: Planning and Implementation of Conservation Programmes

Indigenous knowledge, biodiversity and sustainable development, Sacred groves. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, IUCN, UNEP, WCPA, TRAFFIC in wildlife protection. Institutions and their role in conservation: Zoos, Natural history museums & collections, Zoological survey of India, Botanical survey of India, Forest research Institute, Survey of India. People and conservation. Role of NGOs in conservation.

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2. Gibbs J, Malcolm L, Sterling J (2008) Problem-Solving in Conservation Biology and Wildlife Management. 2nd ed. Wiley-Blackwell
3. Laladhas K, Oommen V, Nilayangode P (2018) Biodiversity for Sustainable Development. Springer International Publishing, pp 79-86
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5. Odum E P, Barrett W, (2005) Fundamentals of Ecology. 5th ed. Cengage Learning.
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7. Sharma P D (2017) Ecology and Environment. 13th ed. Rastogi Publications
8. Sondhi S (2012) Protected Animals of India. The Energy and Resources Institute, TERI
9. Thangadurai D, Ching G, Jeyabalan S, Islam S (2019) Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management. United States: Apple Academic Press

NATURAL RESOURCE CONSERVATION AND MANAGEMENT
(SIAS EVS 01 01 03 C 4004)

Course title: Natural Resource Conservation and Management

Course objective: To create awareness among the students about the natural resources, their status, importance and need of preservation.

Learning outcomes:

- It will be helpful for students to understand different types of natural resources and their status in the present context.
- The understanding of issues concerning different natural resources will be helpful to find scientific solution based on participatory approach.
- To achieve their sustainable use as well as proper management.
- Participate in sustainable development

Course content:

Unit-I: **Natural Resources: An Introduction**

Natural Resources: Concept and Classification of Natural Resources; Factors influencing resource availability, distribution and uses; Mineral Resources***:*** Mineral Resources and Reserve; Mineral exploration and exploitation, Environmental impacts of mineral extraction; Oceanic Minerals: Exploration prospective and Impacts

Unit-II: Physical Resources

Soil Resource: Soil Characteristics and Classification; Soil Development, Soil Profile; Degradation of Soil: Soil Erosion, Desertification and Salinization; Soil and Land Management: Soil Conservation and Management Strategies; Water Resources: Water Composition and Quality: Rainwater, Rivers, Lakes, Groundwater, Seawater; Impacts of Exploitation of Surface & Ground Water, Environmental Issues of Water Resource Projects; Rain Water Harvesting and Ground Water Recharge.

Unit-III: Energy Resources

Fossil Fuels: Classification, Composition, Characteristics of Coal, Petroleum and Natural Gas; Renewable Energy Resources: Overview and Principal of generation and Environmental Implications of renewable Energy: Hydropower, Tidal Energy, Ocean Thermal Energy Conversion (OTEC), Wind Energy, Geothermal Energy, Solar Energy (Solar Collector, Photo-voltaic Modules,

Solar Ponds), Nuclear Energy (Fusion & Fission), Bioenergy; Energy use pattern in India and the World.

Unit-IV: Forest Resources

Forest Resources: Classification and Forest Types in India; Importance, Use and Over Exploitation; Human Interaction with Forests: Causes and Effects of Deforestation; Purposes and Techniques of Forest Management; Urban Forestry

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10. Tiwari G, Ghosal M (2005) Renewable Energy Resources: Basic Principles and Application. Narosa Publishing House
11. Twidell J, Weir T (2015) Renewable Energy Resources. Routledge

ENVIRONMENTAL STATISTICS

(SIAS EVS 01 01 04 C 2002)

Course title: Environmental Statistics

Course objective: To enhance students' ability in collection, understanding and interpretation of the environment data or the information related thereto**.**

Learning outcomes:

- The students will be benefitted in shorting and managing of data to reach at the final conclusion.
- It will be helpful in the assessment and understanding of the environmental components.
- Finally, it will be helpful to predict, sort out and provide solutions of the environmental problems.

Course content:

Unit-I: Understanding and Representation of Data

Importance of statistics in Environmental Sciences, Attributes and Variables: types of variables, scales of measurement, tabulation of data, concept of frequency distribution, Graphical representation of Data – Line chart, Pie chart, Bar chart, Box plot

Unit-II: Descriptive Statistics

Measures of Central Tendency - mean, mode and median, Measures of Dispersion - range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, Skewness and Kurtosis.

Unit-III: Probability Theory

Basic concepts of probability theory: Mutually Exclusive Events and Independent Events, Probability Laws, Conditional Probability, Discrete and Continuous Random Variables, Theoretical Probability Distributions - Binomial, Poisson, Normal and Log-Normal distributions,

Unit-IV: Relationship and Testing of Parameters

Correlation, Regression, Concept of Sample and Population, Sampling Types, Concepts of Sampling Distribution, Standard Error and Significance Levels and Confidence Limits. Hypothesis Testing: Null Hypothesis, Type I and Type II errors, t-test, Chi-square test, F-test, Principles of Experimental Design, ANOVA: one-way and two-way

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SEMINAR

(SIAS EVS 01 01 05 C 0202)

Course title: Seminar

Course objective: The main objective of this course is to eliminate the hesitation of students by presenting in front of the Faculties and other students.

Learning outcomes:

- To learn how to make a presentation
- To learn how to present on a formal platform
- To learn how to take questions from faculty as well as students.

Every student, who has been enrolled in M.Sc. (Environmental Sciences) programme, shall have to deliver a Seminar on a recent topic related to Environmental Science, as per the programme of the School of Earth, Environment and Space Studies. The seminar will be of 30-40 minutes duration during which the presentation will be followed by a questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board. The speaker has to submit an abstract to be distributed during the Seminar in addition to a review paper giving relevant details of the background of the subject, various aspects of the topic and references.

PRACTICAL-I (ECOLOGY & BIODIVERSITY)
(SIAS EVS 01 01 06 C 0055)

Course title: Practical-I (Ecology & Biodiversity)

Course objective: To provide practical knowledge of the structure of an ecosystem concerning its biodiversity and various factors affecting them.

Learning outcomes:

• Practical knowledge to study the biodiversity of an ecosystem.
• Examine water quality of an aquatic water body
• Field knowledge of an ecosystem structure and its parameters.

Course content:

Unit-I: Parameters of grassland vegetation (Two exercises to be done in examination)
Minimum size and number of quadrat, Frequency of plant species, Density of plant species, Abundance of plant species, Importance Value Index (IVI)

Unit-II: Primary Productivity determination (One exercise to be given)
Harvest method, Light and dark bottle method.

Unit-III: Parameters of aquatic bodies determination
Hardness, Transparency, Turbidity, Conductivity, Chlorophyll content estimation

Unit-IV: Water quality parameters determination (Any two exercises)

Dissolved oxygen (DO), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Alkalinity, Total dissolved solid (TDS), visiting aquatic ecosystem and learn methods of water and plankton collection

FOUNDATION COURSE IN ECOLOGY AND ENVIRONMENT
(SIAS EVS 01 01 01 GE 4004)

Course title: Foundation Course in Ecology and Environment

Course objective: To give students an understanding of basic concepts of ecology and how ecosystem functions.

Learning outcomes:

- The physical aspects of the environment
- Relationship between organisms and their environment
- The structure and functions of ecosystem
- Ability to interpret population characteristics

Course content:

Unit-I: **Fundamentals of Ecology**

Definition and Basic concept of Ecology; Scope of ecology; Subdivision of Ecology: Autecology and Synecology; Organizational Level of Ecological Systems.

Unit-II: Environmental Factors

Definition and Types of Environmental Factors; Abiotic factors: Temperature, light, water, precipitation and wind; Biotic factors. Shelford's Law of Tolerance, Liebig's Law of Minimum, Concept of Limiting Factors.

Unit-III: Ecosystem Ecology

Definition and Types of Ecosystem; Terrestrial Ecosystem: Forest and Grassland; Aquatic Ecosystem: Lentic and Lotic; Structure and Function of an Ecosystem; Food Chain: Grazing and Detritus; Trophic Levels, Energy Flow Models; Ecological Pyramids: Number, Biomass and Energy.

Unit-IV: **Population and Community Dynamics**

Population Characteristics: Natality, Mortality, Age Distribution, Dispersion, Migration. Age Structure of Population; Ecological Niche; Ecotone and Edge effect; Interactions between Populations, Life History Strategies (r and k Species); Key-stone Species; Flagship Species;

Ecological Succession: Characteristics of Succession, General process, Significance, Types of Succession: Xerosere and Hydrosere, Concept of Climax.

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2. Cunningham W P, Cunningham M A (2008) Principles of Environment Science Enquiry and Applications. 5th ed. Tata McGraw Hill, New Delhi
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4. Juniper T (2019) The Ecology Book: Big Ideas Simply Explained. DK
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10. Smith (2014) Elements of Ecology. 8th edition. Pearson Education India

REGIONAL AND GLOBAL ENVIRONMENTAL ISSUES
(SIAS EVS 01 01 02 GE 4004)

Corse title: Regional and Global Environmental Issues

Course objective: The objective of this course is to aware students regarding the emerging regional and global environmental issues.

Learning outcomes:

• To know about the local environmental issues and movements
• How these issues may impact at the global level
• How we can play an important role to minimize the impact of these aspects

Course content:

Unit-I: Global and National Environmental Issues

Sea-level Change- primary and secondary impacts- Adapting to Sea level changes. Global Warming and Greenhouse gases- Global and national scenario, Deforestation, . National Action Plan on Climate Change (NAPCC), Intergovernmental Panel for Climate Change (IPCC), Climate Change and Biodiversity loss, Climate change and food security, Ozone depletion.

Unit-II: Environmental Disasters

Nuclear issues, Nuclear power, Nuclear weapons, Nuclear and radiation accidents, Bhopal gas disaster 1984, Three Mile Island accident (1979), Kyshtym Nuclear Disaster (1957), Wind Scale Fire Nuclear Disaster (1957), Love canal tragedy, Chernobyl disaster 1986, Fukushima Daiichi nuclear disaster 2011, Nuclear safety, High-level radioactive waste management.

Unit-III: Environmental Issues and Movements

Global and national movements of Significance impact: Green Belt movement, Green Peace, Chipko movement, Narmada Bachao Andolan, Tehri dam, Urja gram, Beej Bachao Andolan, Silent valley-Doon valley and related issues/case studies

Unit-IV: Contemporary Issues

Green Buildings, GRIHA rating norms, Genetic pollution, Genetically modified food controversies, Intensive farming Monoculture, Swachh Bharat Abhiyan. Water conservation- development of watersheds, Rainwater harvesting and groundwater recharge, Namami Gange and Yamuna action

plan, SDGs , NAPCC- National Water Mission (NWM), National Mission for Sustaining Himalayan Ecosystem (NMSHE) and National Mission for Strategic Knowledge on Climate Change (NMSKCC), National Solar Mission (NSM), National Mission for Enhanced Energy Efficiency (NMEEE), National Mission on Sustainable Habitat (NMSH), National Mission for Sustainable Agriculture (NMSA) and Green India Mission (GIM).

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SEMESTER-II

ENVIRONMENTAL CHEMISTRY
(SIAS EVS 01 02 07 C 4004)

Course title: Environmental Chemistry

Course objective: To understand the chemistry that governs natural and polluted environments by utilizing and building on the tools acquired in general chemistry, chemical kinetics, and thermodynamics. The chemistry of species in the atmosphere, hydrosphere, lithosphere, and their interactions will be examined. Additionally, concepts of ecotoxicology will be introduced.

Learning outcomes:

- A sense of water chemistry and various physical properties involving in the chemical processes.
- A sense of the atmospheric chemistry and processes involved in the troposphere.
- Knowledge of soil properties and toxicological compound emerging into the environment.

Course content:

Unit-I: Chemistry of Water and Aquatic System

Stoichiometry, Gibb's energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, the solubility of gases in water. The carbonate system; Chemistry of water, Properties of water and their significance, types, sources and consequences of water pollution, Physicochemical and bacteriological sampling and analysis of water quality. Redox potential, alkalinity, acidity, calcium and other metals in water, organic pollutants in sewage, soaps, oil and detergents, radionuclide in water

Unit-II: Atmospheric Chemistry

Particles, ions and radicals in the atmosphere. Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Oxygen and ozone chemistry. Chemistry of air pollutants, Photochemical smog. Methods of monitoring and control of air pollution- SO_2, NOx, CO, SPM. Effects of pollutants on human beings, plants, animals and materials. Air Quality Standards

Unit-III: Soil and Sediment Geochemistry

Inorganic and organic components of soil, Weathering of rocks, rock-forming minerals, Soil properties, acid-base and ion-exchange reaction in soil, Macro and micronutrients in soil, Nitrogen pathways and NPK in soils.

Unit-IV: Toxic Chemicals in the Environment

Organic compounds: Hydrocarbons, Chemistry of hydrocarbons, phenols, chlorofluorocarbons, pesticides, chemical fertilizers, environmental effects, effects on macro and microorganisms. Gasoline lubricants and greases, Pesticides**:** Classification, degradation, analysis, pollution due to pesticides and heavy metals, Principles of green chemistry.

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ENVIRONMENTAL POLLUTION AND CONTROL
(SIAS EVS 01 02 08 C 4004)

Course title: Environmental Pollution and Control

Course objective: To get knowledge about the technologies available to control the pollution which has been emerged to the environment already by various human activities.

Learning outcomes:

- A sense of the technologies and methods available to control the water pollution
- A sense about the methods and technologies which have been used until now for the control and purification of the polluted air.
- Knowledge about the noise pollution abatement and soil pollution control

Course content:

Unit-I: Water Pollution

Primary treatment methods – screening, grit removal, primary sedimentation, secondary treatment methods, Activated sludge process, Trickling filters, Rotating biological contactors, Oxidation ponds and Lagoons. Advanced wastewater treatment, removal of nutrients and solids. Wastewater reuse and sludge disposal.

Unit-II: Air Pollution

Control methods for particulates-gravitational settling chambers, Centrifugal Collectors, Wet Collectors, Fabric filters, electrostatic precipitators. Control methods for gaseous pollutants-adsorption, absorption, condensation, combustion. Air pollutants Sampling, Major air pollutants in India.

Unit-III: Noise Pollution

Basics of sound, Sound propagation, Measurement of noise and indices, Effect of meteorological parameters on noise propagation. Noise control and abatement measures, Noise exposure levels and standards, Impact of noise on human health.

Unit-IV: Soil Pollution

Soil Pollution control. Phytoremediation process: Phytostimulation, Phytostabilization, Phytoextraction, Phytovolatilization, Phytodegradation, Industrial effluents and their interactions

with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers. The land-use plan, soil surveys in relation to land use planning, methods of site selection and evaluation.

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ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT
(SIAS EVS 01 02 09 C 4004)

Course title: Environmental Management and Impact Assessment

Course objectives: Understating the environmental laws, acts, standard for environmental compliance. Understating the EIA and its methodologies for Industries and Regulators.

Learning outcomes:

- Understand critical theories of environmental impact assessment
- Be able to critique environmental impact statements effectively
- Be able to apply knowledge to Indian situations/cases

Course content:

Unit-I: Introduction to EIA and Environmental Planning

Origin, aims and needs of EIA, EIA guidelines 1994, EIA notification and amendments; Environmental Impact Assessment (EIA) as a tool in environmental management, EMS and QMS, ISO 14000 Series, Corporate Social Responsibility (CSR) 26000. Baseline information and predictions (Land, water, atmosphere, energy etc.), Restoration and rehabilitation technologies. Concept and strategies of sustainable development, Environmental priorities in India and Sustainable Development.

Unit-II: EIA Methodology

Types of Projects requiring Environmental Clearance, Types of EIA, Project screening, Scoping, Base-line study, Impact identification, Prediction and assessment of impacts, Mitigation measures. Public participation, Review and decision making, Generic structure of EIA Document, Composition of Expert Appraisal Committee (EAC), State Level Expert Appraisal Committee (SEAC), Life Cycle Assessment (LCA) in EIA: principles and practical implications for industrial projects, Benefits and future of EIA.

Unit-III: Environmental Audit

Introduction, Concepts, Steps, Methodology and Types of Environmental audit, . Environmental Auditing: Procedure, quantitative methods of environmental auditing (Leopold Matrix method and Battelle method) Cost-Benefit analysis, National Environmental Policies and guidelines for

environmental audit in India Main areas covered by the auditor in the case of environment audit in an Industrial unit, Environmental impact statement (EIS).

Unit-IV: Case Studies

Environmental Impact Assessment of major developmental projects – river valley projects, mining projects, thermal power plants, transport (rail, road highway), oil refineries and petrochemicals. Prediction and assessment of impacts on the biological, cultural and socio- economic environments.

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3. Guinee J B (2002) Handbook on Life Cycle Assessment: Operational Guide to ISO Standards. Springer
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INSTRUMENTAL TECHNIQUES FOR ENVIRONMENTAL ANALYSIS (SIAS EVS 01 02 10 C 4004)

Course title: Instrumental Techniques for Environmental Analysis

Course objectives: To provide a fundamental understanding of the design, operational principles and practical applications of modern instrumental methods employed in chemical analysis of environmental samples.

Learning outcomes:

- Students will be able to use adequate equipment and determine the state of pollution in the environment
- They will be able to correctly perform sampling and prepare the samples
- To adequately use instrumental methods of chemical analysis and interpret the results.

Course content:

Unit-I: Basics of Analytical Approach

Defining of Problem and Designing of Analytical Method; Sampling: Types and Methods for Solid, Liquid and Gaseous Matrix; Sample Storage; Sample Preparation; Measurement and Assessing of Data; Method Validation and Documentation; Titrimetry; Gravimetry; Colourimetry

Unit-II: Spectroscopic Analytical Techniques

Spectrophotometry (UV-Visible Spectrophotometry, Atomic Absorption Spectrophotometry, Flame Photometry); Plasma Emission Spectroscopy (Induced Coupled Plasma Mass Spectrometer, Induced Coupled Plasma Atomic Emission Spectroscopy); Fourier-Transform Infrared Spectroscopy; Nuclear Magnetic Resonance Spectroscopy; X-Ray Spectroscopy (X-Ray Fluorescence, X-Ray Diffraction); Nephalometry and Turbidimetry

Unit-III: Chromatographic Techniques

Chromatographic Techniques (Paper Chromatography, Thin Layer Chromatography, Gas Liquid Chromatography, High Pressure Liquid Chromatography, Ion-exchange Chromatography); Electrophoresis

Unit-IV: Microscopy Techniques

Optical Microscopy (Brightfield, Darkfield, Phase Contrast, Fluorescence, Confocal); Electron Microscopy (Scanning and Transmission Electron Microscopy); Flow Cytometry

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5. Khopkar S M (2008) Basic Concepts of Analytical Chemistry. New Age International Pvt Ltd Publishers, New Delhi
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PRACTICAL-II
(ENVIRONMENTAL MANAGEMENT)
(SIAS EVS 01 02 11 C 0055)

Course title: Practical-II (Environmental Management)

Course objective: To make the students capable in monitoring and analysis of the physical and chemical parameters to know various changes, which may be harmful for the living beings as well as the environment.

Learning outcomes:

- The students will acquire the knowledge of various physiochemical parameters in the environment (air, water, soil, etc.) and methods of their analysis via different means.
- Besides, they will also gain the information about different laboratory equipment and instruments, etc.
- The students will able participate in solving so many environmental problems related with the analyzed parameters.

Course content:

Unit-I: Recording of Meteorological Parameters (select any two parameters)
Atmospheric pressure, rainfall, ambient temperature, wind speed and direction, Wind Chill and temperature, humidity and dew point.

Unit-II: Heavy Metals Analysis Using Atomic Absorption Spectrophotometer
Analysis of Aluminium (Al), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Mercury (Hg), Nickel (Ni) and Lead (Pb) from wastewater.

Unit-III: Soil Samples Collection and Analysis
Sampling and Collection of soil sample, Determination of physical and chemical properties of soil: CEC, pH, moisture content, Soil water holding capacity, organic matter content, Nitrogen, Phosphate phosphorus, Calcium Carbonate content

Unit-IV: Field Visits and Data Collection
Make Field visits to river/lake and/or wastewater treatment plants, measurement of noise form industrial, residential and commercial zones within the university premises.

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2. Carter M R (2008) Soil Sampling and Methods of Analysis. United States: CRC Press
3. Chhonkar P K, Dwivedi B S, Singh D (2007) Manual on Soil, Plant and Water Analysis. India: Westville Publishing House
4. Tahir A (2016) Manual of Soil Plant and Water Analysis. India: Daya Publishing House

SOLID AND HAZARDOUS WASTE MANAGEMENT
(SIAS EVS 01 02 01 DCEC 4004)

Course title: Solid and Hazardous Waste Management

Course Objective- to provide brief knowledge about the origin of different categories of waste generated, their disposal and to concentrate on 3R that is reduce, reuse and recycle of waste

Learning objectives:

- Develop understanding on various technological applications for processing of waste and their disposals in various ways.
- Acquire knowledge on waste to energy productions in the perspectives of sustainable development.
- Apply basic concepts in hazardous waste management and integrated waste management for urban areas.

Course content:

Unit-I: Basics of Solid Waste

Solid Waste: Types and Classification; Sources and Generation Rate; Factors Influencing Waste Generation; Waste Composition, Collection and Characterization, Waste Processing, Waste Minimization; Waste Recycling

Unit-II: Solid Waste Management

Solid Waste Management: Traditional Methods of Waste Management; Plastic Waste Management; Waste Management Options: Sanitary Landfill, Composting, Incineration, Energy Recovery options; Waste Legislations: Overview of Waste Management Legislations: The Plastic Waste Management Rules, 2016; The Construction and Demolition Waste Management Rules, 2016; The Solid Waste Management Rules, 2016

Unit-III: Hazardous Waste Management

Hazardous Waste: Definition, Sources and Classification, Hazard communication, Hazardous Waste Control, Treatment and Management; Radioactive Waste Management; Biomedical Waste Management, E-Waste Management

Unit-IV: Legislations Related to Hazardous Waste Management

The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016; The Bio-Medical Waste Management Rules, 2016; The e-waste (Management) Rules 2016; The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000; The Batteries (Management and Handling) Rules, 2010 with Amendments.

REFERENCES

1. Blackman Jr, WC (2016) Basic hazardous waste management. CRC Press
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FOREST AND WILDLIFE ECOLOGY

(SIAS EVS 01 02 02 DCEC 4004)

Course title: Forest and Wildlife Ecology

Course objective: Knowledge about the importance and existence of forest and wildlife

Learning outcomes:

- Knowledge about the forest composition and techniques to grow a forest in a sustainable manner
- Knowledge of value aspects of the wildlife on the earth ecosystem
- Knowledge of various protected areas and role of various bodies in the protection of wildlife

Course content:

Unit-I: Forest

Types and composition of forests of India, Structural organization of forest ecosystems, Primary production in different ecosystems and methods of measurement of primary production, Social forestry: Objectives, scope and necessity, Agroforestry, Extension forestry, Eucalyptus dilemma, people's participation, Roles on NGOs.

Unit-II: Silvicultural Practices

Silvicultural principles and practices, Impact of deforestation and shifting cultivation on forest ecosystems. Forest management: Objectives and principles, Techniques, Sustainable yield relation, Biodiversity and Forest.

Unit-III: Values of Wildlife

Concept of wildlife, Role of wildlife in nature, Factors influencing wildlife management such as habitats, population, behavior, food-habits, health, etc., Common flora and fauna of India. Tools for data collection and analysis. Preservation of Breeding Stock; Artificial stocking; Habitat Improvement, Game Farming.

Unit-IV: Wildlife Protection:

Indian wildlife IUCN Categories, National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Ecological basis of wild life conservation and management, Special projects for endangered species (Project tiger, Gir lion Sanctuary Project, Crocodile breeding project, sea turtle

conservation), International trade of wildlife, Animal cruelty: causes and prevention, Wildlife and range management, Management of Fire, Role of NGO's in wildlife and forest life and range management, Role of local communities in wildlife management.

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1. Balakrishnan M (2016) Wildlife Ecology and Conservation (21st Century Biology and Agriculture: Textbook Series). Scientific Publishers
2. Chiras D, Reganold J (2009) Natural Resource Conservation: Management for a Sustainable Future. 10th edition, Pearson, USA
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ENVIRONMENTAL BIOTECHNOLOGY

(SIAS EVS 01 02 03 DCEC 4004)

Course title: Environmental Biotechnology

Course objective: To provide basic understanding of the role of biotechnology in the field of environment

Learning outcomes:

- Explain the technologies, tools and techniques in the field of environmental biotechnology.
- To know about the role of microorganisms as biotechnological agents.
- Knowledge about the basic terminology of molecular biology and genetics.
- Study of bioreactors for environmental application.

Course content:

Unit-I: Basic Techniques in Genetic Engineering

Brief account of the structure and functions of DNA and RNA, Recombinant DNA Technology: Enzymes (restriction endonucleases, DNA ligase, exonucleases and DNA polymerases), cloning vectors. Gene identification and isolation; genomic library, cDNA library, environmental genomics/metagenomics. Introduction of genes into new hosts using plasmid and phage vector. Gene transfer methods in bacteria and plants.

Unit-II: Biogeotechnology and Waste Gas Treatment

Xenobiotics compound: persistence and biomagnification. Bioleaching of metals: characteristics of commercially important microbes, mechanisms of bioleaching and current biomining processes. Biobeneficiation of gold ores. Biodesulfurization of coal. Biological treatment of waste gas (polluted air), Genetically Modified Organism (GMOs) and their impact on the environment.

Unit-III: Fermentation Technology

Bioreactor: basics, types and application. Use of natural and genetically engineered microorganisms from extreme environment like thermophiles, alkalophiles, acidophiles and halophiles in industrial applications. Production of enzymes like cellulase, proteases, and amylases for acetic acid production, Production of renewable and alternative sources of energy: bio-hydrogen, biodiesel and bioethanol.

Unit-IV: Biofertilizers and Biopesticides

Nitrogen fixation mechanism (biochemistry of nitrogenase, genetics of nitrogen fixation and regulation of nif genes expression), Bio-fertilizers: types, benefits, application and future prospects, Biopesticides: concept, categories, development and utilization in pest management. Bioremediation: concept, types of bioremediation technology, application of bioremediation in agricultural and industrial waste treatment.

REFERENCES

1. Alexander M (1999) Biodegradation and Bioremediation, 2nd edition, Academic Press
2. Brown T A (2012) Gene Cloning and DNA Analysis: An Introduction 6th Edition, Wiley
3. Fulekar M H (2010) Environmental Biotechnology - Theory and Application. CRC Press. Science Publisher, USA
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ENVIRONMENTAL POLLUTION AND HEALTH

(SIAS EVS 01 02 03 GE 4004)

Course title: Environmental Pollution and Health

Course objective: To provide deep knowledge of the effect of environmental pollution on human health

Learning outcomes:

- It will be helpful for student to analyze types of pollution, sources, their effects on human health and protective measures taken to mitigate the pollution
- Develop understanding regarding different diseases caused due to environmental (air, water, soil etc.) pollution
- Examine the correlation between environmental pollution and human health

Course content:

Unit-I: Air Pollution

Air pollution: types and major sources of air pollution, physico-chemical and biological effects of air pollutants on surrounding atmosphere, air borne diseases and their effects on human health, Indoor air quality and its effect on human health, Ventilation: standards, methods and health hazards. National and International ambient air quality standards for air quality monitoring, Air pollution control techniques

Unit-II: Water Pollution

Water pollution- types and major sources of water pollutants, physico-chemical and biological effect of water pollutants on water bodies, water borne diseases and infections, national and international water quality standards for drinking purpose and domestic use. Methods used for water purification

Unit-III: Noise Pollution

Noise pollution: basics of sound, concept of sound pressure level and decibel scale, sources of noise, concept of equal loudness contours and frequency weighting networks, percentile indices of noise and the concept of Equivalent Continuous Sound Level (Leq), noise measurement: sound level meter, direct and indirect effects of noise on human health, national and international standards for noise exposure levels, noise control methods.

Unit-IV: Radiation, Soil pollution and Environmental Health

Radiation pollution: sources, effect on human health and protection, Soil pollution- sources, effects, Uptake, bioaccumulation, bio-transformation and excretion of xenobiotic, Vector-borne diseases: transmission and control, impact of fleas, ticks and mites on human health, Environmental Health Management, Pollution control in India in the context of human health

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6. Santra S C (2016) Environmental Science. New Central Book Agency
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BIODIVERSITY CONSERVATION AND WILDLIFE MANAGEMENT

(SIAS EVS 01 02 04 GE 4004)

Course title: Biodiversity Conservation and Wildlife Management

Course objective: To aware the students about the biodiversity and wildlife, its importance, status and need of worldwide efforts in its conservation.

Learning outcomes:

- The students will get the knowledge about trends of biological diversity and conservation strategies and thereafter be able to create awareness for its conservation and development.
- Knowledge of value aspects of the wildlife on the earth ecosystem
- Knowledge of various protected areas and role of various bodies in the protection of wildlife

Unit-I: Introduction

Concepts and components of biodiversity, types of diversity, Importance of biodiversity: aesthetic, cultural and ecosystem services, biodiversity informatics, biodiversity values, biodiversity losses, In-situ conservation: sanctuaries, biospheres reserves, national parks, preservation plots. Ex-situ conservation: captive breeding, botanical gardens, zoos, aquaria, homestead garden, herbarium;

Unit-II: Mega Diversity Zones and Biodiversity Hotspots

Concepts, distribution and importance of mega-diversity zones, Biogeographic regions Biodiversity hotspots, National and global red data lists, Categories of species and their management, Restoration of biodiversity, Acceleration of ecological succession, Reintroduction of biota. Methods for inventorying and monitoring biodiversity trends, Habitat evaluation.

Unit-III: Values of Wildlife

Concept of wildlife, Importance of wildlife in nature, Factors influencing wildlife management such as habitats, population, behavior, food-habits, health, etc., Common flora and fauna of India. Tools for data collection and analysis. Preservation of Breeding Stock; Artificial stocking; Habitat Improvement, Game Farming.

Unit-IV: Planning and Implementation of Conservation Programmes

Indian wildlife IUCN Categories, National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Ecological basis of wild life conservation and management, Special projects for

endangered species (Project tiger, Gir lion Sanctuary Project, Crocodile breeding project, sea turtle conservation), International trade of wildlife, Animal cruelty: causes and prevention, Role of local communities in wildlife management, National and international programmes for biodiversity conservation.

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SEMESTER-III

PHYSICAL ENVIRONMENT

(SIAS EVS 01 03 12 C 4004)

Course title: Physical Environment

Course objective: To make the students familiar with the physical environment that includes air, water, soil, mountains, climate, humidity, temperature, sunlight, etc., and problems concerned and mitigation measures.

Learning outcomes:

- It will increase students' knowledge related to aquatic and terrestrial environment, earth processes, different resources and climate change related issues.
- It will be helpful for the students to enhance knowledge of remote sensing and GIS and their use for the coverage, identification and interpretation of environmental components and associated information.
- They will able to understand different climate change related issues

Course content:

Unit-I: Atmospheric Environment

Atmosphere: composition and vertical distribution of temperature, earth and sun relationship, Insolation and heat budget of earth, Scales of meteorology, hydrostatic equilibrium, Hypsometric equation, Potential temperature, lapse rates, water vapor in the air, Humidity, relative humidity, specific humidity, absolute humidity, mixing ratio, and vertical stability of atmosphere, clouds (classification and formation), circulation in the atmosphere, winds, wind roses, air masses and classification, Coriolis force, global pressure belt system and monsoons, Cyclone, El Nino and La Nino, Impacts of El Nino on Indian monsoon.

Unit-II: Aquatic and Terrestrial Environment

Global water balance. Ice sheets and fluctuations of sea levels. Origin and composition of sea water. Hydrological cycle. Inland water bodies (lakes, streams, rivers, estuaries and wetlands). Rocks; Igneous, sedimentary and metamorphic rocks, weathering, erosion, transportation and deposition of earth`s material through running water, wind, glaciers. Interior of the earth- minerals and rocks- earth processes- plate tectonics, sea-floor spreading, mountain building, rock deformation.

Unit-III: Introduction to Remote Sensing and GIS

Introduction, Types of Remote Sensing, Fundamental concepts of Remote Sensing and GIS, EMR spectrum, Radiation laws, Elements of photographic systems, Types of sensors, Image classification, Image processing, Aerial photo interpretation. Normalized difference vegetation index (NDVI), Basic principles of photogrammetry, Multispectral, Thermal, and Hyperspectral Sensing, Spectral reflectance, Vegetation, Soil and Water. Transmittance, Absorbance. Application of Remote Sensing and GIS in environmental management (Land use; Wastelands; Forest, Water resources, Wildlife habitat)

Unit-IV: Global Climate Change

History of Climate Change, Causes of Climate Change, Milankovitch's theory of Climate Change, Greenhouse gases and their effects, Role of humans on Climate Change, Urban climatology, Climatic -Feedback Mechanisms and Possible Impacts of global Climate Change, World Climate, Koppen Classification of Climate.

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ENVIRONMENTAL POLICY AND LAW
(SIAS EVS 01 03 13 C 4004)

Course title: Environmental Policy and Law

Course objective: To acquaint the students with the environmental issues and the measures taken for its protection along with the norms prevailing at international and national level.

Learning outcomes:

- Students will be able to get basic knowledge of environment, pollution and various principles.
- Students will be able to get the knowledge about constitutional provisions for the protection of environment.
- Students will get the knowledge about the Environment (protection) Act, powers of central government and state government to make laws and Environment Tribunals.

Course contents:

Unit-I: Introduction to Environmental Legislations

Environment protection: Issues and Problems; International and National efforts for Environment Protection; General Principles in Environmental Law: Precautionary Principle; Polluter Pays Principle; Sustainable Development, Constitutional provisions of Constitution of India regarding Environment (Article 48A, 51A(g) and 253).

Unit-II: National & Global Environmental Initiatives

International Initiatives towards Environmental Protection: Stockholm Conference, Earth Summit, World Summit on Sustainable Development, Rio+20, Ramsar Convention, Vienna Convention, Montreal Protocol, Kyoto Protocol; Sustainable Development Goals; Eco-mark scheme, Creation of UNEP and its role, UNFCCC, Convention on Climate Change, CoPs, CDM, Convention on Conservation of Antarctic Marine Living Resource.

Unit-III: Environmental Laws & Legislations

The Water (Preventions and Control of Pollution) Act, 1974; National Water Policy, 2002; Air (Prevention and Control of Pollution) Act, 1981; Environmental (Protection) Act, 1986; National

Environmental Policy, 2006; Motor Vehicle Act, 1988 (Environmental Aspects Only); Public Liability Insurance Act, 1991; Coastal Regulation Zone (CRZ) Notification, 1991; Noise Pollution (Regulation and Control) Rules, 2000

Unit-IV: Legislation Related to Biodiversity

National Forest Policy, 1988; Wildlife Protection Act, 1972 and Amendments; Forest Conservation Act, 1980; Indian Forest Act, Revised 1982; Biological Diversity Act, 2002;

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ENVIRONMENTAL HEALTH AND TOXICOLOGY

(SIAS EVS 01 03 14 C 4004)

Course title: Environmental Health and Toxicology

Course objective: To aware students about the need of suitable environmental conditions essential for survival otherwise may create harmful impact in the forms of diseases and disorders.

Learning outcomes:

- It will be helpful for students to understand different types of toxicants in the environment and how they could be reached to human being and cause different diseases.
- Instead, the students will know about biotransformation of xenobiotics compounds.
- Information related to genetic disorders produced due to certain toxic substances that may be present in the environment.

Course contents:

Unit-I: Principles of Toxicology

Environmental Toxicology: Definition and Its Importance; Occurrence of Toxicants and their Effects; Exposure, Uptake, Transportation, Storage, Metabolism and Excretion of Toxicants

Unit-II: Pollution and Human Health

Trace Element Deficiency and Disorders; Occupational Health Hazards; Biogeochemical Factors in Environmental Health; LD50, LC50; Epidemiological Issues: Goiter, Fluorosis, Itai-itai, Acute and chronic Arsenic toxicity, Blackfoot disease, Arsenicosis, Minamata.

Unit-III: Biotransformation: Metabolism of Xenobiotics

Biotransformation: Types and Mechanism; Characteristics of Biotransformation; Consequence of Biotransformation; Biotransformation of Endogenous Substances; Activation of Xenobiotic; Factors Affecting Biotransformation; Induction; Genetic Polymorphisms.

Unit-IV: Genetic Toxicology

Carcinogenesis: Carcinogens, Chemical Carcinogenicity, Mechanism of Carcinogenicity; Oncogenes and Tumor Suppressor Genes; Mutagenicity: Mutagens, Concept of Bioassay;

Environmental Mutagen Testing: Bacterial Mutagenesis Assays, Gene Mutation Chromosome Damage Assays, DNA Damage and Repair Assays.

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PRACTICAL – III
ENVIRONMENTAL MONITORING & ANALYSIS
(SIAS EVS 01 03 15 C 0055)

Course title: Practical-III (Environmental Monitoring & Analysis)

Course objective: To make the students capable in monitoring and analysis of the physical and chemical parameters to know various changes, which may be harmful for the living beings as well as the environment.

Learning outcomes:

- The students will acquire the knowledge of various physiochemical parameters in the environment (air, water, soil, etc.).
- They will also gain the information about different laboratory equipment and instruments, etc., and
- Participating in solving many environmental problems related to the analyzed parameters.

Course contents:

Unit-I: Determine Air Pollutants (Two exercises to be given)

1. PM_{10}; 2. $PM_{2.5}$; 3. NO_x; 4. SO_2; 5. CO; 6. O_3; 7. NH_3

Unit-II: Use of Flame Photometer and Spectrophotometer

Estimation of alkali metals in various samples by flame-photometry, calculate the lambda max of the given compound by UV-Vis spectrophotometer.

Unit-III: Microbial Studies (Two exercise to be given)

Media preparation, Sterilization, inoculation, Cultivation, Preparation of nutrient broth, Isolation and enumeration of soil bacteria and fungi, Grams staining of Lacto bacilli

Unit-IV: Microbes in Water Samples

Inoculation of polluted water sample, Standard Plate Count, Standard Coliform Test, MPN Test, Fecal Coliform test, Enumeration of Fecal Streptococci, Membrane Filtration Technique

SUMMER TRAINING (REPORT AND PRESENTATION)
(SIAS EVS 01 03 16 C 0001)

Course title: Summer Training (Report and Presentation)

Course objective: To get exposure to science laboratories and the working strategies and writing skills outside the campus

Learning outcomes:

- Knowledge about the science which is going on in the science laboratories in the interesting field
- Learning of writing skills
- Learning of presentation skills

Every student, who has been enrolled in M.Sc. (Environmental Science) programme, shall have to attend summer training for 04-06 weeks in different organizations related to the environment and prepare a report and also deliver a presentation of summer training work as per the master degree programme. The presentation will be of 20-25 minutes duration during which the presentation will be followed by a questions session by the audience comprising of faculty and students of the departments. Every student shall be required to submit the topic of his/her training to the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board.

WATER QUALITY MANAGEMENT
(SIAS EVS 01 03 04 DCEC 4004)

Course title: Water Quality Management

Course objective: To provide basic understanding of the usage of technical and non-technical measures and activities, to maintain and improve the water quality according to the requirement

Learning objectives:

- Select and apply appropriate methods to assess water quality in natural waters in relation to their anticipated use
- Design and evaluate water quality monitoring networks for different types of surface and groundwater in relation to set objectives.

Unit I: Introduction

Linking water quality & health; impurities in water, their significance and estimation techniques; water borne diseases; standards of potable water. Impact of water pollutants on environment; self-purification of waste in streams; zones of purification; eutrophication.

Unit-II: Water Treatment

Aeration and types of aerators; purpose and mechanism of flocculation; coagulants used in water treatment; factors influencing coagulation; estimation of coagulant dose; types of flash mixers and flocculators; sedimentation; sedimentation tanks; filtration; types and design of filters; operational issues in filtration; chemical and non-chemical methods of disinfection; factors effecting efficiency of filtration; chick's law, tertiary treatment methods for removal of color, salinity, hardness, fluorides, Arsenic, iron and manganese (using adsorption, RO; Electro-dialysis; ion-exchange; chemical; and distillation techniques).

Unit-III: Wastewater Treatment

Physical treatment methods-screen chamber; grit separators; primary and secondary settling tanks. Biological treatment: Biology of sewage treatment; BOD growth curve and analysis; estimation of BOD rate constant; types of biological treatment processes; process description and design principals; removal of nitrogen and phosphorus. Sludge stabilization and dewatering systems; Low cost sewage treatment technologies-septic tanks; reed bed; oxidation ponds and lagoons.

Unit-IV: Water Resources and Quality Management in India

Water availability; water stress index; status and trend of surface and groundwater; issues and policy interventions; pollution of rivers, lakes and groundwater; GAP and National River Action Programme; role of national and international agencies in water health and sanitation.

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NATURAL DISASTER MANAGEMENT
(SIAS EVS 01 03 05 DCEC 4004)

Course title: Natural Disaster Management

Learning objectives: To provide basic conceptual understanding of disasters and its relationships with development. To understand approaches of Disaster Risk Reduction (DRR) and the relationship between vulnerability, disasters, disaster prevention and risk reduction.

Learning outcomes:

- Students can analyze and evaluate the environmental, social, cultural, economic, legal aspects influencing the vulnerabilities and capacities to face disasters.
- To enhance awareness of Disaster Risk in relation to Indian scenario.
- Students have the knowledge of earthquake distribution, early warning systems, seismic structural awareness and hazard mitigation.

Course contents:

Unit-I: Introduction to Hazards

Hazard Classification – Natural hazards and Technological hazards; Effects of Hazards; Vulnerability and Susceptibility of Hazards; Hazards and Risk Assessment; Hazard Prediction and Warning; Biological Hazards: Biological Warfare, Anthrax;

Unit–II: Earthquakes and Landslides and Volcanoes

Earthquakes: Types and Distribution of Earthquakes, Prediction and Control of Earthquakes, Tsunami, Mass Movements: Types, Factor affecting, Prevention & Control; Volcanoes: Distribution, Types, Eruption Processes and Products.

Unit-III: Water Related Hazards

Flood: Types, Leading Factors and Associated Hazards, Flood Control Measures, Prediction of Floods; Drought: Leading factors, Consequences and Strategies for Drought Mitigation; Desertification: Causative agents, effect and associate hazards; Famine; El Nino and La-Nina, Impact on global economy and Climate, Environmental disasters: Minamata disaster, Love canal disaster.

Unit-IV: Weather Related Hazards

Tropical Cyclone: Introduction, Anatomy, Life cycle, patterns of tropical cyclones, Effects and Forecasting, Cyclone Risk and Mitigation Strategies; Storm Surge, Tornadoes; Thunderstorms; Lightening.

REFERENCES

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ENVIRONMENTAL MICROBIOLOGY
(SIAS EVS 01 03 06 DCEC 4004)

Course title: Environmental Microbiology

Course objective: Understand the role of microbes in biogeochemical processes in different ecosystems

Learning outcomes:

- Basic microbiological principles, the methods in microbial ecology
- Theoretical and practical application in the field of environment.
- Learning of different experimental techniques

Unit-I: General and Aquatic Microbiology

Classification, characteristics, occurrence and distribution of microorganisms. Microbial cultivation and growth. Role of Microorganisms in Wastewater and Water Treatment: Microbial mats, Bio-films; Bioassay tests for toxicity evaluation, Pathogens and Indicator microorganisms; Eutrophication of water bodies.

Unit-II: Soil Microbiology

General characteristics and activities of microorganisms in surface soil, Mineralization and Immobilization of soil nutrients, Microbial degradation of cellulose, hemicelluloses and lignin. Microbes in Agriculture- Biological nitrogen fixation, bio-fertilizers, Mycorrhiza and their environmental significance. Microbe mediated C, N and S transformations.

Unit-III: Food Microbiology

Foodborne infections: bacterial (Clostridium, Salmonella, Shigella, Staphylococcus), Mycotoxins in food with reference to Aspergillus species. Genetically modified foods. Microbes in food production. Applications of microbial enzymes in food industry

Unit-IV: Applied Environmental Microbiology:

Bioremediation: principle and mechanisms, types and environmental applications. Specific Processes: Biodegradation of pesticides and hydrocarbons, Bio-hydrometallurgy, Microbial Enhanced Oil Recovery, Biodegradable Plastics, Biosurfactants. Release of genetically engineered microbes and environmental risk.

REFERENCES

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SUSTAINABLE DEVELOPMENT AND RESOURCE MANAGEMENT
(SIAS EVS 01 03 05 GE 4004)

Course title: Sustainable Development and Resource Management

Course objective: Resource management strategies and a critical insight of the major sustainability issues It aims to provide fundamental knowledge about the natural resources, their importance, and need of preservation, effective.

Learning outcomes:

- Engages students with sustainability-related issues as described in the SDGs, individuals becomes sustainability change-makers.
- The understanding of issues concerning different natural resources will be helpful to find scientific solution based on participatory approach to achieve their sustainable use as well as proper management.
- Develop a future-oriented perspective that highlights the significance of their decisions, choices and actions on the quality of life of present and future generations.

Unit-I: Introduction to Sustainable Development

Principles of Sustainable Development: History and emergence of the concept of Sustainable Development, Environmental issues and crisis: greenhouse gases, desertification, etc. International Contribution: International Summits, Conventions, Agreements, Action plan for implementing sustainable development.

Unit-II: Natural Resources and Conservation

Natural Resources: Concept and Classification of Natural Resources; Factors influencing resource availability, distribution and uses; Mineral Resources***:*** Mineral Resources and Reserve; Mineral exploration and exploitation, Environmental impacts of mineral extraction; Oceanic Minerals: Exploration prospective and Impacts: forest management strategies, strategies of water conservation; rain water harvesting; soil resources: importance of soil, soil conservation strategies; food resources: world food problem, green revolution.

Unit-III: Non-renewable and Renewable Energy Resources

Fossil Fuels: Classification, Composition, Characteristics of Coal, Petroleum and Natural Gas; Renewable Energy Resources: Overview and Principal of generation and Environmental

Implications of renewable Energy: Hydropower, Tidal Energy, Ocean Thermal Energy Conversion (OTEC), Wind Energy, Geothermal Energy, Solar Energy (Solar Collector, Photo-voltaic Modules, Solar Ponds), pros and cons of Nuclear Energy (Fusion & Fission), Bioenergy; Energy use pattern in India and the World.

Unit-IV: Sustainable Resource Management

Approaches in resource management: ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies; concept of sustainability science: different approaches towards sustainable development and its different constituents; sustainability of society, resources and framework; sustainable energy strategy; principles of energy conservation; Energy use pattern in India and the World.

REFERENCES

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2. Boyle G (2012) Renewable Energy: Power for a Sustainable Future. 3rd ed. Oxford: Oxford University Press and Open University.
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AGRICULTURE AND ENVIRONMENT

(SIAS EVS 01 03 06 GE 4004)

Course title: Agriculture and Environment

Course objective: To learn about the basic concept of agriculture and environment and how to correlate these two for the sustainable use of natural resources

Learning objectives:

- Develop understanding about, how the environment influences the agricultural sector
- To prevent, control and contain diseases, vectors and pests in order to enhance agricultural production and productivity
- The students will be informed about the impact of climate change on agriculture

Course content:

Unit-I: Agricultural Practices

Sustainable Agriculture, Organic Farming, Hydroponic Greenhouse/Glasshouse agriculture practices, Dry-land Farming, Zero Tillage, Agro-forestry, Social Forestry Irrigation Practices, Water Logging and Secondary Salinization, Environmental Impacts of Irrigation Projects.

Unit-II: Crop Protection

Pesticides: Classification, Pesticide Resistance; Biological and Ecological Pest Control, Integrated Pest Management, Pesticide Safety. Biopesticides, characteristic of Bacillus Thuringiensis, Plant Incorporated Protectants (PIPs)

Unit-III: Crop Production

Bio-fertilizers, applications and future prospects, Integrated nutrient management, NPK Fertilizers and Their Environmental Effects, Vermicomposting, Allelopathy, Biotechnological Innovations in Crop Protection.

Unit-IV: Sustainable Agriculture

Agriculture and Food Security; Green-Revolution: Environmental Implications, Impact of climate change and modernization in agriculture, genetically modified crops, participatory approach of modern agriculture, Organic farming, Role of microorganisms in sustainable agriculture and environment

REFERENCES

1. Gardiner D T, Miller R W (2008) Soils in our environment. Upper Saddle River, New Jersey: Pearson/Prentice Hall
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SEMESTER-IV

DISSERTATION (RESEARCH WORK, SEMINAR, REPORT AND VIVA-VOCE)

(SIAS EVS 01 04 01 SEEC 002020)

Course title: Dissertation (Research work, Seminar, Report and Viva voce)

Course objective: Skill Enhancement Elective Course (Compulsory and exclusively for M.Sc. (Environmental Science) students). To get exposure to science laboratories and the working strategies and writing skills in or beyond the campus

Learning outcomes:

- Knowledge about the science which is going on in the science laboratories in the interesting field
- Experience to work in laboratory on a local environmental problem
- Learning of writing skills

Every student will be required to undertake a research project based on any of the areas of Environmental Sciences. The project report will be submitted in the form of dissertation duly certified by the Head of the Department. The project will be presented for evaluation at the end of semester by the internal and external examiners.

RESEARCH METHODOLOGY AND WRITING SKILLS

(SIAS EVS 01 04 17 C 4004)

Course title: Research Methodology and Writing Skills

Course objective: To provide an understanding of methods of research and writing of the report

Learning outcomes:

- It will improve research knowledge of the students
- They will able to identify different environmental problems
- Help to understand publication of the data

Course content:

Unit-I: Introduction of research

Meaning and objective of research, types of research, research problems, review of literature, methodology, primary and secondary data, discussion, references, significance of research, selection of research topic, abstract and key words.

Unit-II: Steps in research

Defining a problem, sampling types and design, preparation for the survey and field visit, questionnaire, probability and non-probability sampling, samples storage, standard preparation, digestions of samples, analysis of the samples

Unit-III: Data interpretation

Arrangement of the data, measurement of the central tendency, standard deviation, linear regression, correlation, ratio and percentage, t-test and chi-square test, use of excel formulae, diagrammatic and graphical representation of the data.

Unit-IV: Report writing

Steps of report writing, major findings, conclusions, suggestions, copyright issues, plagiarism, citations, references, bibliography, writing and publication of report.

REFERENCES

1. Dharmapalan B (2012) Scientific Research Methodology. United Kingdom: Alpha Science International
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6. Learning Outcome Index, Core Courses

PSO	CC-1	CC-2	CC-3	CC-4	CC-5	CC-6	CC-7	CC-8	CC-9	CC-10	CC-11	CC-12	CC-13	CC-14	CC-15	CC-16	CC-17
PSO-1		X	X	X	X	X			X		X	X	X				
PSO-2		X	X	X	X	X					X		X				
PSO-3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PSO-4							X	X	X	X	X	X			X		x
PSO-5					X			X					X			X	
PSO-6			X	X	X		X	X	X				X			X	
PSO-7					X				X				X			X	x
PSO-8	X	X				X	X	X	X	X	X			X	X	X	
PSO-9			X		X							X					x
PSO-10			X		X		X		X				X			X	

Learning Outcome Index, Elective Courses

PSO	CC-1	CC-2	CC-3	CC-4	CC-5	CC-6	CC-7	CC-8	CC-9	CC-10	CC-11	CC-12	CC-13
PSO-1		X	X	X		X		X	X		X	X	X
PSO-2		X			X	X	X	X	X		X	X	X
PSO-3	X	X	X	X	X	X	X	X	X	X	X	X	
PSO-4	X		X	X	X	X			X	X			
PSO-5	X				X		X			X		X	X
PSO-6	X	X		X	X	X	X		X	X	X	X	
PSO-7											X		
PSO-8			X		X	X				X			
PSO-9			X	X					X		X		
PSO-10	X					X							

7. Semester-wise Courses and Credit Distribution

Percentage of Core Subject, Elective Subject and Practical/Dissertation

Semester	Total Credit (Semester)	Department Offering	Core Subject		Elective Subject	
	Credits	Credits	Credit	(%)	Credit	(%)
I	25	33	21	64	12	36
II	25	33	21	64	12	36
III	26	34	22	65	12	35
IV	24	24	20	83	4	17

Online Classes of all Courses Offered by Our Department Including GEC, DCEC, Excluding GEC taken from other Departments

Semester	Total Credit	Credit F-F Mode	Credits Online Mode	Online Mode Credit (%)
I	33	21	12	36
II	33	21	12	36
III	34	22	12	35
IV	24	20	4	17

8. Course-level Learning Outcomes

The course level learning outcomes have been given in the scheme of syllabus. Depending upon the nature of the course, every course has planned with different learning outcomes.

9. Teaching-Learning Process

1. Lectures

2. PowerPoint slides

3. Classroom Discussions

4. Laboratory Practical

5.Anthropometric measurements and nutritional deficiency Problem Solving

6. Project Work

7. Presentations/Seminars

10. Blended Learning

Blended Learning is a pedagogical approach that combines face to-face classroom methods with computer-mediated activities in the process of teaching and learning. It implies nice blend of face-to-face and online activities to make the learning processes more interesting and engaging. It focuses on integration of traditional classroom activities and innovative ICT-enabled strategies. It emphasises student-centric learning environment where the teacher is the facilitator for productive and measurable learning outcomes. It optimises and compliments the face to face learning, giving ample freedom and flexibility to the students and teachers to access and explore the wide range of open-access sources such as video lectures, podcasts, recordings and articles through digital platforms. It gives freedom and autonomy to the teachers in selection of appropriate digital platforms, resources and time-slots to complement and supplement face to face learning. The Blended Learning doesn't undermine the role of the teacher, rather it gives him/her an opportunity to explore the unexplored in accordance with the requirements of the curriculum.

11. Assessment and Evaluation

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills

- Group Examinations on Problem solving exercises
- Seminar Presentations
- Multiple Choice Questions (MCQ)
- Surprise Quizzes
- Problem Solving Tasks

12. Keywords

- LOCF
- NEP-2020
- Blended Learning
- Face to face (F to F) Learning
- Programme Outcomes
- Programme Specific Outcomes
- Course-level Learning Outcomes
- Postgraduate Attributes
- Learning Outcome Index
- Formative Assessment and Evaluation
- Comprehensive and Continuous Evaluation

13. Appendices

1. Curricular Reforms— Extracts from National Education Policy-2020

14. References

2. National Education Policy-2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
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